1-1-2008

Justification for Class III Permit Modification January 2008 SWMU 28-2 Operable Unit 1332 Mine Shaft

Sandia National Laboratories/NM

This work supported by the
United States Department of Energy
under contract DE-AC04-94L85000.

SWMU 28-2
Mine Shaft

Environmental Restoration Project

Site History

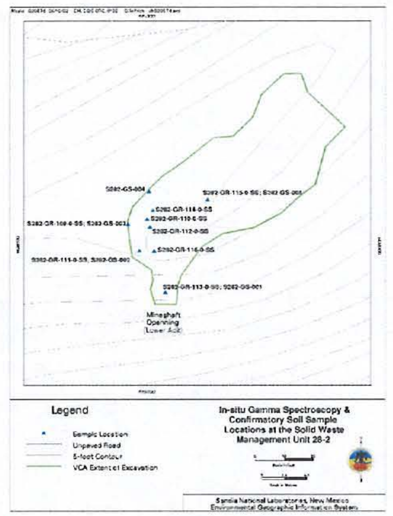
- SWMU 28-2 is one of 10 mines identified as SWMU 28 Mine Shafts in the Foothills Test Area. SWMU 28-2 is situated in the U.S. Forest Service Withdrawn Area near the southeast corner of Kirtland Air Force Base.
- SWMU 28-2 is an abandoned mine where activities took place in the early to mid-1900s. Based on interviews of SNL/NM personnel, it was used for experimental testing and possible disposal activities.
- Depleted uranium was found immediately beneath the ground surface outside the mine when a barrier was being installed in 2001 to secure the opening of the mine shaft from entry.

Depth to Groundwater

- The depth to groundwater at the site is not known, as there are no wells in the immediate vicinity, but it is likely to be greater than 100 ft bgs (based on drilling at this site).

Constituents of Concern

- Metals
- HE Compounds
- Radionuclides



Photograph of depleted uranium removed from near the entrance to SWMU 28-2.

Photograph of in situ gamma spectroscopy measurement at SWMU 28-2

Photograph of the sealed mine entrance at SWMU 28-2

Summary of Investigations

- In April 1998, 12 soil samples were collected from inside the mine as part of the RFI. The soil samples were analyzed for the COCs.
- In December 2001, while installing a barrier to the entrance, depleted uranium was found outside of the mine entrance.
- In July 2002, a VCA was conducted to remove the depleted uranium. An initial radiation walkover survey was conducted to identify anomalies. The anomalies and surrounding contaminated soil were removed. A confirmatory radiation walkover survey was conducted to verify that the site was successfully remediated. Following the confirmatory radiation survey, five in situ soil gamma spectroscopy measurements were taken, and eight confirmatory soil samples plus one duplicate were collected and analyzed for the COCs. The insitu gamma spectroscopy measurements revealed activities for uranium-238, the indicator radionuclide, in the remaining soil are slightly above or consistent with the background level of 2.31 pCi/g.

Summary of Data Used for NFA Justification

- Twenty soil samples plus one duplicate collected in 1998 and 2002 were used in the risk assessment for SWMU 28-2.
- HE was detected in all of the samples collected in 1998. Ten samples contained 1,3,5-trinitrobenzene at concentrations ranging from 140 J to 200 µg/kg. Six samples contained hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) at concentrations ranging from 150 J to 220 J µg/kg. No detectable levels of HE were found in the VCA confirmatory samples collected in 2002.
- Arsenic was detected above the background concentration in two samples collected in 1998 and in two samples collected in 2002 at concentrations ranging from 10.1 to 20.5 mg/kg. Beryllium was detected above the background concentration in all of the samples collected in 2002 at concentrations ranging from 0.863 to 1.23 mg/kg. Beryllium was not detected above the background concentration in any of the samples collected in 1998. Barium was detected above the background concentration in two samples collected in 1998 and in eight samples collected in 2002 at concentrations ranging from 274 to 1,880 mg/kg. Chromium was detected above the background concentration in two samples collected in 2002 at a maximum concentration of 22.2 mg/kg. Chromium was not detected above the background concentration in any of the samples collected in 1998. Lead was detected above the background concentration in all samples collected in 1998 and 2002 at concentrations ranging from 74.8 J to 484 mg/kg. Eleven samples collected in 1998 contained detectable mercury above the background concentration, and all the samples collected in 2002 contained elevated mercury at concentrations ranging from 0.0601 to 1.02 mg/kg. Silver was detected above the background concentration in two samples collected in 2002 with a maximum value of 1.78 mg/kg, but was not detected in any of the samples collected in 1998.
- Uranium-238 had MDLs above background activity levels in two samples collected in 1998; six samples collected in 2002 had activities ranging from 2.4 to 452 pCi/g which are above the background activity. Thorium-232 was detected above background activity levels in three samples collected in 1998 and in all of the samples collected in 2002 with activities ranging from 1.08 to 1.77 pCi/g. All cesium-137 activities for samples collected in 1998 and 2002 were below the NMED-approved background activity level. All of the samples collected in 2002 contained uranium-235 activities or MDAs above the approved background activity level, with MDAs ranging from 0.228 to 7.12 pCi/g; all of the samples collected in 1998 had associated MDAs above the approved background activity levels with MDAs ranging from 0.232 to 0.349 pCi/g.

Recommended Future Land Use

- Recreactional land use is established for Site 28-2

Results of Risk Analysis

- Risk assessment results for the residential scenario are calculated per NMED risk assessment guidance in 2003 as presented in the "Supplemental Risk Document Supporting Class 3 Permit Modification Process".
- Because COCs were present in concentrations or activities greater than background-screening levels or because constituents were present that did not have background-screening levels, it was necessary to perform a risk assessment for the site. The risk assessment analysis evaluated the potential for adverse health effects for a residential land-use scenario.
- The maximum concentration value for lead was 484 mg/kg. The EPA intentionally does not provide any human health toxicological data on lead; therefore, no risk parameter values could be calculated. The NMED guidance for lead screening concentrations for construction and industrial land-use scenarios are 750 and 1,500 mg/kg, respectively. The EPA screening guidance value for a residential land-use scenario is 400 mg/kg. The maximum concentration for lead at this site is greater than the residential screening value. However, because the site had been adequately characterized, using the 95% UCL of the mean lead concentration (259.6 mg/kg) is lower than all the screening values; therefore, lead was eliminated from further consideration in the human health risk assessment.
- The human health incremental TEDE under a recreational land-use scenario is 1.8 mrem/yr, which is significantly less than the EPA numerical guidance of 15 mrem/yr. The human health incremental TEDE under a residential land-use scenario is 3.2E-1 mrem/yr, which is significantly less than the numerical guidance of 75 mrem/yr. Therefore, SWMU 28-2 is eligible for unrestricted radiological release.
- The total human health HI calculated for nonradiological COCs is 1.46 for a residential land-use scenario, which is greater than the NMED guideline of 1. The total estimated excess cancer risk is 5E-5 for a residential land-use scenario, which is above the NMED guideline of 1E-5. The incremental HI is 0.96 (below the guideline), and the incremental estimated excess cancer risk is 2.02E-5 (above the guideline) for a residential land-use scenario.
- Although both the HI and estimated excess cancer risk are above the NMED guidelines for a residential land-use scenario, maximum concentrations were used in the risk calculations. Using the 95% UCL of the mean concentration of the main contributor to risk (arsenic), the incremental HI and excess cancer risk are reduced to 0.49, and 1.5E-7, respectively. Thus, using realistic concentrations in the risk calculations that more accurately depict actual site conditions reduces the incremental HI and estimated excess cancer risk to values below the NMED guidelines.
- Using the SNL ecological risk assessment methodology, the ecological risk for SWMU 28-2 is predicted to be low.
- In conclusion, human health risk under a residential land-use scenario and ecological risks are acceptable per NMED guidance. Thus, SWMU 28-2 is proposed for CAC without institutional controls.

Risk Assessment Values for SWMU 28-2 Nonradiological COCs

COC Name	Maximum Concentration/UCL Concentration (mg/kg)	Residential Land-Use Scenario[a] (Maximum Concentrations)		Residential Land-Use Scenario[a] (UCL Concentrations)	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Inorganic					
Arsenic	20.5/**10.3**	0.95	5E-5	**0.48**	**3E-5**
Barium	1880	0.36	--	0.36	--
Beryllium	1.23	0.01	1E-9	0.01	1E-9
Chromium, total[b]	22.2	0.10	1E-7	0.10	1E-7
Mercury	1.02	0.04	--	0.04	--
Silver	1.78	0.00	--	0.00	--
Organic					
1,3,5-Trinitrobenzene	0.2 J	0.00	--	0.00	--
RDX	0.22 J	0.00	5E-8	0.00	5E-8
Total		**1.46**	**5E-5**	**1.00**	**3E-5**

Note: UCLs are calculated only for risk drivers. UCL concentrations and associated risk are in **bold**.
[a]EPA (1989).
[b]Chromium, total considered to be chromium VI in risk calculations (most conservative)
– = Information not available.

For More Information Contact

U.S. Department of Energy
Sandia Site Office
Environmental Restoration
Mr. John Gould
Telephone (505) 845-6089

Sandia National Laboratories
Environmental Restoration Project
Task Leader: Brenda Langkopf
Telephone (505) 284-3272

Sandia National Laboratories

Justification for Class III Permit Modification

January 2008

SWMU 28-2
Operable Unit 1332
Mine Shaft

NFA Submitted September 1995
RSI Response Submitted June 1997
VCA Report Submitted April 2004

Environmental
Restoration
Project

United States Department of Energy
Sandia Site Office

Sandia is a multiprogram Laboratory operated by Sandia Corporation, a Lockhead Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-ACO4-94AL85000.

NFA

Department of Energy
Albuquerque Operations Office
Kirtland Area Office
P. O. Box 5400
Albuquerque, New Mexico 87185-5400

SEP 21 1995

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. David Neleigh, Chief
New Mexico and Federal Facilities Section
Multimedia Planning and Permitting Division
U.S. Environmental Protection Agency, Region VI
1445 Ross Avenue, Suite 1200, MS 6PD-N
Dallas, TX 75202-2733

Dear Mr. Neleigh:

Enclosed are two copies of the third set of No Further Action (NFA) proposals for 14 solid waste management units (SWMUs) from the Resource Conservation and Recovery Act (RCRA) Hazardous and Solid Waste Amendments (HSWA) Final Permit for Sandia National Laboratories/New Mexico (SNL/NM), ID No. NM5890110518.

Copies of these proposals are also being submitted for comment to the New Mexico Environment Department (NMED), Hazardous and Radioactive Materials Bureau. The Class 3 permit modification process will be initiated after regulatory comments are addressed.

If you have any questions, please contact John Gould at (505) 845-6089 or Mark Jackson at (505) 845-6288.

Sincerely,

George K. Laskar

for Michael J. Zamorski
Acting Area Manager

Enclosures

cc w/enclosures:
T. Trujillo, AL, ERD
L. Aker, AIP (2 copies)
W. Cox, SNL, MS 1147

cc w/o enclosures:
M. Jackson, KAO
J. Johnsen, KAO-AIP
C. Soden, AL, EPD
N. Morlock, EPA, Region VI
T. Roybal, SNL, MS 1147
M. Davis, SNL, MS 1147
T. Vandenberg, SNL, MS 0141
E. Krauss, SNL, MS 0141

PROPOSAL FOR NO FURTHER ACTION
Environmental Restoration Project

Site 28, Mineshafts
OU 1332

Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for the
United States Department of Energy

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

LIST OF ATTACHMENTS

1. Introduction

1.1 ER Site 28, Mineshafts

Sandia National Laboratories/New Mexico (SNL/NM) is proposing an administrative no further action (NFA) decision for Environmental Restoration (ER) Site 28, Mineshafts, Operable Unit (OU) 1332. ER Site 28, formerly included in OU 1297, was identified in the Hazardous and Solid Waste Amendment (HSWA) Module IV (Ref. 1) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518) (Ref. 2).

1.2 SNL/NM Administrative NFA Process

This proposal for a determination of an administrative NFA decision has been prepared using the criteria presented in Section 4.5.3 of the SNL/NM Program Implementation Plan (Ref. 3). Specifically, this proposal will "contain information demonstrating that there are no releases of hazardous waste (including hazardous constituents) from solid waste management units (SWMU) at the facility that may pose a threat to human health or the environment" (as proposed in the Code of Federal Regulations [CFR] Section 40 Part 264.51[a] [2]) (Ref. 4). The HSWA Module IV contains the same requirements for an NFA demonstration:

> Based on the results of the RFI [RCRA Facility Investigation] and other relevant information, the Permittee may submit an application to the Administrative Authority for a Class III permit modification under 40 CFR 270.42(c) to terminate the RFI/CMS [corrective measures study] process for a specific unit. This permit modification application must contain information demonstrating that there are no releases of hazardous waste including hazardous constituents from a particular SWMU at the facility that pose threats to human health and/or the environment, as well as additional information required in 40 CFR 270.42(c) (Ref. 1).

In requesting an administrative NFA decision for ER Site 28, Mineshafts, this proposal is using existing administrative/archival information to satisfy the permit requirements. A unit can be eligible for an administrative NFA proposal based on one or more of the following criteria taken from the RCRA Facility Assessment Guidance (Ref. 5):

- Criterion A: The unit has never contained constituents of concern (COCs).
- Criterion B: The unit has design and/or operating characteristics that effectively prevent releases to the environment.
- Criterion C: The unit clearly has not released hazardous waste or constituents into the environment.

Specifically, ER Site 28, which is comprised of ten individual mine sites, is being proposed for an administrative NFA decision because nine of the sites never contained hazardous waste or constituents (Criterion A), and one of the sites has not released hazardous waste or constituents into the environment (Criterion C).

1.3 Local Setting

ER Site 28 is comprised of ten locations where past mining activity took place. The mines included as ER Site 28 have long since been abandoned, or were never used beyond some very limited prospecting. The individual mine locations vary considerably, ranging from small prospector pits to vertical and horizontal shafts that extend from 50 to over 600 feet into the subsurface. Most of the mines are situated in fractured granite and metamorphic Precambrian-age rocks (hard rock mines) comprising the Manzanita Mountains, although one location is in younger Pennsylvanian-age limestone (Madera Formation) that lies directly over the Precambrian granite and metamorphics.

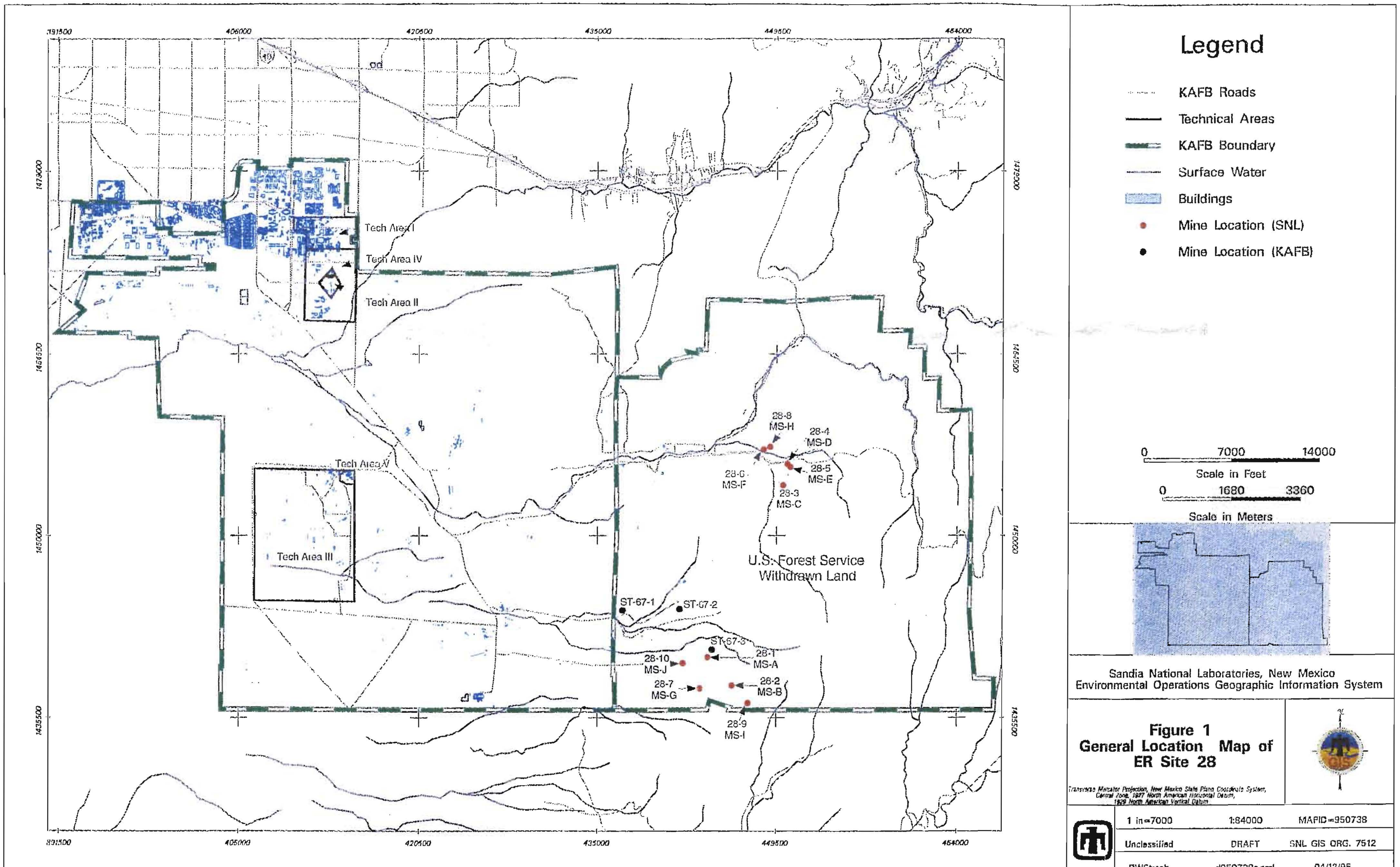
ER Site 28 (all ten locations, 28-1 through 28-10) is located in the south-central and central part of the United States Forest Service Withdrawn Area (withdrawn to Kirtland Air Force Base, here after referred to as the "Withdrawn Lands"). Figure 1 shows the general location of the ten sites within the Kirtland Air Force Base (KAFB) boundary. Figure 1a shows more precise locations of 28-1 through 28-10 and surface topography within the south-central part of the Withdrawn Lands. Figures 1 and 1a also show mine locations ST-67-1 through ST-67-3, which are KAFB mine sites that are being investigated under the KAFB Installation Restoration Program (IRP).

The southern portion of the Withdrawn Lands was used extensively by the military during World War II for ordnance testing (Ref. 6). Numerous shells, some of which may still be live, and pieces of shrapnel are scattered over much of the area. Personnel at KAFB determined that removal and/or disposal of the shells would be too costly. The shells are considered a United States Air Force (USAF) responsibility (Ref. 7).

2. History of the SWMU

2.1 Sources of Supporting Information

In preparation to request an administrative NFA decision for ER Site 28, a background study was conducted to collect available and relevant site information. Background information sources include records, reports, and investigative field notes/log books. Interviews were conducted with SNL/NM staff and contractors familiar with activities performed in the vicinity of these mines. Radiation surveys were conducted at all locations to determine if radioactive waste or materials were disposed of in the mines. The studies were documented and referenced in this report (Section 3.3 and 3.4).



Legend
KAFB Roads
Technical Areas
KAFB Boundary
Surface Water
Buildings
Mine Location (SNL)
Mine Location (KAFB)
0 7000 14000
Scale in Feet
0 1680 3360
Scale in Meters
Tech Area I
Tech Area IV
Tech Area II
Tech Area V
Tech Area III
U.S. Forest Service Withdrawn Land
28-8 MS-H
28-4 MS-D
28-6 MS-F
28-5 MS-E
28-3 MS-C
ST-67-1
ST-67-2
ST-67-3
28-10 MS-J
28-1 MS-A
28-7 MS-G
28-2 MS-B
28-9 MS-I
Sandia National Laboratories, New Mexico
Environmental Operations Geographic Information System
Figure 1
General Location Map of ER Site 28
1 in=7000
1:84000
MAPID=950738
Unclassified
DRAFT
SNL GIS ORG. 7512
DWStrech
d950738a.aml
04/12/95

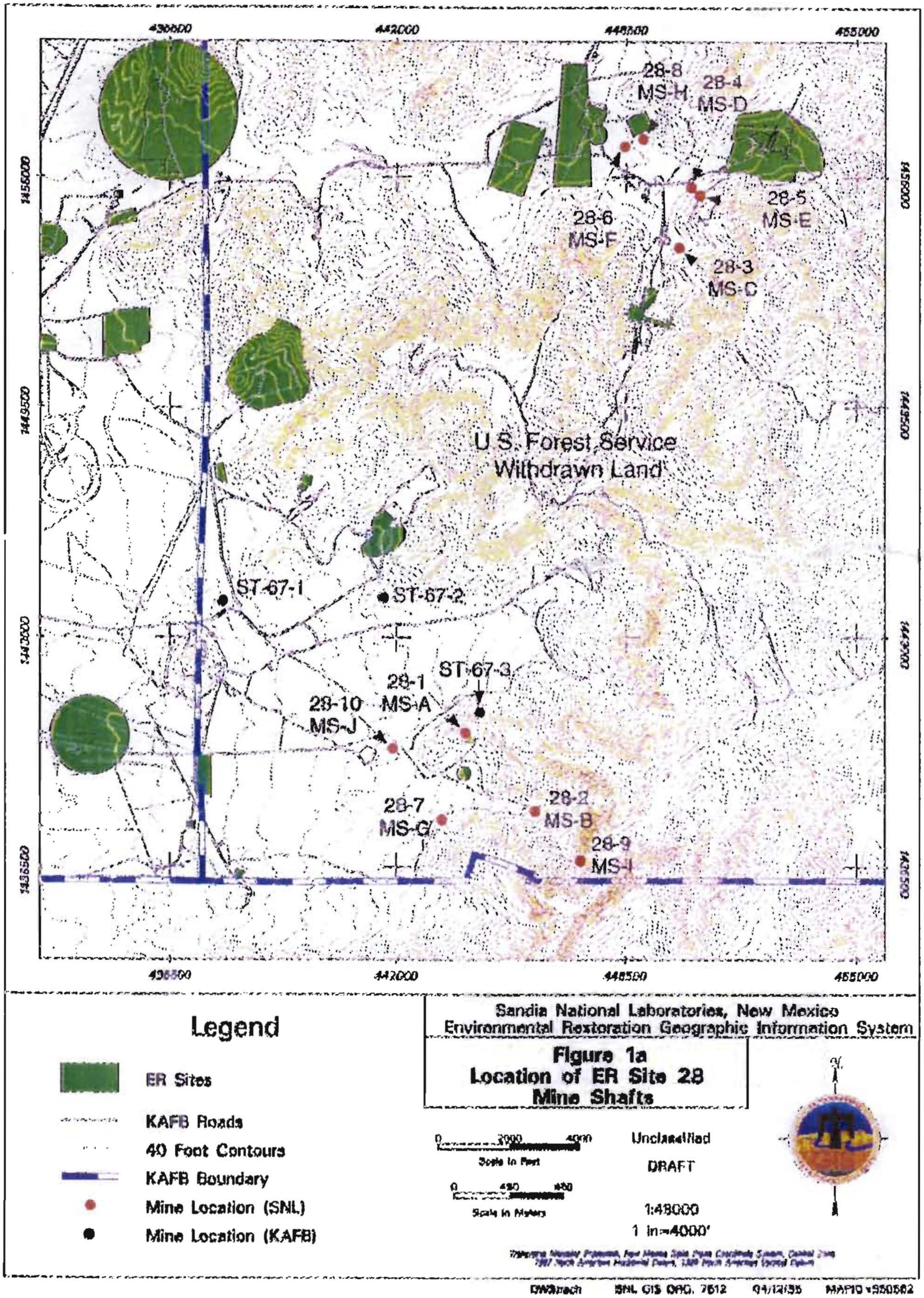


Figure 1a.
Location of ER Site 28 Mineshafts

The following information sources, listed in order of importance relative to this NFA proposal, were used in the evaluation of ER Site 28:

- Radiation survey report and field log book: document a detailed radiation survey of all of the ER Site 28 mine locations.

- Documented field inspections and mapping surveys of the mines:
  (1) SNL/NM Health Physics Division inspections associated with the radiation survey (1982-83)
  (2) KAFB inspections and mapping surveys (1993)
  (3) Three distinct SNL/NM ER Project inspection efforts (1989 - 1995), including some soil sampling and radiation survey work, and photography and land survey of all mine locations.

- Eight interviews with thirteen SNL/NM facility personnel (current and retired).

- Miscellaneous information sources including SNL/NM and KAFB correspondence (memorandums, letters, and field notes regarding ER Site 28).

- The Comprehensive Environmental Assessment and Response Program (CEARP) Phase I Report (Ref. 7) and CEARP records contained in the Environmental Operations Record Center.

Using this information, a brief history of ER Site 28 and a discussion of all relevant evidence regarding past waste practices and releases at the site have been prepared and are presented in this proposal for an administrative NFA decision.

2.2 Previous Audits, Inspections, and Findings

The mines that comprise ER Site 28 became ER sites because of concerns that SNL/NM or KAFB may have disposed of radioactive waste, and/or hazardous waste in the mines. The cited sources for these concerns are two published reports:

- Defense Nuclear Agency (DNA), 1971, "Radioactive Waste Survey," performed by DNA, Headquarters Field Command, Kirtland Air Force Base, Albuquerque, New Mexico, August 16, 1971 (Ref. 8)

- Engineering Science, 1981, "Installation Restoration Program, Phase I: Kirtland Air Force Base," prepared for the USAF, AFESC/DEV, Tyndall AFB, Florida (Ref. 9)

In the early 1980s, citing the reports listed above, six mine locations were identified and named "MS-A through MS-F" (equivalent to 28-1 through 28-6). There was concern at this time, based on interviews with SNL/NM staff, that these mines (and some of the test areas/dirt mounds also investigated) may have had unacceptable levels of radioactivity from past disposal and/or testing.

CEARP findings related to ER Site 28 are based on interviews with SNL/NM personnel. These appear to be the same individuals that were interviewed in the early 1970s for the DNA inspection, which was cited as the source of information for the Engineering Science phase I records search report (for KAFB) (Ref. 9). Specific information cited in the CEARP Reports regarding ER Site 28 includes the following:

- Burning of aluminum-cased rocket motors in a horizontal mineshaft in the Frustration Mine area
- Solid wastes were disposed of in mineshafts near the New Aerial Cable Test Site
- Radioactive, mixed, and solid wastes may have been disposed of in some mineshafts and adits (no specific location referenced)

The CEARP information sources regarding Site 28 are limited to three interviews with three individuals (former SNL/NM staff). There are no other documented sources of information that indicate environmental concerns related to the mines, including the RFA and Hazardous Ranking System (HRS) information.

2.3 Historical Operations

ER Site 28 is comprised of ten locations where past mining activity took place (labeled 28-1 through 28-10 in Figures 1 and 1a. The previous labels, MS-A through MS-J, are also shown). The mines included as ER Site 28 have long since been abandoned, or were never worked beyond some very limited prospecting. The individual mine locations vary considerably, ranging from small prospecting pits to vertical and horizontal shafts that extend from 50 to over 600 feet into the subsurface. The old mine features, including adits, shafts, and prospecting pits, are the remnants of mineral mining activities conducted in the early- to mid-1900s. Fluorite was the most common target mineral, but barite, galena, and other sulfide minerals also were apparently mined based on examination of tailings piles. The Blackbird Mine (28-4) was one of the largest fluorite mining operations in the area and was active in the 1940s (Ref. 10). Most of the mines are the work of very small, independent prospector operations and were abandoned without ever producing significant amounts of ore. The exact times when these smaller mines may have been active are impossible to determine with existing records, and are not relevant to this proposal.

These mines are not ER sites because of the past mining activities, but rather speculation that SNL/NM personnel later used these remnant features to dispose of various wastes. According to CEARP interviews, various wastes may have been placed in a mine(s). Based on follow-up interviews, at least one rumor regarding the disposal of explosives in a mine is false. The disposal actually took place in a dry well, not in a mine (Ref. 11).

In addition, the CEARP findings state that a radiometric study was conducted by SNL/NM personnel and that although no radiation levels significantly above background were detected, "no entry was made into the mines." In fact, most of the mines were entered several times as part of this "radiometric study" in order to obtain accurate radiation readings (Ref. 12 and

13). The final report from this radiometric study (Ref. 12) and the field log book of the lead investigator (Ref. 13) document these entries. The information in these references provides critical descriptions of mines which are very dangerous to enter (28-2 and 28-9, in particular). The radiation survey is discussed further in Sections 3.3 and 3.4. Section 5 contains specific references from the ER Site 28 background files that provide more detailed historical background information.

ER Site 28 is somewhat confusing because it is comprised of 10 "mine sites", and many of these individual sites have more than one feature, such as multiple adits (horizontal) or shafts (vertical). In addition, there has been considerable confusion regarding who is actually investigating a given mine site, since KAFB and SNL/NM have both listed the same site (using different names) on their RCRA HSWA Permits. This duplication issue was cleared up between 1991 and 1993 through a series of letters between KAFB, SNL/NM, and Environmental Protection Agency (EPA) (Ref. 14, 15, 16, and 17). During an early radiation survey of these mines by SNL/NM personnel (described in Section 3.3 and 3.4), the locations were named "MS-A" through "MS-J" (this nomenclature may have been started by KAFB in the DNA report [Ref. 9]). Later, after the CEARP established the nomenclature of "ER Site 28", these locations were renamed 28-1 through 28-10.

Finally, there are a lot of small mines scattered throughout the KAFB "Withdrawn Lands" that are not included as ER Site 28. Many of these mines have been examined and contain insignificant features (small pits) or have no evidence of postmining activity, and therefore were not added to the site list. Any mines (or areas) directly referred to in the CEARP documentation have been included as part of ER Site 28, regardless of the significance of the mine features in those locations. The mines that are included as ER Site 28 are the most likely to have had something disposed of in them, based mainly on their accessibility, but also considering all of the information gathered to date.

2.4 Individual Mine Descriptions

The following site descriptions of ER Site 28-1 through 28-10 have been compiled based on numerous SNL/NM and KAFB site visits, mapping surveys and interviews with past field investigators. There have been five major, well-documented field inspection/investigation efforts: one conducted by KAFB (Ref. 18), and four conducted by various SNL/NM groups (Ref. 12, 13, 19, 20, 21, 22, and 23). These previous investigations, inspections, and mapping surveys are discussed in detail in Sections 3.3 and 3.4. Detailed descriptions based on mine entry and exploration of sites 28-1, 28-2, 28-7, 28-9, and 28-10 are present in the survey report completed by KAFB (Ref. 18). Terminology contained in these descriptions can be confusing and has been intentionally avoided in the descriptions presented below. Figures 1 and 1a show the locations of each mine site, and photographs of each mine entrance are included in Figures 2 through Figure 11. These figures should be consulted while reading the descriptions provided below to gain a clear picture of the features at each site.

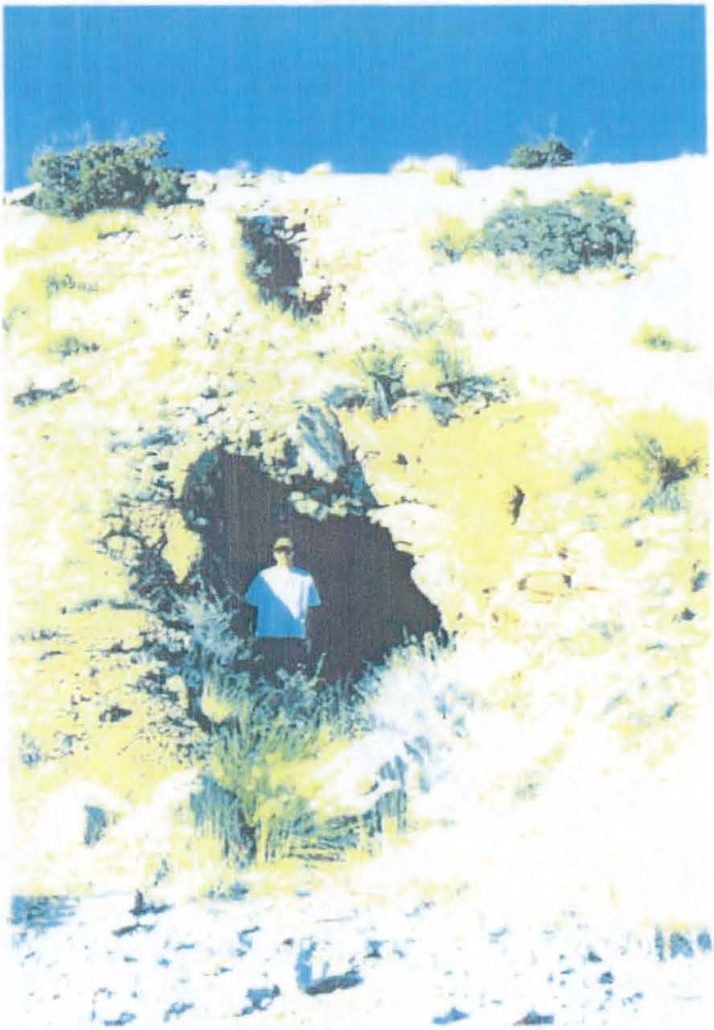


Figure 2a.
Site 28-1, Adit Behind Technician Connected/Continuous
With Excavated Trench in Background

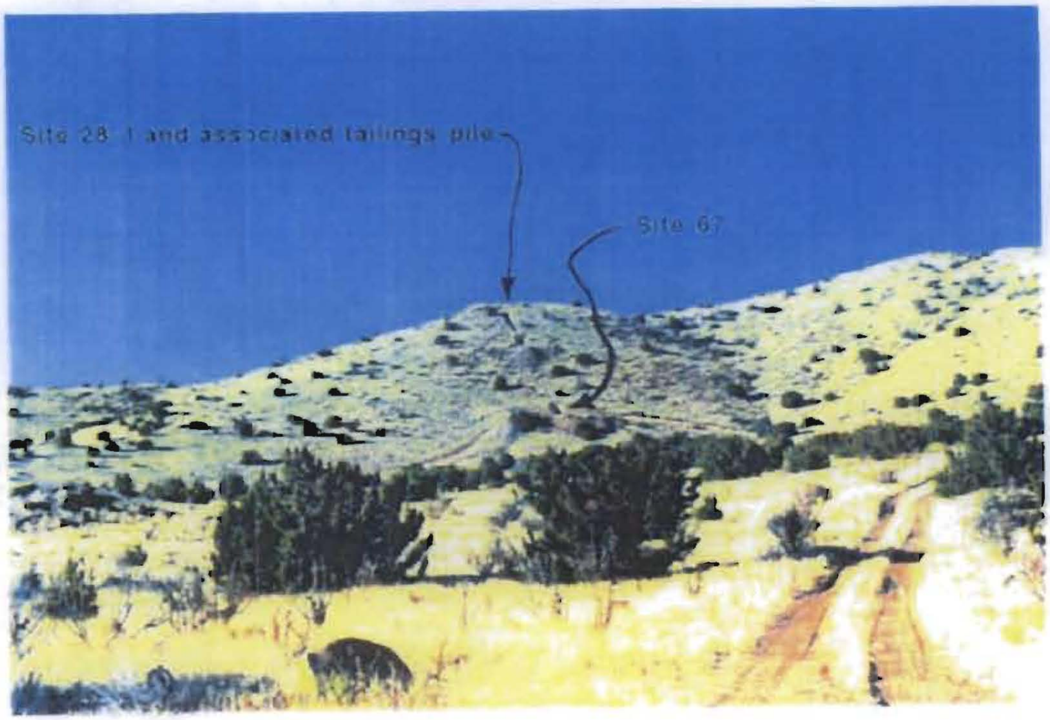


Figure 2b.
View Looking North at Site 67 and 28-1

Figure 3a.
Site 28-2, lower caved-in adit located between the two ER personnel.
Yellow instrument is the Global Positioning System (GPS) instrument.

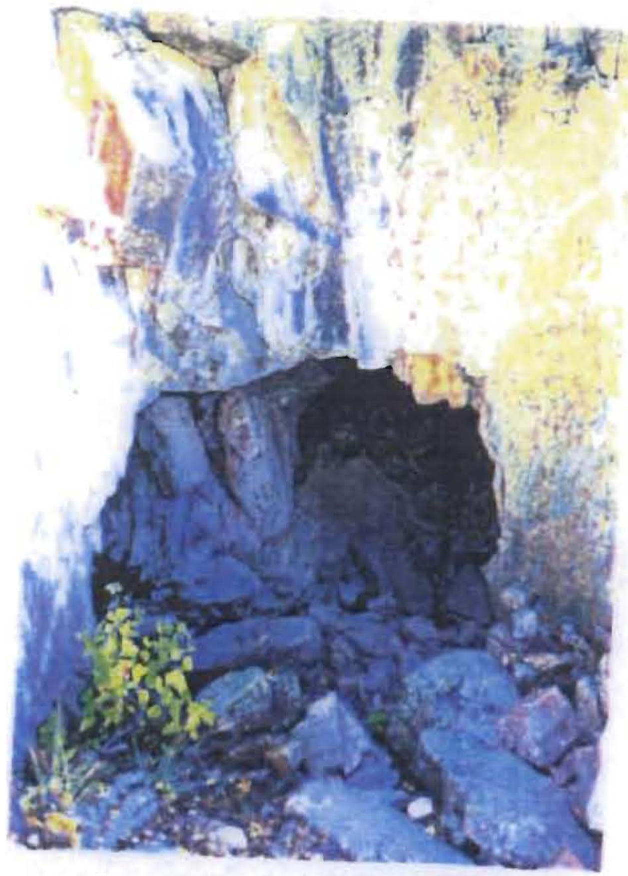


Figure 3b Site 28-2. Upper adit location.
View of the opening.

Figure 3c Site 28-2. View into the adit showing green vegetation, indicating the common presence of water.

Figure 3b and c.
Site 28-2

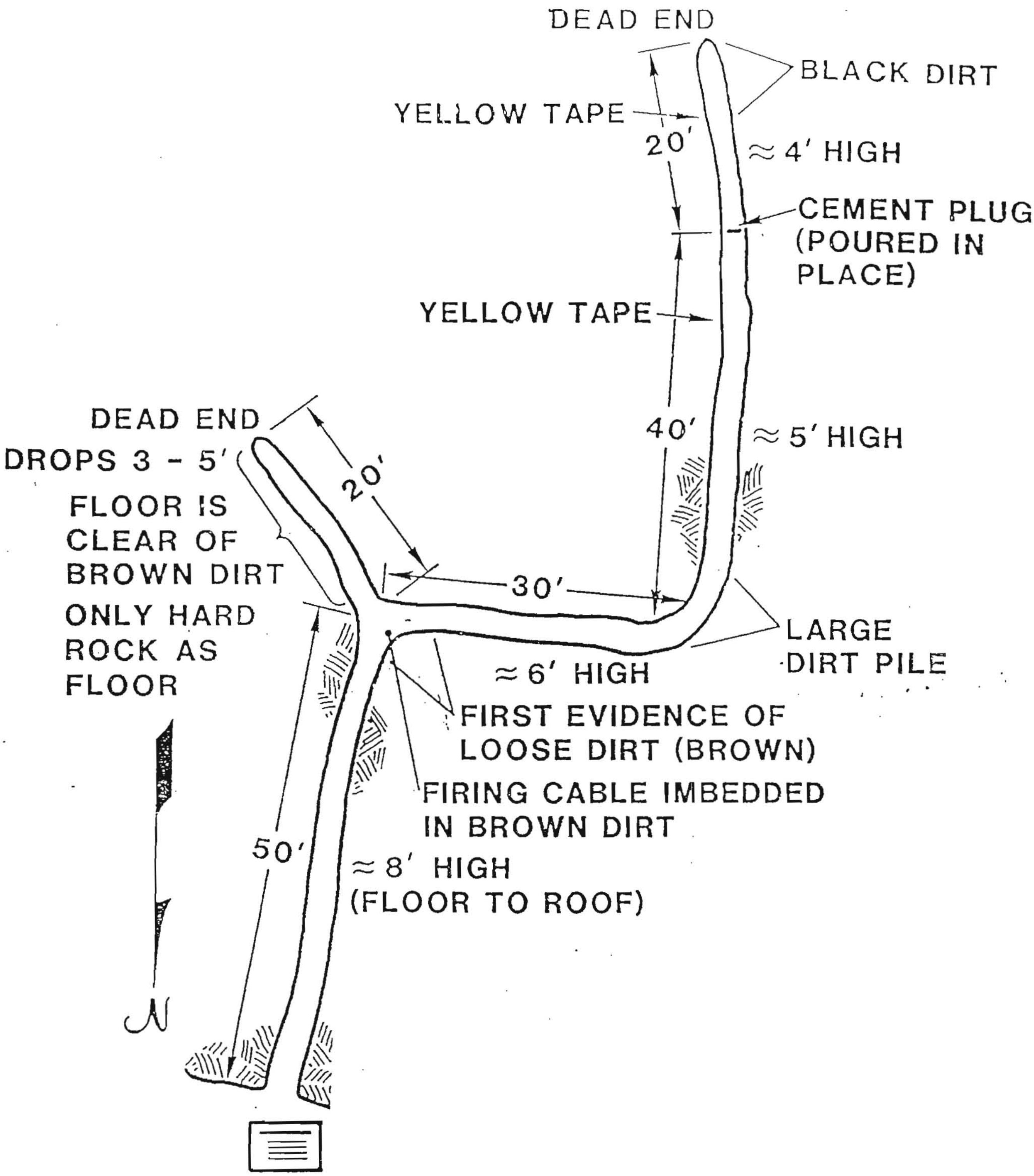


Figure 3d.
Site 28-2, Sketch Map of the Lower Adit

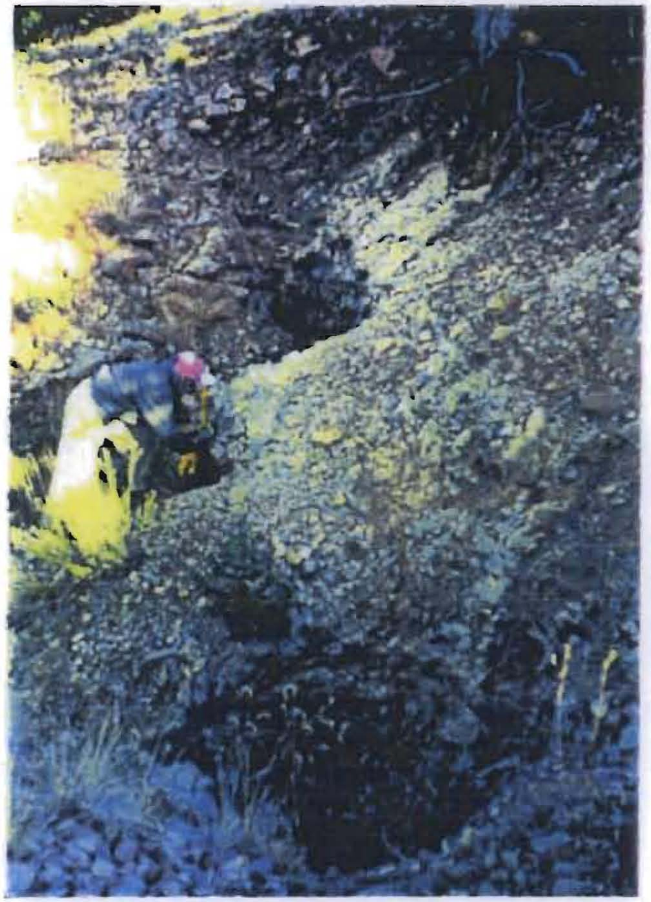


Figure 4a Site 28-3. Horizontal adit located above and vertical shaft located below ER GPS surveyor.

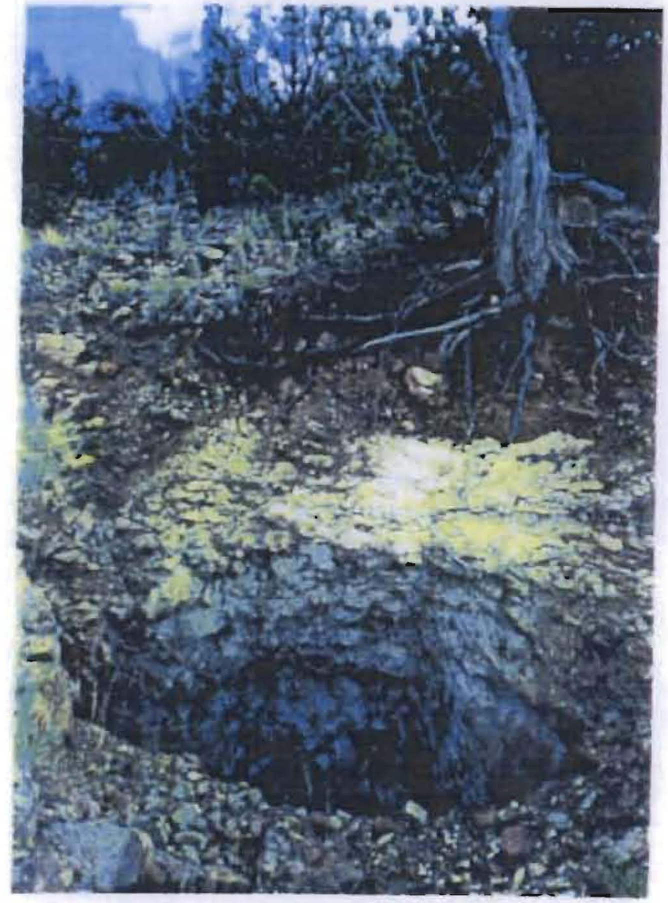


Figure 4b Site 28-3. Horizontal adit.

Figure 4a and b.
Site 28-3

Figure 4c.
Site 28-3, Vertical Adit With View Looking Down

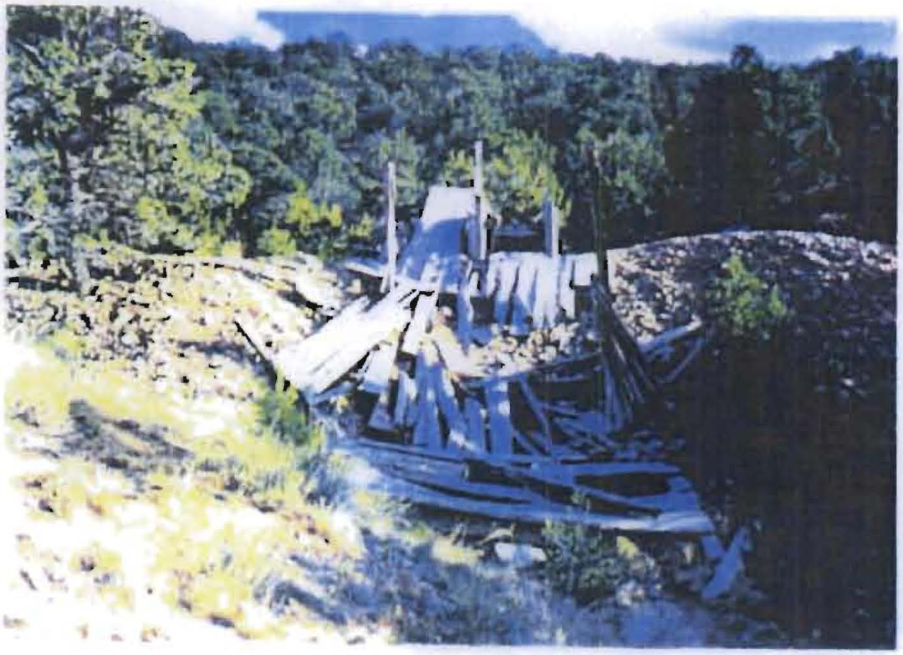


Figure 5a Site 28-4. Blackbird Mine. View to the north of the main shaft and associated timbers.

Figure 5b Site 28-4. Closeup of the top of the main shaft.

Figure 5a and b.
Site 28-4

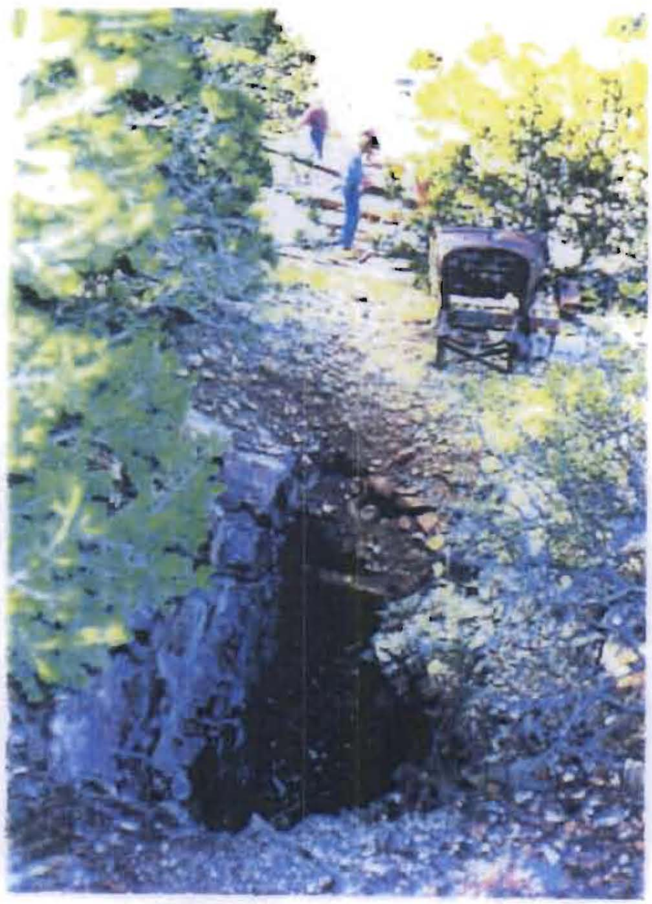


Figure 5c.
Site 28-4, One of Two Shallow Trenches Located
Just Southeast of the Main Shaft

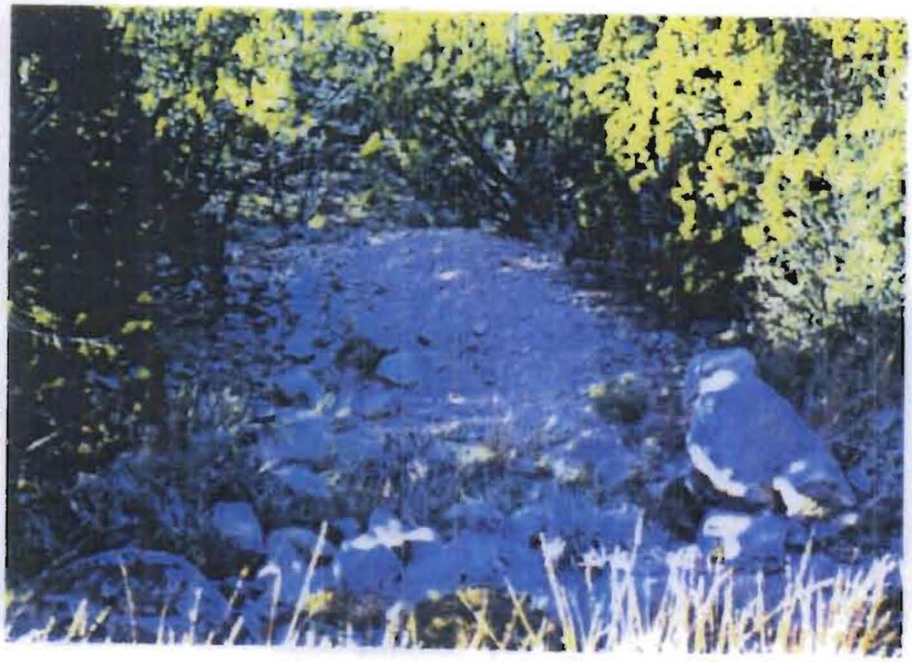


Figure 6.
Site 28-5, Small, Nondescript Tailings Pile

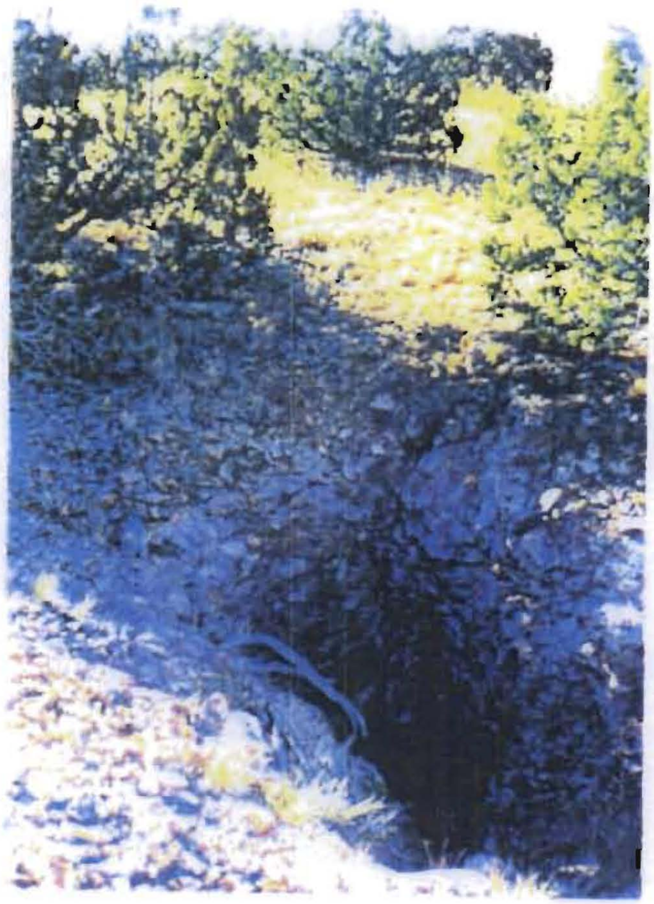


Figure 7.
Site 28-6, Vertical Shaft

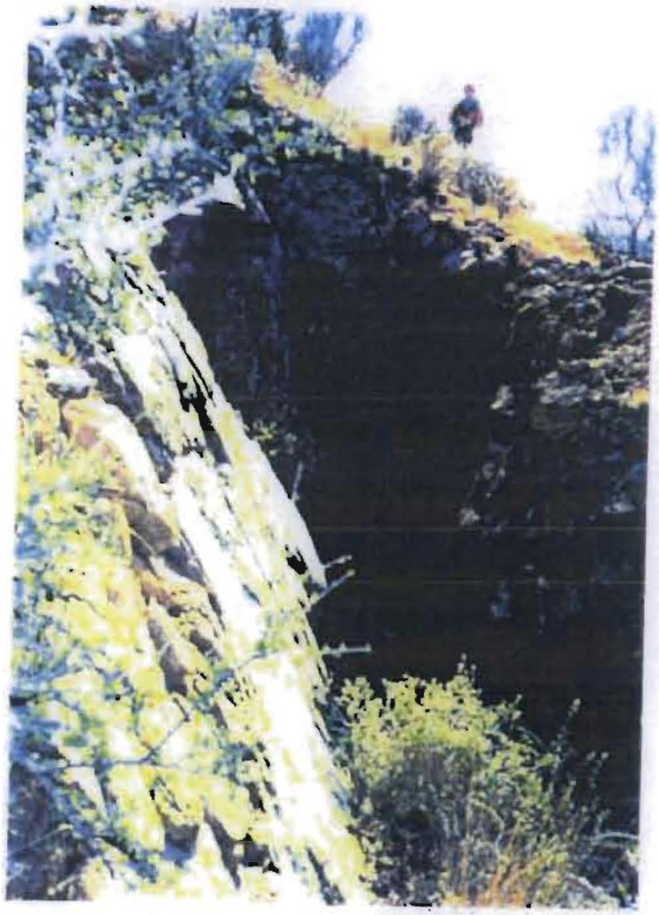


Figure 8a Site 28-7. View looking south of horizontal adit.

Figure 8b Site 28-7. Closeup of the inside of the adit.

Figure 8a and b.
Site 28-7

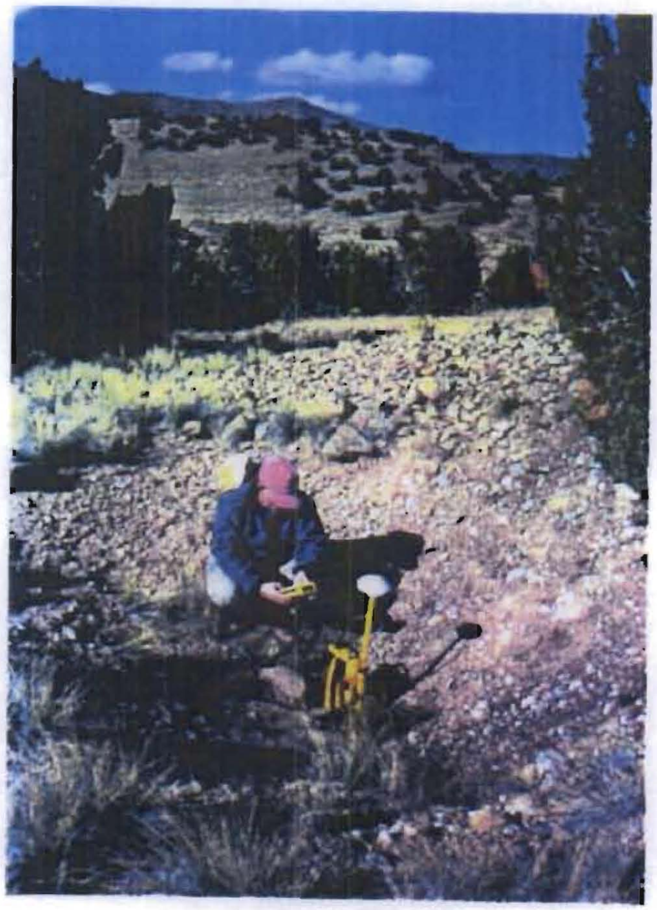


Figure 9 Site 28-8. View looking to the north. GPS technician surveying in location.

Figure 9.
Site 28-8, view is looking to the north.
GPS technician is surveying in location.

Figure 10a Site 28-9. Horizontal adit. View to the east.
GPS instrument antenae in foreground.

Figure 10b Site 28-9. Closeup of inside of adit.
Approximately 5 ft. from
ceiling to floor.

Figure 10a and b.
Site 28-9

Figure 11.
Site 28-10, Vertical Shaft

2.4.1 ER Site 28-1 (MS-A)

This site is located in the southern portion of the Withdrawn Lands (Figures 1 and 1a) in the vicinity of the Frustration Mine (ER Site 67). The Frustration Mine is a horizontal adit approximately 50 feet deep used by SNL/NM to house an experimental seismic station during the 1960s and 1970s (see Figure 2b). The station was used to record seismic disturbances from various testing programs. ER Site 28-1 is defined as the mining features in the immediate vicinity, not including ER Site 67 (Frustration Mine). All of the excavations described below are on the south-facing slope of a narrow ridge which protrudes from the main escarpment of the Manzanita Mountains (Figures 1a and 2b). Just over the ridge to the northeast is a large vertical mineshaft that is part of the KAFB IRP (Site ST-67-3, see Figure 1a).

Figure 2a displays the 28-1 entrance, which is a large, narrow trench feature (~3 to 5 feet wide at the surface, 60 feet in length, and up to ~75 feet deep) cut into the south-sloping hillside. Figure 2b shows the location of this trench relative to the Frustration Mine (ER Site 67). Site 28-1 is approximately 75 vertical feet above the Frustration Mine. The depth of the trench is greatest in the center, and decreases to the south due to the downward slope of the surface relative to the trench (Figures 2a and 2b). The trench is continuous beneath the "roof" over the field technician's head in Figure 2a, and contains some original timbers used to support the opening (shoring). Moving down into the trench from the surface, the width increases to approximately 10 feet in some places. Significant collapse has occurred in the trench as indicated by rubble (rock) within the mine. The sidewalls appear very unstable, characterized by loose, fractured blocks.

At approximately the center point along the length of the trench there is a more vertical shaft that angles downward to the southeast at ~45 degrees from the floor of the trench. Although difficult to see from the surface, the shaft has been thoroughly inspected and described as extending approximately 25 feet downward from the trench floor (Ref. 18). It does not connect to the topographically lower Frustration Mine (Ref. 18). There is a section of radio tower located just behind the technician shown in Figure 2a that appears to have been used as a ladder to gain access to the bottom of the shaft. From the surface, the entire trench and upper part of the 45 degree shaft can be completely inspected.

There are two small prospect pits located 150 feet and 250 feet east of the main workings and a shallow shaft near the crest of the hill, 200 feet east of the trench adit described above. None of these other smaller mining features described above show any evidence of postmining activity.

With the exception of the near-vertical shaft extending downward from the central floor of the trench, the entire 28-1 mine can be easily inspected from the surface. The lower shaft was thoroughly inspected by KAFB personnel during several August 1993 mapping inspections (Ref. 18), and by SNL/NM personnel during 1982-83 (Ref. 12 and 13) and again in June 1989 (Ref. 23). Except for the section of radio tower, there is no evidence of postmining activity in the 28-1 mine.

2.4.2 ER Site 28-2 (MS-B)

ER Site 28-2 is located in the same general vicinity as 28-1, approximately 3000 feet to the southeast (Figures 1 and 1a). There are two adits at this site, a lower and an upper (Figures 3a and 3b). The lower adit is described in detail in other reports (Ref. 12, 13, 18, and 23) and was previously posted with a radiation warning sign. In addition, it is easily accessed by a high-clearance vehicle via an unmaintained gravel road (Figure 1a). In addition to the lower adit, there is an upper adit, the portal of which is located approximately 60 vertical feet above the lower adit.

Both mines were entered for a complete visual inspection. Both KAFB and SNL/NM personnel have entered and inspected both the lower and upper adits comprising ER Site 28-2 (see Section 3.3 for a detailed account of these inspections). Based on site background interviews conducted by SNL/NM ER personnel, SNL/NM staff used to detonate waste explosives in the lower mine adit at 28-2 (Figure 3a, Ref. 24, 25, 26, and 27). This has been confirmed based on the presence of the "concrete wall and detonation cord" inside the mine described below, as well as a follow-up visit to the site with a former SNL/NM staff member who participated in these activities (Ref. 24 and 25). The explosives were loaded into the drift (back of the mine) and detonated so that rock debris would not be thrown out the front of the mine (Ref. 24). There have been no reports of disposal or explosive activity in the upper adit. There has been some collapse in the drift and part of the main adit, probably as a result of these detonations. The main entrance is nearly closed off with rock and soil debris, and is currently unsafe to enter (Figure 3a).

The lower adit extends to the south-southwest to a point 50 feet from the opening before turning to the southeast for 20 feet. See Figure 3d for a detailed sketch map of the lower adit. At the turn in the adit, a drift (side tunnel or horizontal shaft) extends to the west for 30 feet and then turns to the south for a distance of 60 feet. There is a large concrete plug located 20 feet from the face of the drift. This plug nearly blocks the drift and appears to have been moved after it was placed. See Figure 3d for a detailed sketch map of the lower adit.

There are piles of brown soil located at the entrance to the first drift, at the turn in the drift, and in front of the concrete plug. The soil behind the plug at the very back of the drift is black. It appears the soil was brought into the mine in burlap or canvas bags that have since rotted away. The yellow tape used to seal the bags is all that remains. It is possible, however, that the bags were cut and the soil was dumped onto the piles.

Visual evidence suggests that some type of explosive ordnance test(s) was conducted in this mine. The concrete plug probably acted as a Klotz device to attenuate the gas pressure and shock waves from detonations, as did the piles of soil. Two-conductor black detonation cable is visible protruding from the first soil pile. The radiation hazard sign previously posted at the portal has been removed.

This upper adit extends to the south for 15 feet and then turns to the southeast for 15 feet. A short (< 2 feet) drift extends to the south 4 feet from the adit face. Another short drift extends to the southwest from just beyond the portal. There is a 1.5-inch-diameter pipe protruding from the portal that was apparently used for draining water. Mud and green vegetation in the adit indicate that it is often saturated (Figure 3c). What remains of an abandoned road continues up the south side of the canyon to the east for a distance of approximately 1,800 feet, where it crosses to the north side, continuing up-slope for 400 feet. The road dead-ends at a leveled pad of unknown origin or use. Although a section of two-conductor black detonation wire was observed on the slope below this adit, there is no indication of any postmining activity.

2.4.3 ER Site 28-3 (MS-C)

This mine site is located in the north-central portion of the Withdrawn Lands (Figure 1 and 1a), in the same canyon as ER Site 81 (New Aerial Cable Site, which is represented in Figure 1a by the green polygons approximately 2,000 feet south of 28-3).

28-3 includes two distinct excavations (Figure 4a): one is basically horizontal and extends approximately 30 feet into the hill slope (Figure 4b), and the other is vertical and is approximately 30 feet deep (Figure 4c) (Ref. 20). Both features are small, with openings that are less than 10 feet in diameter. Below the surface the respective adits become thinner with depth and can be visually inspected from the surface. The vertical shaft has some remnant timbers toward the bottom of the hole, which shows signs of collapse. The horizontal adit angles downward for approximately 6 feet, then levels out and tapers in diameter until it comes to an end.

Special attention was paid to these adits because of the statement in the CEARP Report (Ref. 7) that indicated solid waste may have been put in mineshafts in the vicinity of the New Aerial Cable Site. These adits are the closest mines to the New Aerial Cable Site. Both adits can be easily inspected from the surface and show no evidence of postmining activity, including disposal of solid waste.

2.4.4 ER Site 28-4 (MS-D)

Site 28-4 is located in the north-central portion of the Withdrawn Lands (Figure 1 and 1a), approximately 200 feet north of 28-3. The mine is in Lurance Canyon just south of Coyote Springs Road (Figure 1a), and just west of ER Site 94 (Lurance Canyon Burn Site). The main part of this mine site is a shaft covered with broken wooden framing, which is the historic Blackbird Mine (Figures 5a and 5b). In addition to the shaft, there are two trenches at this site.

The main shaft is at least 49 feet deep, based on New Mexico Bureau of Mines and Mineral Resources report (Bulletin 21) dated 1946. It is not possible to determine the exact depth due to caving near the collar (now less than 10 feet deep and filled with broken rock). This report also describes a drift at a depth of 42 feet extending from the shaft toward the southeast for 87 feet with stopes to the surface. There is abundant timbering at the collar, indicating that there was once a headframe over the shaft. An old truck frame mounted near the collar is all that remains of a makeshift hoisting winch (Figure 5c). There are also concrete pads and scrap lumber piles near the shaft.

The two trenches are located immediately southeast of the shaft (Figure 5c). The closest trench is up to 6 feet deep and was formed by the collapse of the stopes described in the 1946 report. The other trench is approximately 3 feet deep and 25 feet long. It was excavated to explore the mineralized zone at the surface. The trenches are minor features that show no evidence of postmining activity.

The main shaft and trenches can be easily inspected from the surface, with the exception of the collapsed area in the main shaft. There is no visible evidence in both the mine features and the general area of any postmining activity.

2.4.5 ER Site 28-5 (MS-E)

This location is in the same vicinity as 28-4 and 28-3 (north-central part of the Withdrawn Lands), approximately 400 feet southeast of 28-4 (Figures 1 and 1a). Site 28-5 is comprised of a very small pile of what appears to be tailings from a prospecting pit (Figure 6). The area was searched thoroughly for a shaft or adit feature, but nothing was found (Ref. 20). The SNL/NM Health Physicist who surveyed the locations for radioactivity verified that this was the same location he surveyed back in the early 1980s (Ref. 19). Besides the pile of tailings, there is no other evidence in the area of either mining or postmining activities.

2.4.6 ER Site 28-6 (MS-F)

This site is located in the north-central part of the Withdrawn Lands on the north side of Lurance Canyon, approximately 2,000 feet northwest of Site 28-4 on a small ridge (Figures 1 and 1a). The site is bounded to north by ER Site 236 and to the west by ER Sites 63A, 63B, and 236 (Figure 1a). Site 28-6 is comprised of a single vertical shaft that is approximately 15 feet deep and 5 feet in diameter (Figure 7). A small collar of tailings material surrounds the shaft.

This shaft can be easily inspected from the surface and there is no evidence of postmining activity.

2.4.7 ER Site 28-7 (MS-G)

Site 28-7 is located in the southwestern portion of the Withdrawn Lands, approximately 2,000 feet due west of 28-2 and 2,000 feet south of 28-1 (Figures 1 and 1a). This is an area of KAFB land where extensive military testing has been conducted. As a result of this testing, numerous "dummy" and expended 3- to 5-inch shells are scattered throughout the area. The shells are not related to activities directly associated with the mines (the mines just happen to be in the area where these shells were fired) and are considered a USAF responsibility (Ref. 7).

This mine site consists of an adit that extends approximately 30 feet into the hill slope towards the south (Figure 8a and 8b). The adit is approximately 6 feet high at the entrance and 3 feet wide, and is relatively uniform in dimension. There is evidence of minor caving at the entrance.

A fragment of a shell is visible at the entrance of the adit (Figure 8b). It is similar to the shells that are found throughout the area, and appears to have simply landed in the entrance area. The interior of the mine has been carefully inspected and no shells can be seen within the mine. It is possible that the caving at the entrance to the mine resulted in part from the impact of the shell. Another explanation is erosion, because the hill slopes in this area. The entire adit can be viewed from the entrance and there is no evidence of postmining activities or disposal in the adit.

2.4.8 ER Site 28-8 (MS-H)

This site is located in the north-central part of the Withdrawn Lands on the north side of Lurance Canyon, approximately 2,000 feet northwest of Site 28-4 on the same small hill/ridge as Site 28-6 (Figures 1 and 1a). This site is in the immediate vicinity of 28-6 and is a very small depression/excavation (Figure 9). It is probably a prospecting pit that was abandoned prior to significant excavation. This feature is insignificant and shows no evidence of postmining activity.

2.4.9 ER Site 28-9 (MS-I)

Site 28-9 is located in the southwestern portion of the Withdrawn Lands, approximately 2,000 feet southeast of 28-2 and 4,000 feet east-southeast of 28-7 (Figures 1 and 1a). This mine is comprised of a single adit located up the steep west-facing slope of the Manzanita Mountains at an elevation of approximately 7,340 feet (Figure 1a, 10a and 10b). This location is significantly more remote than the others, with no road in the near vicinity (the closest road is the unmaintained gravel road that leads to Site 28-2).

The adit extends into the mountain horizontally approximately 650 feet to the east, making this the most extensive underground mine in the area. Drifts, each 10 feet long, extend from the adit in opposite directions (north and south) along a fault. Most of the adit contains a plated, wooden skid-type track. There are two small prospect pits located on either side of the canyon leading to this adit, but no other mine features have been noted in the near vicinity.

Both KAFB and SNL/NM personnel have entered and inspected the mine (see Section 3.3 for a detailed account of these inspections). Based on these inspections, there is no evidence of postmining activity or disposal. This canyon and adjacent slopes contain scattered 5-inch and 3-inch shells, however no shells have been observed in the immediate vicinity of the mine entrance or within the mine.

2.4.10 ER Site 28-10 (MS-J)

Site 28-10 is located in the southwestern portion of the Withdrawn Lands, approximately 2,000 feet west of 28-1 (Figures 1 and 1a). This area is located on the north side of a small hill that houses a building and support structures used during laser tests at the Sandia Optical Range.

Site 28-10 is a vertical shaft on the north slope near the summit of the hill, and is approximately 50 feet deep (Figure 11). There is a concrete slab (approximately 4 feet by 6 feet) just north of the main shaft, which may have been used to anchor a hoist or some other type of mining equipment. The opening is surrounded by a rim of tailings, and the shaft itself may have caved in to some degree, although it is difficult to say how much.

The main shaft can be visually inspected from the surface. In the shaft itself there is no evidence of any postmining activity. There are numerous 4.2-inch-mortar-round shipping canisters on the ground in an area just south of this shaft on top of the hill. The canisters are related to military training conducted in the area and are considered a USAF responsibility (Ref. 7). A small amount of unidentified slag material was observed at the collar of the main shaft, but it is not abundant and appears to be related to mining activities (possibly some crude smelting was done).

Three other adits were excavated to explore a fluorite mineralized zone near the base of the northwest quadrant of this hill. All three adits are caved, but appear to have been less than 15 feet in length. There is a caved shaft and caved adit located on the east side of the hill. None of these other workings in the area are significant, nor show any signs of post mining activities.

2.4.11 Summary

Of the ten ER Site 28 mines, only three (28-1, 28-2 [both adits], and 28-9) would require physical entry into the mine to be fully inspected. The only vertical shaft that has significantly collapsed, obscuring deeper portions of the mine, is 28-4 (Blackbird Mine). Vertical shafts at 28-1 (in the bottom of the trench), 28-3, 28-4, 28-6, and 28-10 may have experienced some minor collapse, but probably not major collapse on the same scale as Site 28-4 (was ~50 feet deep, now only ~10 feet). This is partly based on the appearance of the shaft, as well as the size of the surrounding tailings piles relative to the shaft's depth. In any case, there is still uncertainty about the actual location of shafts and adits at these mines, which may yet be subject to collapse. The vicinity is still very hazardous.

As discussed in Section 2.2, these mines are not ER sites because of the past mining activities, but rather speculation that SNL/NM or KAFB later used these remnant features to dispose of various wastes. Some of this speculation may have resulted from the "Radiation Warning Sign" posted at Site 28-2. This sign was later removed after the mine was thoroughly surveyed and sampled for radiation, and found to have only background levels/concentrations (this mine was actually surveyed for radiation twice). None of the speculation documented in the CEARP Report (Ref. 7) was based on visits to the mines or physical/visual evidence.

The individual site descriptions presented in this section are summarized from several significant investigative efforts conducted by both KAFB and SNL/NM personnel. These sources of information are further detailed in Sections 3.3 and 3.4.

It is also important to understand that many of the mines associated with ER Site 28 represent significant safety hazards. In particular, unprotected vertical shafts and horizontal adits are dangerous places where people, either due to curiosity or lack of awareness, can fall into and/or become trapped due to caving/collapse of wall and roof material. Several of the mine sites contain vertical shafts that are deep enough to cause a fatal fall. Further characterization efforts that require entry into the mines could be very dangerous, and would require significant support structures to be constructed, and elaborate health and safety precautions.

3. Evaluation of Relevant Evidence

3.1 Unit Characteristics

The characteristics of the mine sites are highly variable, as discussed in the previous section and shown in Figures 2 - 11. These mine features were not designed to hold waste, and are not appropriate for this purpose.

3.2 Operating Practices

Hazardous wastes were not managed or contained at ER Site 28.

3.3 Presence or Absence of Visual Evidence

There have been five major, well-documented field inspection/investigation efforts that have supplied most of the information contained in this NFA proposal: one conducted by KAFB and four conducted by various SNL/NM groups. All of the investigative efforts shared the same primary objective: to determine if the mines had been used for any activities that resulted in an environmental problem/concern. Secondary objectives included mapping the mines, surveying their locations, and documenting each location with photographs.

This section details the following information for each investigative effort: (1) who performed the investigation, a description of the investigation, and the specific objectives, including whether or not physical entry was made into the mines at Sites 28-1, 28-2 (both adits), and 28-9 (the only mine sites that require physical entry to fully inspect); (2) the number of site visits and the time-frame of those visits; and (3) the references that document these inspections/investigations. These investigations are summarized below in chronological order. After a summary of these efforts, conclusions specific to each location are presented.

3.3.1 SNL/NM Radiation Survey of the Mines

Description: In the early 1980s, citing the reports listed below, SNL/NM identified six mine locations and named them "MS-A through MS-F" (equivalent to 28-1 through 28-6).

- Defense Nuclear Agency (DNA), 1971, "Radioactive Waste Survey," performed by DNA, Headquarters Field Command, Kirtland Air Force Base, August 16, 1971.

- Engineering Science, 1981, "Installation Restoration Program, Phase I: Kirtland Air Force Base," prepared for USAF, AFESC/DEV Tyndall AFB, Florida.

There was concern at this time, based on interviews with SNL/NM staff and the reports cited above, that these mines (and some of the test areas/dirt mounds also investigated) may have unacceptable levels of radioactivity from past disposal and/or testing. SNL/NM Reactor Applications and Health Physics Divisions conducted this radiation survey designed to address these areas of potential radioactive contamination, including the mineshaft sites MS-A through MS-F (28-1 through 28-6). During this survey, four other mine sites were identified and named MS-G through MS-J (equivalent to 28-7 through 28-10). All of the sites were surveyed using SNL/NM's mobile radiation measurement laboratory, consisting of a computerized multichannel analyzer, a portable intrinsic germanium gamma spectrometer, and various other portable instruments. The results of the radiation survey are covered in Section 3.4. The radiation survey work involved detailed visual inspection of each ER Site 28 location (the same mine sites addressed in this survey [MS-A through MS-J] later became ER Site 28-1 through 28-10). Physical entry was made into 28-1, 28-2 (both adits), and 28-9. All other locations were either entered or inspected and surveyed from the surface.

Objective: The radiation survey had two main objectives: (1) identify and visually inspect the suspect mine locations, and (2) survey each location (including soil samples) for radiation to determine whether an environmental problem exists.

Timeframe: Field work was conducted in 1982-1983 and involved multiple visits to several of the locations, including 28-1 and 28-2.

References: Final Report (Ref. 12). Field log book (Ref. 13).

3.3.2 SNL/NM ER Investigation of Mines in the Frustration Site Area

Description: SNL/NM ER Project personnel conducted an investigation of ER Site 67 (Frustration Mine), 28-1, and 28-2 (both adits) in response to KAFB's request to move their M-60 Gun Range into that general area. These mines were entered and physically inspected, as well as sampled (for radiation measurements). Detailed descriptions of the mines were documented and a map of 28-2 (lower adit), was made (Figure 3d).

Objective: Determine if any significant contamination hazards are present in the mines, with the primary emphasis on radiation.

Timeframe: Field work was conducted on June 20, 1989.

References: Investigation Report (Ref. 23). Analytical results are also included (Ref. 23).

3.3.3 KAFB 377th ABW EMR Inspection and Detailed Mapping Survey

Description: KAFB 377th Air Base Wing Environmental Management and Restoration (377th ABW EMR) personnel conducted detailed mapping and inspection surveys of ER Site 67, 28-1, 28-2 (both adits), 28-4, 28-7, 28-9, and 28-10. This was part of the overall effort aimed at defining ownership of the mines (between KAFB and SNL/NM), as well as providing sound documentation of the condition and status of the mines. Sites 28-1, 28-2 (both adits), 28-7, and 28-9 were entered and thoroughly inspected. Inspections focused on looking for evidence of postmining activity.

Objective: Clearly document individual mine sites and their features, their condition, their location (mapping) on detailed topographic maps, and any evidence of postmining activity. Use this information to sort out ownership (between SNL/NM and KAFB) of the mines.

Timeframe: Field work conducted on August 2, 4, 6, 10, and 13, 1993.

Reference: Memorandum documenting results of field work (Ref. 18) (maps included).

3.3.4 SNL/NM ER Field Trip With Radiation Survey Lead Investigator

Description: ER field trip with the lead investigator of the 1982-1983 SNL/NM Radiation Survey conducted in 1982-1983. Purpose was to revisit and confirm locations that were surveyed in 1982-1983. Physically confirmed all locations except 28-9. Based on its unique location and features, 28-9 did not need to be revisited.

Objective: Make sure that the ER Site 28 locations are correct and complete, i.e., correspond to all of the locations previously surveyed. Site 28 was defined based on the locations originally identified and surveyed as part of the 1982-1983 investigation.

Timeframe: Field trip conducted on August 26, 1993.

Reference: Memo documenting trip (Ref. 19).

3.3.5 SNL/NM ER Field Inspection and Surveying/Photographing of Each Location

Description: Various field inspection trips conducted by SNL/NM personnel that included visits to all mine locations. Physical entry was made into 28-1, but not 28-2 (both adits) and 28-9 due to safety concerns related to the rather unstable condition of these old mines. All locations were visited at least twice, and thoroughly inspected from the surface. KAFB personnel most familiar with the mine sites were present for one of the field trips.

Objective: Photograph and survey with a Global Positioning System (GPS) instrument all locations (the GPS instrument is shown in Figures 3a, 4a, 9, and 10a). Document the current condition of the mines and look for any evidence of any type of postmining activity.

Timeframe: Four main inspection visits conducted November 4, 1994; February 3 and 11, 1995; and March 22, 1995.

References: Inspections documented in field log book. Pages of the log book have been copied for the site file and are included (Ref. 13, 20, and 22).

3.3.6 Summary of Findings From the Field Investigations

The mine sites comprising ER Site 28 are highly variable with regard to their physical characteristics. Because this is an important factor in visually inspecting the mines and evaluating whether or not individual sites may have been used in the past for waste disposal, the mine sites are broken into two groups below based on their physical characteristics.

- Group 1: Small- to moderate-size mine features (shaft, adit, pit/excavation) that can be completely visually inspected from the surface at the mine opening (internal portion of the mine can be completely viewed): 28-3, 28-4, 28-5, 28-6, 28-7, 28-8, and 28-10.

- Group 2: Larger mines that must be entered to be completely inspected: 28-1, 28-2 and 28-9.

<u>Group 1</u>

All of the Group 1 sites can be completely inspected from the surface, and have been visually inspected at least twice. Sites 28-3, 28-4, 28-5, 28-6, and 28-8 show no signs of any postmining activity, including disposal of any type of waste. According to the CEARP Report, solid waste was placed in a mine(s) near the New Aerial Cable Site (ER Site 81). The only mine site in the immediate vicinity is 28-3, and both adits at this location are free of solid waste. Sites 28-4, 28-5, 28-6, and 28-8 are in the general vicinity of the New Aerial Cable Site, and are also free of any signs of waste disposal.

Group 1, Site 28-7 is free of any signs of purposeful waste disposal; however, a 5-inch expended shell is visible at the entrance of the Site 28-7 adit (Figure 8b). It is similar to the shells that are found throughout the area that were part of military testing conducted in the 1940s (Ref. 6), and appears to have simply landed in the entrance area. The interior of the mine has been carefully inspected and no shells can be seen within the mine, nor is there any indication that shells have been buried within the adit. The shallow depth of material on the floor implies that nothing is buried there. Therefore, SNL/NM will request the shell at the entrance be removed by KAFB Explosive Ordnance Disposal personnel.

During inspections of the Site 28-10 vertical shaft, a small amount of "slag material" has been noted in the tailings pile surrounding the top of the shaft. This material is very porous (lots of small air holes) and looks like material from a furnace (clinker or furnace slag). During recent archaeology surveys at similar mine sites, fire hearths (pits) were identified that may have been used for smelting. Based on the small volume of this material (less than 55 gallons) and the lack of any other indications of nonmining debris such as detonation cord, tape, hazard flagging, old signs, etc., that are commonly associated with explosive testing or burn testing, this "slag material" is interpreted to be related to the original mining activities.

In summary, all Group 1 mine sites do not show any evidence of postmining use for waste disposal or other activities that would result in a significant release of hazardous or radioactive materials to the environment. The only direct evidence of postmining activity associated with a site, the shell in the entrance of Site 28-7, is due to the mine being located in the target zone for military testing.

Group 2

Group 2 sites are more significant, and more difficult to inspect visually because of their size and the safety hazards associated with entering these old mine features. Sites 28-1 and 28-9 were entered and do not have any visual evidence of postmining activity. Of the three Group 2 sites, only Site 28-2 shows any evidence of postmining activity. Site 28-1 does have a small portion of an old radio tower in it, which appears to have been used as a ladder to access the lower shaft inside the mine. Other than this ladder, there is no debris, no unusual staining (including burn or explosive markings), or any other physical indication of postmining activity. Site 28-9 is the most remote mine location (requires a significant hike up a steep canyon to access, over 2,000 feet from the nearest road and an elevation gain of over 800 feet, (Figure 1a) and shows no evidence of any activity since the mine was abandoned. Site 28-2 is the only notable exception with regard to visible evidence of postmining activities. One of the main reasons that ER Site 28 was identified during the CEARP appears to be related to activities conducted by SNL/NM personnel at 28-2. Visual inspections by SNL/NM Health Physics personnel (1982-1983) and KAFB personnel (August 1993) reported that a radiation warning sign, yellow tape associated with SNL/NM testing activities, and burlap bags of black soil were all present inside the lower adit location of 28-2 (Ref. 13 and 20). The upper adit was inspected in the meanwhile, and showed no signs of postmining activity. Follow-up interviews and a field visit to the 28-2 site with SNL/NM personnel familiar with activities related to this mine revealed that explosives (hexahydro-1,3,5-trinitro-1,3,5,-triazine [RDX]; Composition 4 [C-4]; and detcord) were periodically open-detonated in a side shaft of 28-2, which contained a concrete wall just inside the main adit (Ref. 24, 25, and 27, Figure 3d). The detonations in the side shaft reportedly resulted in total collapse of the side shaft, but the main adit is currently largely open and the concrete wall is still visible (last detailed inspection was in August 1993). However, the entrance to the main adit is largely collapsed (Figure 3a) and the mine is not in a safe condition for entry.

Interviews conducted as part of the CEARP indicated a horizontal mine in the Frustration Site area was used to burn aluminum-cased rocket motors (Ref. 28). ER personnel conducted follow-up interviews to try to determine which mine was used for this burning activity (Ref. 24). The results of this follow-up interview indicated the burning occurred either in the Frustration Mine (ER Site 67) or in the horizontal trench adit (28-1). Site 28-1 has been thoroughly inspected (Ref. 12, 18, 20, 21, and 22) and there is no visual evidence of either the remaining aluminum casings of the rockets, nor of any areas where burning may have taken place (black burn marks or burn residues). A recent inspection of ER Site 67 (Frustration Mine) revealed no evidence that the burning activities took place in this mine.

3.4 Results of Previous Sampling/Surveys

3.4.1 Basewide Radiation Survey

In the 1982-1983 timeframe, SNL/NM Reactor Applications Division and Health Physics Division conducted a base-wide radiation survey designed to address six mine locations (MS-A through MS-F) identified as part of the DNA inspection, (Ref. 8) U.S. Air Force phase I records search report (Ref. 9). During this survey, four other mine sites were identified (named MS-G through MS-J) and included in the study (Ref. 12). These mines sites are equivalent to 28-1 through 28-10, which represent all of the ER Site 28 locations (the visual evidence obtained by this field investigation of the mine sites is also summarized in Section 3.3).

All of the sites were surveyed using SNL/NM's mobile radiation measurement laboratory, consisting of a computerized multichannel analyzer, a portable intrinsic germanium gamma spectrometer, and various other portable instruments. Both in situ readings were taken, as well as soil samples. The purpose of this study was to first determine whether radiation levels above background were present, and if so, then to determine what radionuclides were responsible for the elevated readings. Important references for this survey include Ref. 12 (Radiation Survey of KAFB/DOE Controlled Areas, Kirtland Air Force Base, Albuquerque, NM), and Ref. 13 (the field log book notes for this survey written by the Lead Investigator from SNL/NM Reactor Applications Division).

The results of the survey, as recorded in the final report (Ref. 12), conclude that the mine sites 28-1 through 28-10 show no signs of having been used for radioactive waste disposal or testing with radioactive materials. The radiation spectra from in situ instrument readings and soil sample analytical results showed nothing more than slight variations in background levels due to the types of rocks found at each location. Visual inspections performed during the project revealed nothing that conflicts with this conclusion, with one notable exception. Site 28-2 was posted with a radiation warning sign, which the study concluded was unwarranted based on several readings and soil samples collected in this mine. It is unknown who placed the sign; investigators speculated it was simply used in an effort to keep out trespassers. The sign was subsequently removed in 1989 by SNL/NM personnel. The report also noted that all of these mines are in poor repair and represent conventional safety hazards that should be appropriately fenced and posted to prevent an accident.

3.4.2 SNL ER Project Radiation Survey of 28-2 and ER Site 67

Another field investigation/sampling effort was conducted at ER Site 67 (Frustration Mine) and Site 28-2 (lower adit) on June 20, 1989. The effort was led by SNL/NM ER Project personnel and conducted to determine if any radiation hazards existed in the mines. The investigation was requested prior to KAFB moving an M-60 Gun Range into the vicinity to make sure the area was free of radiation hazards. The primary concern was the 28-2 location (referred to in the investigation report as "the unnamed adit"), which was still posted at this time with the radiation warning sign.

A radiation survey was performed throughout the 28-2 (lower adit) mine with a TMB-3 radiation meter. No readings above background were recorded, and the readings ranged from 0.03 to 0.05 milliroentgens per hour. Two soil samples (black and brown dirt) were collected for gamma spectroscopy analysis at the SNL/NM Division 3313 Radiation Diagnostic Laboratory. Results indicate background conditions (no radionuclides present above background concentrations) and are consistent with the TMB-3 radiation readings in the mine. Analytical results are included (Ref. 23).

The investigation report concluded that no radiation hazards were detected at the Frustration Mine (ER Site 67) and the "unnamed adit" (Site 28-2). The radiation warning sign at Site 28-2 was removed on July 19, 1989, by SNL/NM personnel. It is possible that the radiation sign was used to keep curious visitors from entering the mine, and did not indicate a real radiation hazard.

3.5 Assessment of Gaps in Information

The main information gap for ER Site 28 relates to the lack of chemical data for the mine sites. Up to this point, the mine sites have been visually inspected and surveyed for radiological contaminants. Radiological concerns have been addressed by direct sampling of material from the mines or by taking various radiation measurements. The main reason for this apparent data gap is the fact that visual inspections have not revealed anything out of the ordinary at nine of ten mines to target for sampling with regard to hazardous chemicals or constituents. Therefore, the only mine site with a real hazardous chemical data gap is Site 28-2 (lower adit). The only location where postmining activities appear to have taken place inside a mine is at Site 28-2; therefore it is the only mine for which there is any concern.

Even at 28-2, where waste explosives have been open-detonated, obtaining soil samples to determine any adverse environmental impact is virtually impossible due to the fact that the side shaft where the detonations took place is reported as being collapsed. In addition, the information collected to date simply does not indicate nor suggest the presence of hazardous material (explosive residuals) in sufficient quantities to present a significant release source. Based on a recent study of open detonation of explosives performed by the U.S. Army Armament, Munitions, and Chemical Command (Ref. 29) and risk calculations using the results of this study, the residual explosive material, if any remained after the detonations, will not pose a significant threat to human health and the environment. Attachment 1 is a summary of the U.S. Army study and Attachment 2 includes risk calculations using the results of the study.

Since collecting a soil sample from many of these locations could put the personnel conducting the sampling at significant risk, there should be a clearly defined sampling target and benefit to the sampling event. Based on what has been seen in the mines during five major field investigations, there is not sufficient justification to put sampling personnel at risk.

3.6 Rationale for Pursuing an Administrative NFA Decision

ER Site 28 was defined as an SWMU as a result of second-hand information obtained through interviews with SNL/NM personnel. Follow-up interviews conducted by ER Project personnel and visual inspections of the sites by SNL/NM and KAFB personnel have determined that only two of the ten mines listed as ER Site 28, 28-2 and 28-7, actually show any signs of postmining activity. All mines in the vicinity of the New Aerial Cable Site (ER Site 81) have been inspected and do not contain any type of wastes (CEARP information indicated mines in the vicinity of Site 81 had been used for solid waste disposal, see Section 2.2). All of the locations, including 28-2 and 28-7, have been surveyed for elevated (relative to background) radiation, and all locations showed only background levels (Ref. 12 and 23).

Based on both interviews and site inspections, Site 28-2 was used prior to 1982 for detonating small quantities of waste explosives (Ref. 24 and 25). The main issue regarding this particular site is whether these detonations, which resulted in the collapse of a side shaft in the mine, constitute a concern relative to a potential release to the environment. Based on a recent study of open detonation of explosives performed by the U.S. Army Armament, Munitions, and Chemical Command (Ref. 29) and risk calculations using the results of this study, the residual explosive material, if any remained after the detonations, will not pose a significant threat to human health and the environment (see Attachments 1 and 2).

The only other mine site that has been affected by postmining activity, based on several visual inspections, is 28-7. This site occurs in an area where extensive military testing occurred in the 1940s. As a result, this mine has a 5-inch shell (expended) positioned at the entrance. This mine was not used for disposal of these shells, as evidenced by the numerous shells lying on the ground in the immediate vicinity (if the mine had been used for disposal, the shells in the immediate vicinity would have been gathered up and placed in the mine; it could not have been used due to the shallow amount of soil on the floor). The shells present in this military range are not SNL/NM's responsibility.

As part of the ER Project follow up, eight SNL/NM staff members (several now retired) were interviewed specifically about the CEARP statements summarized in Section 2.2 (Ref. 11, 19, 26, 27, 28, and 30). Out of this interview process, SNL/NM ER personnel were able to verify that waste explosives were detonated in the 28-2 (lower adit) site. However, no individuals had any direct knowledge of disposal of other wastes in any of the mines, including 28-2. One interviewee clarified that explosives rumored to have been disposed of in a mine were actually disposed of in a dry well (Ref. 11).

Based on the information gathered to date, including documented detailed inspections of the mines, interviews, and the results of the radiation survey conducted in 1982-1983, there is no significant threat of a release from this SWMU that would pose a threat to human health and the environment. Eight of the ten ER Site 28 locations show no evidence of any postmining activity, and thereby do not pose a threat of a release.

The NFA criteria that apply to ER Site 28 are as follows:

- Criterion 1 (unit has never contained constituent of concern): Sites 28-1, 28-3, 28-4, 28-5, 28-6, 28-7, 28-8, 28-9, and 28-10.

- Criterion 3 (unit clearly has not released hazardous waste or constituents into the environment): Site 28-2.

4. Conclusion

Based upon the evidence cited above, no potential remains for a release of hazardous constituents which may pose a threat to human health or the environment. Therefore all ten ER Site 28 mine locations are recommended for an NFA determination.

5. References

5.1 ER Site References

Section 5.1 contains a comprehensive bibliographical list of the documents relating to ER Site 28. This list is arranged numerically by reference citation in the text.

1. U.S. Environmental Protection Agency (EPA), August 1993. Module IV of RCRA Permit No. NM5890110518, EPA Region 6, issued to Sandia National Laboratories, Albuquerque, New Mexico.

2. U.S. Environmental Protection Agency (EPA), August 1992. Hazardous Waste Management Facility Permit No. NM5890110518, EPA Region 6, issued to Sandia National Laboratories, Albuquerque, New Mexico.

3. Sandia National Laboratories/New Mexico (SNL/NM), February 1995. "Program Implementation Plan for Albuquerque Potential Release Sites," Sandia National Laboratories, Albuquerque, New Mexico.

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

5. U.S. Environmental Protection Agency (EPA), October 1986. "RCRA Facility Assessment Guidance," EPA/530-86-053, pb87-107769, Environmental Protection Agency, Washington, DC.

6. Sandia National Laboratories/New Mexico (SNL/NM), 1995. Environmental Operations Records Center Reference Number ER/1334/057/95-001, Sandia National Laboratories, Albuquerque, New Mexico.*

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

8. Defense Nuclear Agency (DNA), August 1971. "Radioactive Waste Survey," performed by the Defense Nuclear Agency, Headquarters Field Command, Kirtland Air Force Base, New Mexico, August 16, 1971.

9. Engineering Science (ES), 1981. "Installation Restoration Program, Phase I: Kirtland Air Force Base," prepared for the U.S. Air Force, AFESC/DEV, Tyndall AFB, Florida.

10. New Mexico Bureau of Mines and Mineral Resources, 1946, Bulletin 21, "Fluorspar Resource of New Mexico."

11. Sandia National Laboratories/New Mexico (SNL/NM), 1994. Environmental Operations Records Center Reference Number ER/7585/1332/82/Int/94-121, Sandia National Laboratories, Albuquerque, New Mexico.*

12. Minnema, D. M., and G. E. Tucker, August 1989. "Radiation Survey of KAFB/DOE Controlled Areas Kirtland AFB, Albuquerque, New Mexico," August 18, 1989.

13. Mitchell, Mike, November 1994. Field Notes. "Site 28 Field Trip," November 4, 1994.

---

*The SNL/NM reference numbers refer to a SNL/NM Records Center coding system intended to maintain the confidentiality of SNL/NM employees.

14. Mr. Davidson, HQ, 1606th Air Base Wing, Memorandum to HQ/MAC/LEEV (Ms. Hopper), Subject: Installation Restoration Program (IRP) Site Closeout Decision Documents, September 18, 1991.

15. Denise Bleakly, Memorandum to Warren Cox, Subject: Review of KAFB IRP/SNL ER Site Transfer Information, December 15, 1992.

16. Decision Paper, 02/92, Installation Restoration Program (IRP), 542d Crew Training Wing (CTW), Kirtland AFB, New Mexico.

17. Denise Bleakly, Memorandum to Warren Cox, Subject: Body of Text for EPA Request Concerning ER/IRP ER Site Exchange and ER Site 28, July 28, 1993.

18. Sandia National Laboratories/New Mexico (SNL/NM), 1992. Environmental Operations Records Center Reference Number ER/7585/1332/Int/92-023, Sandia National Laboratories, Albuquerque, New Mexico.*

19. Sandia National Laboratories/New Mexico (SNL/NM), 1993. Environmental Operations Records Center Reference Number ER/7585/1332/67/Int/93-199, Sandia National Laboratories, Albuquerque, New Mexico.*

20. Mitchell, Mike, March 1995. Mine Site Tour, (ER Site 28) Field Notes, March 22, 1995.

21. Jeff Havlena, Memorandum to Kathy Gaither, August 21, 1991.

22. Mitchell, Mike, February 1995. Field Logbook Notes - Surveying GPS and Photos of Mine Sites, February 24, 1995.

23. Sandia National Laboratories/New Mexico (SNL/NM), 1993. Environmental Operations Records Center Reference Number ER/7585/1332/Int/93-013, Sandia National Laboratories, Albuquerque, New Mexico.*

24. Skip Wrightson, Memorandum to Kathy Gaither, Subject: Notes of Field Activities 8/26/93 Mineshaft (Site 28) Locations, August 30, 1993.

25. Norris, Thomas A., Letter to Warren Cox, Subject: Letter to Mrs. Nancy R. Morlock (EPA Region 6), August 19, 1993.

26. Wrightson, Skip, to: Kathy Gaither, Caroline Byrd, Subject: Notes of Field Activities, 8/26/93 Mineshaft (Site 28) Locations, August 30, 1993.

*The SNL/NM reference numbers refer to a SNL/NM Records Center coding system intended to maintain the confidentiality of SNL/NM employees.

27. Minnema, Doug, November 1982. Doug Minnema's Logbook from 1982-1983, Radiation Survey Fieldwork, November 8, 1982.

28. Sandia National Laboratories/New Mexico (SNL/NM), 1994. Environmental Operations Records Center Reference Number ER/7585/1332/27/Int/94-005, Sandia National Laboratories, Albuquerque, New Mexico.*

29. U.S. Army Armament Headquarters, January 1992. "Development of Methodology and Technology for Identifying and Quantifying Emission Open Burning and Open Detonation Thermal Treatment Methods, Bang Box Test Series," Vols. 1, 2, and 3, Test Summary, U.S. Army, Sandia National Laboratories, Albuquerque, New Mexico.

30. Sandia National Laboratories/New Mexico (SNL/NM), 1993. Environmental Operations Records Center Reference Number ER/7585/1332/82/Int/93-019, Sandia National Laboratories, Albuquerque, New Mexico.*

5.2 Reference Documents

Sandia National Laboratories/New Mexico (SNL/NM), 1993. Environmental Operations Records Center Reference Number ER/7585/1332/Int/93-034, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico, September 1993, Environmental Operations Record Center Record Number ER/1334 057/94-001.

Sandia National Laboratories/New Mexico (SNL/NM), February 1994, draft. "Program Implementation Plan for Albuquerque Potential Release Sites," Sandia National Laboratories, Albuquerque, New Mexico.

5.3 Aerial Photographs

Aerial photographs were not used to gather information on ER Site 28.

---

*The SNL/NM reference numbers refer to a SNL/NM Records Center coding system intended to maintain the confidentiality of SNL/NM employees.

ATTACHMENT 1

OU 1332, ER Site 28

Open Burning/Open Detonation of Explosives

Open Burning/Open Detonation of Explosives

Site 28 contains a mine where explosives may have been detonated or open burned. The degree to which explosives were destroyed in open detonation events had not been conclusively documented until recently. The U.S. Army Armament, Munitions, and Chemical Command sponsored a study from 1988 to 1992 to document the combustion by-products of open burning/open detonation of rocket propellant and explosives. This study was conducted to meet regulatory needs for treatment permitting under the RCRA and for site investigation work under the RCRA and the CERCLA (603). The remainder of this section discusses the results of this study and how it relates to the approach in this NFA Proposal.

The technical steering committee that developed the study was formed from experts in field sampling, instrumentation, field and laboratory analysis, environmental documentation, atmospheric dispersion, data processing, combustion and explosive phenomenology, and quality assurance (QA)/quality control (QC). The EPA Headquarters and Research Triangle Park provided technical guidance and support during the test planning and execution phases of the test as well as review of both data collection and analytical procedures and assurance of instrument accuracy. During the study, the EPA Atmospheric Research and Exposure Assessment Laboratory, Quality Assurance Division, Research and Monitoring Evaluation Branch performed a technical audit with excellent results.

The study consisted of detonating or open burning explosives or rocket propellant within a building (referred to as the bangbox). This building contained the combustion by-products that allowed for a quantitative determination of the emissions. Various types of monitoring equipment were used to provide the best information on the tests.

Results of the study indicate that after open detonation/open burning, the explosives and rocket propellant are consumed to less than 4 ppm (measured by the weight of total explosive). Table 4-3 shows the carbon emissions resulting from the combustion of TNT.

Table 4-3
Carbon Emissions Produced by Combustion of TNT

Species	Percent Produced by Combustion of TNT
Carbon dioxide	97.20
Carbon monoxide	0.50
C_1 to C_{10} volatile hydrocarbons and other organics	0.57
Elemental carbon (soot)	1.71

TNT was used in the test because it contains less oxygen than other commonly used military explosives. Oxygen-deficient explosives are less likely to burn as completely as other explosives and thus provide a worst-case result for incomplete combustion by-product production. The amount of TNT surviving the detonation was 3.38 parts per million by weight (ppmw). Most of the explosives used on OU 1332 sites contained TNT.

The two most commonly used types of solid rocket propellant (double-based and composite) were also tested. Solid rocket propellant is a mixture of chemicals held together by carbon-based binders (mostly rubber or plastic). The fate of the carbon-based binders is indicative of the fate of the rocket propellant. Table 4-4 presents the measured results of carbon-containing species.

Table 4-4
Carbon Emissions Produced by Combustion of
Double-Based/Composite Rocket Propellant

Species	Percent Produced by Combustion of Double-Based/Composite Rocket Propellant
Carbon dioxide	99.64/99.88
Carbon monoxide	0.15/0.11
Organic carbon	0.21/0.00
Elemental carbon	0.00/0.01

Table 4-4 shows the complete combustion (to greater than 99.64 percent carbon dioxide) of the carbon-containing materials in both types of rocket propellant. The tests clearly indicate that no significant amount of explosives or rocket propellant can survive an open detonation/open burning event.

Dugway Proving Ground in Utah conducted additional testing. To collect emissions samples, various sampling devices were installed in airplanes and under the wings of airplanes that flew through the plumes produced by the open burning/open detonation of rocket propellant and explosives. Soil samples were also taken to improve the definition of the deposition of the combustion by-products in the environment. The tests involved large detonations (approximately 2,000 lb) of HE and large open-burning events with rocket propellants (of up to 7,000 lb).

The results were generally consistent with the smaller-scale bangbox study described above. The data evaluation was complicated by the use of reclaimed (and therefore slightly contaminated) explosives. Compounds not used in the explosive tests were detected as residues in some soils after these tests, indicating that the site may have been contaminated previously by other unrelated activities.

Even with these complications, the soil deposition from these large open-burning/open-detonation events was very low. The highest value of deposition in soil resulting from the detonation of 2,000 lb of TNT was 0.36 ppm of TNT. The detonation of approximately 2,000 lb of RDX resulted in a maximum soil concentration of 15 ppb of RDX. Other combustion by-products were detected in soils in even smaller quantities. The Dugway report lists these.

The combustion by-products from these large explosive tests included some volatile and semivolatile compounds. A risk assessment for both toxicity and carcinogenicity was performed on all of the combustion by-products deposited in the soils from the tests. Based on the risk scenario and the constituent values given in the Dugway report, risks were calculated using the soil concentrations of COCs immediately following completion of the Dugway test. The risk assessment evaluated the risk level for the entire mixture of compound present. Risks for each compound were assumed to be cumulative--a conservative assumption resulting in higher calculated risk level.

The EPA has not yet published the health effects data that are necessary to assess toxicity or carcinogenicity of several of the combustion by-products produced in the Dugway tests. Health effects data for similar compounds were substituted in the risk calculation for those particular compounds. Care was taken to select substitute compounds that would have conservative risk values (i.e., higher risk levels). Attachment 2 includes a more detailed discussion of the methods used and the results of the risk assessment.

Even with the higher risk levels of the substitute compounds, the calculated risk levels for both toxicity and carcinogenicity were acceptable. A toxicity level of less than one (expressed as the Hazard Index) is the criterion defined by the EPA as acceptable. The Hazard Index calculated for the Dugway tests was 0.19. A carcinogenicity risk level of 10^{-6} or less is an acceptable risk level for residential land use -- the most stringent future land use scenario. The carcinogenic risk levels calculated for the Dugway test were less than 10^{-6}.

Explosives experts consulted by SNL/ER interpret the Dugway report as evidence that soil residues from open burning/open detonation conducted at most OU 1332 ER Sites would also have been in the similar parts-per-million range at the time of the testing. The detonations and open burning at one mine in site 28 were significantly smaller than the 2,000 lb of explosives used in the Dugway tests. Negligible quantities of residue would have been dispersed in the air at the time of testing. The combustion by-products deposited at the time of testing onto surface soils would be degraded by natural processes. Up to 44 years have passed since the open burn open/detonation testing in the site 28 mine occurred. Experts believe it highly unlikely that these materials could still be detected on the soil surface of the sites.

The acceptable toxicity and carcinogenic risks discussed above were calculated assuming a residential risk scenario and using deposition values measured immediately after the Dugway test ended. Because of the smaller quantities of explosives used, any residues that may have been deposited at site 28 would have been less significant than those from the Dugway tests. Those residues would have degraded over a period of many years. It can be assumed, then, that the toxicity and carcinogenic risks from the combustion by-products of the open burning/open detonations site 28 will thus be even less than those calculated for the Dugway tests. The site is proposed for future recreational land use. The risk levels allowed for these land-use scenarios are generally higher than the 10^{-6} level allowed for residential land use.

SNL/NM does not believe it is necessary to sample for explosives or rocket propellant at the site based on the study discussed above. Sampling of selected sites will be conducted at SNL/NM to verify the Dugway study results are applicable to the SNL sites. Due to the mine safety concerns, this site is not proposed for sampling.

ATTACHMENT 2

OU 1332, ER Site 28

Calculation of Hazard Indices and Risks From HE Detonation Test Soil Concentration Data

CALCULATION OF HAZARD INDICES AND RISKS FROM HE DETONATION TEST SOIL CONCENTRATION DATA

Scope and Purpose

A series of toxicity and cancer risk calculations were made using reported concentrations of soil residues left by HE detonation tests conducted by the U.S. DoD (U.S. Army, 1992). The purpose of this study was to preliminarily assess the potential for detonation sites at Sandia National Laboratories to pose health hazards. The calculation procedure was designed to produce conservatively large estimates of hazard index and cancer risk so that the effects of any uncertainties in the DoD soil data could be minimized. Such an approach facilitated the following reasoning regarding future assessment of the Sandia sites:

- If the conservative estimates based on the DoD data result in unacceptable risks and hazard indices, further, detailed investigations of the Sandia sites are necessary; or

- If the risk and hazard index estimates fall below recommended EPA levels, the potential for health hazards at the Sandia sites is extremely low, and only limited investigation of the sites, if any, is necessary.

Methodology and Results

Hazard indices and cancer incidences (i.e., cancer risk) were computed using methods and equations promulgated in proposed RCRA Subpart S, Appendices D and E. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and carcinogenic chemicals result from ingestion of contaminated soil. The combined effects of all chemicals potentially in the soils at a detonation site were taken into account. For toxic chemicals, this was accomplished by summing the individual hazard quotients for each chemical into a total hazard index. In the case of carcinogens, individual risks were summed.

Calculation of hazard indices required values of oral reference doses (oral RfDs) for each of the chemicals that was being assessed. Although RfDs are published for many of the chemicals observed in the HE detonation test soil residues, toxicity information for the remaining chemicals is either provisional or not readily available. To include chemicals falling into this latter category in the hazard index calculations, the Sandia ER Program asked EPA Region 6 personnel to provide appropriate RfD values. As of this writing, such data had not yet been made available. Consequently, many of the chemicals were assigned RfDs using various types of reasoning. In some cases, the assigned values were taken from published RfD data for chemicals that are similar to those for which no data is available. In other instances, an assigned RfDs was set to an arbitrarily low value, which produced a conservatively large hazard quotient.

Similarly, calculation of cancer risks required values of ingestion cancer slope factors, many of which have not been published for the chemicals observed in the HE detonation test data. Thus slope factors were also assigned to many of the chemicals, again using either published data for similar chemicals or values that led to conservatively large estimates of risk.

In addition to the above-described conservative assumptions regarding reference doses and cancer slope factors, the following steps were taken to assure that conservatism was built into the calculations:

- Several different concentrations were reported for each chemical included in the list of soil residue constituents resulting from the HE detonation tests (U.S. Army, 1992). The concentrations varied depending on the test site, the type of explosive, and distance away from the detonation center. In all risk and hazard index calculations, only the maximum observed concentration of each chemical was employed.

- Some of the chemicals occurred in soil residue at certain test sites and not at others. For the purposes of risk and hazard index calculation, it was assumed that all of the soil residue chemicals reported at some point or another in the HE detonation test results exist simultaneously in the soil. Therefore, the effects of all chemicals were added, despite the unlikelihood that an actual testing site would contain all chemicals.

- For most of the chemicals for which published RfD and slope factor values were unavailable, it was unclear as to whether each chemical was toxic, carcinogenic, or both. In the calculations, each of the chemicals falling under this category was assumed to be both toxic and carcinogenic, despite the likelihood that many of the chemicals may be neither, one or the other, but not both.

- Some of the chemicals included in the cancer risk analysis are categorized as Class C carcinogens, which, according to EPA guidelines, means that their combined risk need only meet a 1×10^{-5} prescribed risk limit. The calculations were based on the assumption that all chemicals included in the cancer risk assessment were either Class A or Class B carcinogens, which meant that all chemicals would be required to meet the more restrictive limit of 1×10^{-6}.

A list of all of the chemicals included in the hazard index and risk computations, along with their assumed soil concentrations, is presented in Table 1.

Hazard Index Calculations

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed hazard index for toxic chemicals was:

$$HI = \sum_{i} [HSR(i) \times S(i)] \tag{1}$$

where

HI	=	hazard index (dimensionless),
HSR(i)	=	hazard index-to-soil concentration ratio for the ith chemical $(\mu g/kg)^{-1}$
	=	$\dfrac{I \times A}{RfD(i) \times W} \times \dfrac{0.000001\ kg}{\mu g}$
S(i)	=	soil concentration of the ith chemical ($\mu g/kg$),
I	=	soil ingestion rate = 0.2g/day,
A	=	absorption factor (dimensionless) = 1,
W	=	body weight = 16 kg, and
RfD(i)	=	oral reference dose for the ith chemical (mg/kg-day).

Table 2 presents a list of the chemicals that were included in the hazard index calculations along with their RfD values, computed hazard quotients for each chemical, and the total estimated hazard index. Chemicals for which RfD data was unavailable, are distinguished from the chemicals that have published RfD values. The "RfD source data" column lists either the published source of the RfD values or the assumption upon which assigned values were made.

As Table 2 shows the total computed hazard index was 0.1887. This value falls far short of the maximum allowable hazard index of 1 (EPA, 1989).

Cancer Risk Calculations

Following proposed Subpart S methodology, the equation and parameter values used to calculate the summed risk for carcinogenic chemicals was:

$$RISK = \sum_{i} [RSR(i) \times S(i)] \tag{2}$$

where

RISK	=	excess cancer incidence (dimensionless),
RSR(i)	=	risk-to-soil concentration ratio for the ith chemical $(\mu g/kg)^{-1}$
	=	$\dfrac{I \times A \times CSF(i) \times ED}{W \times LT} \times \dfrac{0.000001\ kg}{\mu g}$,
S(i)	=	soil concentration of the ith chemical (μg/kg),
I	=	soil ingestion rate = 0.1 g/day,
A	=	absorption factor (dimensionless) = 1,
CSF(i)	=	cancer slope factor for the ith chemical $(mg/kg\text{-}day)^{-1}$,
ED	=	exposure duration = 70 years,
W	=	body weight = 70 kg, and
LT	=	assumed lifetime = 70 years.

The chemicals included in the cancer risk calculations, the associated slope factors, individual chemical computed risks, and the total computed risk are presented in Table 3. As in the toxic chemical assessment, chemicals having published slope factors are distinguished from the chemicals for which slope factors were assumed. Again the reasoning that went into the assignment of slope factors is summarized. As this table indicates, the total computed cancer risk was 9.924×10^{-7}. This value is less than the assumed risk limit of 1×10^{-6} (EPA, 1989).

Conclusions

Hazard index and cancer risk calculations have been conducted using soil residue chemical concentrations resulting from HE detonation tests conducted by the U.S. DoD. The computations were designed to produce conservatively large estimates of combined hazard index and risk for the purpose of screening Sandia test sites. The conservative procedures employed resulted in a total computed hazard index of 0.1887, and the calculated total risk was 9.924×10^{-7}. The EPA prescribed limits on these two indexes are, respectively, 1 and 1×10^{-6}. Thus, this preliminary assessment indicates that the soil concentrations produced during the open burning/open detonation testing at Dugway Proving Grounds pose no unacceptable risk to human health. This is based on the detonation of up to 2,000 lbs of HE and open burning up to 7,000 lbs of rocket propellant. Sandia sites that open burned or open detonated these quantities or less, under comparable conditions, would likewise be expected to pose no unacceptable risk to human health.

References

U.S. Environmental Protection Agency (EPA), 1989. Risk Assessment Guidance for Superfund: Volume I, Human Health Evaluation Manual (Part A). Office of Emergency and Remedial Response, Washington, D.C. 20460.

Headquarters, U.S. Army Armament, Munitions and Chemical Command (U.S. Army), 1992. Development of Methodology and Technology for Identifying and Quantifying Emission Products from Open Burning and Open Detonation Thermal Treatment Methods, Field Test Series A, B, C, Volume 1, Test Summary. Maintenance Management Division, Demilitarization and Technology Branch , Rock Island, Illinois.

Table 1 - List of Chemicals Included in Risk Calculations and Maximum Observed Soil Concentrations for the DOD Tests

Chemical	Soil Concentration (ug/kg)
BENZ[A]ANTHRACENE	11
BENZO[A]PYRENE	0.67
DIBENZOFURAN	29
DINITROTOLUENE, 2,4-	35
DINITROTOLUENE, 2,6-	21
DIPHENYLAMINE	97
NAPHTHALENE	510
NITRODIPHENYLAMINE, 2-	1.7
NITRONAPTHALENE, 2-	47
NITROPYRENE, 1-	1.2
NITROSODIPHENYLAMINE, N-	1.7
PHENOL	69
PYRENE	53
RDX (CYCLONITE)	15
TRINITROBENZENE, 1,3,5-	39
TRINITROTOLUENE, 2,4,6-	680

Table 2 - Reference Doses and Hazard Index Calculations

Chemical	RfD, oral chronic [mg/kg/day]	Hazard Quotient	RfD Source Data
	Data Available		
DINITROTOLUENE, 2,4-	2.00E-03	2.275E-04	IRIS
DINITROTOLUENE, 2,6-	1.00E-03	2.730E-04	IRIS
DIPHENYLAMINE	2.52E-04	5.004E-03	HEAST
PHENOL	6.00E-01	1.495E-06	IRIS
PYRENE	3.00E-02	2.297E-05	IRIS
RDX (CYCLONITE)	3.00E-03	6.500E-05	IRIS
TRINITROBENZENE, 1,3,5-	5.00E-05	1.014E-02	IRIS
TRINITROTOLUENE, 2,4,6-	5.00E-04	1.768E-02	IRIS
	Data not Available		
BENZ[A]ANTHRACENE	5.00E-05	2.860E-03	RFD LOWEST OF AVAILABLE VALUES
DIBENZOFURAN	5.00E-05	7.540E-03	RFD LOWEST OF AVAILABLE VALUES
NAPTHALENE	5.00E-05	1.326E-01	RFD LOWEST OF AVAILABLE VALUES
NITRODIPHENYLAMINE, 2-	2.52E-04	8.770E-05	RFD FROM DIPHENYLAMINE
NITRONAPTHALENE, 2-	5.00E-05	1.222E-02	RFD LOWEST OF AVAILABLE VALUES
NITROPYRENE, 1-	3.00E-02	5.200E-07	RFD FROM PYRENE
Total Hazard Index	**=**	**1.887E-01**	

HEAST= Health Affects Assessment Summary Tables (1994)
IRIS = Integrated Risk Information System

Table 3 - Cancer Slope Factors and Computed Risks

Chemical	Slope Factor, oral [mg/kg/day]-1	Cancer Class	Computed Risk	Cancer Slope Factor Source Data
	Data Available			
BENZO[A]PYRENE	7.30E+00	B2	6.847E-09	IRIS
DINITROTOLUENE, 2,4-	6.80E-01	B2	3.332E-08	IRIS
DINITROTOLUENE, 2,6-	6.80E-01	B2	1.999E-08	IRIS
NITROSODIPHENYLAMINE, N-	4.90E-03	B2	1.166E-11	IRIS
TRINITROTOLUENE, 2,4,6-	3.00E-02	C	2.310E-09	IRIS
RDX (CYCLONITE)	1.10E-01	C	2.856E-08	IRIS
	Data not Available			
BENZ[A]ANTHRACENE	7.30E+00	A/B*	1.124E-07	SLOPE FACTOR LARGEST OF AVAILABLE VALUES
DIBENZOFURAN	7.30E+00	A/B*	2.964E-07	SLOPE FACTOR LARGEST OF AVAILABLE VALUES
NITRODIPHENYLAMINE, 2-	4.90E-03	A/B*	1.166E-11	SLOPE FACTOR FROM NITROSODIPHENYLAMINE, N-
NITRONAPTHALENE, 2-	7.30E+00	A/B*	4.803E-07	SLOPE FACTOR LARGEST OF AVAILABLE VALUES
NITROPYRENE, 2-	7.30E+00	A/B*	1.226E-08	SLOPE FACTOR LARGEST OF AVAILABLE VALUES
		Total Risk =	9.924E-07	

IRIS = Integrated Risk Information System
* = assumed carcinogen group

RSI

KEQ 1/1332
1333

Department of Energy
Field Office, Albuquerque
Kirtland Area Office
P.O. Box 5400
Albuquerque New Mexico 87185-5400

JUN

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. Benito Garcia, Bureau Chief
New Mexico Environment Department
Hazardous and Radioactive Materials Bureau
2044 Galisteo Street
P.O. Box 26110
Santa Fe, NM 87505-2100

Dear Mr. Garcia:

Enclosed are two copies of the Department of Energy (DOE)/ Sandia National Laboratories/New Mexico (SNL/NM) response to the NMED Notice of Deficiency (NOD) for the third submission of No Further Action (NFA) proposals. NOD responses are provided for the following environmental restoration sites:

OU 1295 - Septic Tanks and Drain Fields
- Site 142 - Building 9970 Septic System
- Site 143 - Building 9972 Septic System
- Site 146 - Building 9920 Drain System
- Site 148 - Building 9927 Septic System

OU 1332 - Foothills Test Area
- Site 15 - Trash Pits
- Site 27 - Building 9820 Animal Disposal Pit
- Site 28-2 - Mine Shaft
- Site 28-10 - Mine Shaft
- Site 67 - Frustration Site

OU 1333 - Canyons Test Area
- Site 59 - Pendulum Site
- Site 63A - Balloon Test Area
- Site 63B - Balloon Test Area
- Site 64 - Gun Site
- Site 92 - Pressure Vessel Test Site

If you have any questions, please contact John Gould at (505) 845-6089, or Mark Jackson at (505) 845-6288.

Sincerely,

George K. Laskar

Michael J. Zamorski
for Acting Area Manager

Enclosures

Benito Garcia

cc w/enclosure:
T. Trujillo, AL, ERD
W. Cox, SNL, MS 1147
J. Parker, NMED-OB
R. Kennett, NMED-OB
D. Neleigh, EPA, Region 6 (2 copies via certified mail)

cc w/o enclosure:
B. Oms, KAO-OB
B. Galloway, SNL, MS 1147
C. Byrd, SNL, MS 1148
S. Young, SNL, MS 1147
S. Dinwiddie, NMED
T. Davis, NMED
S. Kruse, NMED

Sandia National Laboratories
Albuquerque, New Mexico
June 1997

Environmental Restoration Project
Responses to NMED Technical Comments
on No Further Action Proposals
Dated August 1995

INTRODUCTION

This document responds to comments received in a letter from the State of New Mexico Environment Department to the U.S. Department of Energy (Zamorski, April 28, 1997) documenting the review of 14 No Further Action (NFA) Proposals submitted in August 1995.

This response document is organized in sections by operable unit (OU) and subdivided in numerical order by site number. Each OU section provides NMED comments repeated in **bold** by comment number and by site number in the same order as provided in the call for response to comments. The DOE/SNL response is written in normal font style on a separate line under "<u>Response</u>". Responses to general technical comments begin on page 3 and responses to site-specific technical comments begin on page 5. Additional supporting information for the general and site-specific comments is included as figures and tables within each comment and as attachments within each section, as appropriate. When referenced in the site-specific NOD responses, risk assessment analyses will be submitted to NMED at a later date.

TABLE OF CONTENTS

Page

RESPONSES TO NMED COMMENTS
ON NO FURTHER ACTION PROPOSALS
DATED AUGUST 1995

GENERAL COMMENTS

1. **Final, rather than draft, site maps should be provided for each unit proposed for No Further Action (NFA). (Needed for adequate review)**

   Response: Final site maps for OUs 1295, 1332, and 1333 are provided in Attachment A of this section. In addition, all future NFA submittals will be submitted with final rather than draft site maps.

2. **Interviews alone are not sufficient documentation to make an NFA determination. Site history and interviews can be used to guide an investigation or confirm other evidence, but are not sufficient by themselves. In the absence of any other supporting information, screening sampling should be conducted to further corroborate the interview and site history information. (Best Professional Judgment)**

   In most cases, an NFA proposal is not likely to be approved unless it is based on some sampling and analysis of the medium/media of concern. (Best Professional Judgment)

   Response: DOE/SNL believe that, where the actual persons involved with the operation, at the time of the suspected release, provide first-hand, eyewitness accounts, they are reliable sources of information. In most cases, a combination of information is used to determine whether a release has occurred, including sampling. In some cases the suspect media has been removed, and therefore can no longer be sampled. In summary, each case must be judged individually. Where additional sampling is appropriate for those sites reviewed in the third round of NFAs, it is so stated under the site-by-site responses given below.

3. **Analytical results obtained at Environmental Restoration (ER) sites should be compared with sitewide background concentrations, when approved by the New Mexico Environment Department, to determine whether contamination has occurred. (Best Professional Judgment)**

Response: DOE/SNL are currently in the process of negotiating site-wide background concentrations with the New Mexico Environment Department (NMED), and expect that all values except those for OUs 1332, 1333, and 1334 to be approved. Upon final approval of the site-wide background study report, all OUs except for OUs 1332, 1333, and 1334 will compare analytical results to the background concentrations contained in the report. Additional background samples will be collected at OUs 1332, 1333, and 1334 upon mutual agreement with NMED of locations for such sampling.

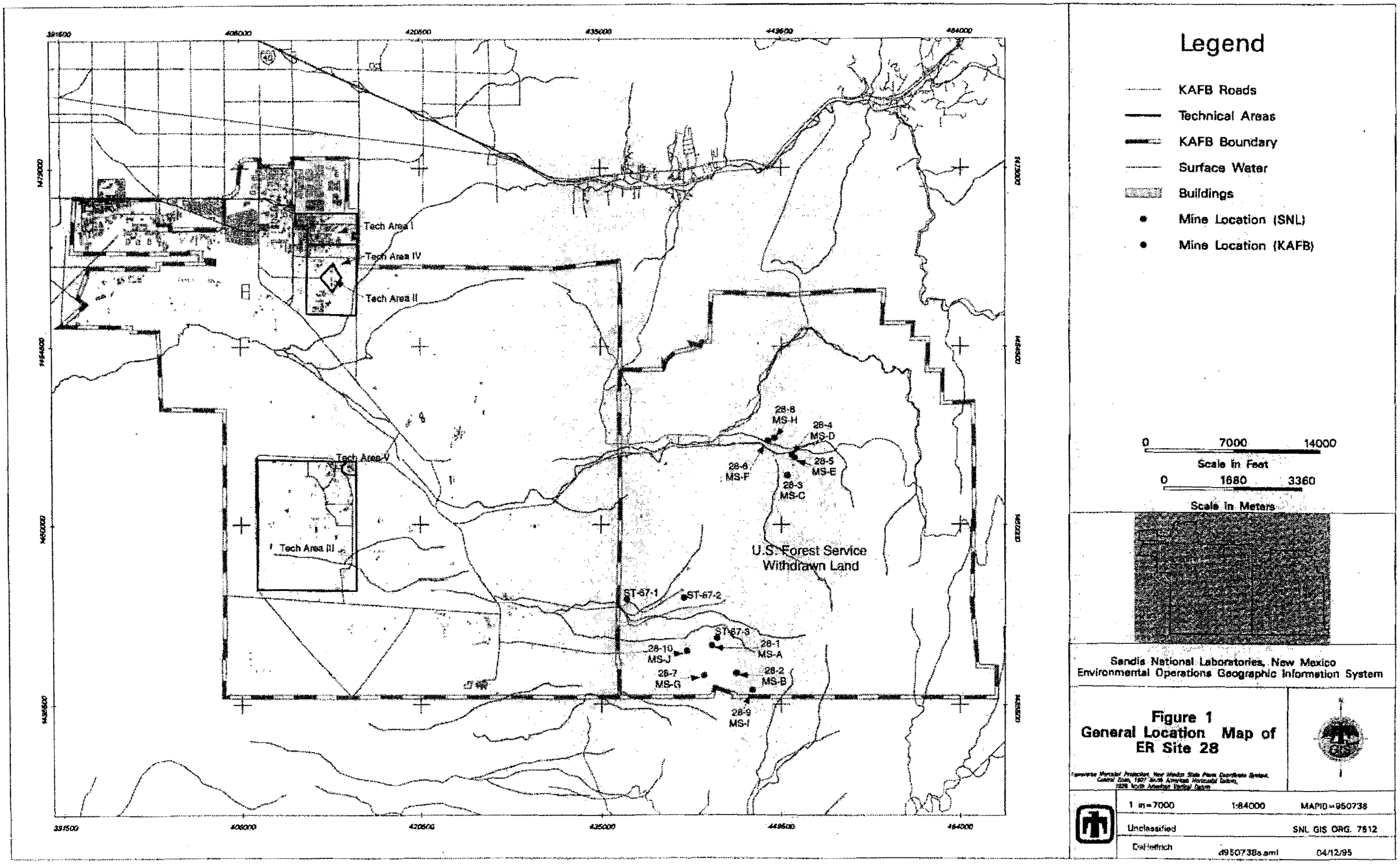
4. **A sampling and analysis plan or RFI Work Plan should be submitted prior to the start of any sampling activities conducted as a result of this Notice of Deficiency. (Permit Condition J.1)**

Response: Where sampling is anticipated, a sampling and analysis plan is developed which is provided to the NMED. Meetings with the NMED Oversight Bureau are scheduled in order to review these sampling plans and make any changes in the technical approach that would benefit the investigation. These practices will continue. However, DOE/SNL may not have always provided the NMED Hazardous and Radioactive Material Bureau with such sampling plans, or an invitation to participate in pre-sampling discussions. If that has happened, it was an oversight for which DOE/SNL apologizes. DOE/SNL will make every effort in the future to be inclusive in the pre-sampling discussions with all appropriate elements of NMED.

5. **Any sources cited in NFA proposals should be documented and referenced. The source documents should be readily available to the public and to any reviewers. (Additional information needed for adequate review)**

Response: Sources cited in all current submissions of NFA proposals are documented and referenced. General ER Project documents (e.g., RFI Work Plans, RFI Reports, NFAs, the Program Implementation Plan, etc.) are available to the public and other reviewers at the DOE Public Reading Room located at the Library Building at Albuquerque Technical-Vocational Institute, Joseph M. Montoya Campus, at 4700 Morris Avenue, NE. DOE/KAO will continue its practice of simultaneously transmitting to NMED copies of all documents sent to the Public Reading Room. OU-specific archival references are located at the ER Project Records Center. The public and regulators can access information from the ER Project Records Center by verbal or written request to John Gould, DOE/KAO, at (505) 845-6089.

FINAL SITE MAPS FOR OU 1332



Legend
KAFB Roads
Technical Areas
KAFB Boundary
Surface Water
Buildings
Mine Location (SNL)
Mine Location (KAFB)
Tech Area I
Tech Area IV
Tech Area II
Tech Area V
Tech Area III
U.S. Forest Service Withdrawn Land
28-8 MS-H
28-4 MS-D
28-6 MS-F
28-5 MS-E
28-3 MS-C
ST-67-1
ST-67-2
ST-67-3
28-1 MS-A
28-10 MS-J
28-7 MS-G
28-2 MS-B
28-9 MS-I
391500
406000
420500
435000
449500
464000
0 7000 14000
Scale in Feet
0 1680 3360
Scale in Meters
Sandia National Laboratories, New Mexico
Environmental Operations Geographic Information System
Figure 1
General Location Map of ER Site 28
1 in=7000
1:84000
MAPID=950738
Unclassified
SNL GIS ORG. 7512
04/12/95

18. **Additionally, background soil samples for analysis of gross α and gross β activity must be collected. (Best Professional Judgment)**

Response: Site-specific background samples will be collected for gross alpha and gross beta.

19. **Any mine adits, shafts and pits posing a health or safety hazard should be sealed or fenced, and appropriate warning signs installed. (The Abandoned Mine Lands Bureau, Mining and Minerals Division, New Mexico Energy, Minerals and Natural Resources Department can be contacted for assistance (505-827-5970).) (Best Professional Judgment)**

Response: Mines posing a health and safety hazard will be sealed or fenced. Warning signs will be installed on fenced mines.

Site 28-2, OU 1332

20. **Information on and results of the Radiation Survey of Kirtland Air Force Base/Department of Energy Controlled Areas conducted on August 18, 1989 must be submitted for review. (Best Professional Judgment)**

Response: Results of all radiation surveys are included as Attachment B to this section.

21. **The lower adit appears to have been used for experimental or disposal purposes. Due to the uncertainty regarding the presence and/or release of hazardous and radioactive constituents at this site, a worst case risk assessment must be submitted. The risk assessment must address all appropriate hazardous and radioactive constituents. A recreational future land use must be assumed. At a minimum, the ground water pathway and ground water to surface water pathway must be addressed. (Best Professional Judgment)**

Response: A risk assessment will be conducted and submitted as requested. DOE/SNL would like to meet with NMED to better define input parameters.

22. **Cross-sections of the suspected disposal area behind the concrete block, showing all excavations and backfilling, must be submitted. (Additional information required for adequate review)**

Response: The request to provide cross-sections of the mine would require mine entrance, coring the floor with heavy equipment, and measuring backfill. The cross-sections are not required to conduct the risk assessment approach developed at the April 16, 1997, meeting. Since the cross-section is not necessary for the developed approach, the required mine entrance does not seem warranted.

The proposed approach for this site was developed from discussions with NMED and EPA personnel during a tour on April 16, 1997, and is discussed in greater detail in the response to OU 1332 Workplan comments sent to NMED May 8, 1997. The approach involves conducting a risk assessment using conservative assumptions about source terms, migration pathways, and receptors. If acceptable risk is found from this assessment, no further work is warranted. DOE/SNL believes that the risk at a site should include real-time risks to site workers conducting assessment/cleanup activities. The 28-2 mine is clearly unstable, based on the obvious collapse of the mine opening. The historical records indicate that SNL personnel walked into the mine without obstruction when the mine was used decades earlier. Currently there is only a small opening through which personnel could crawl into the mine. Any further collapse could trap personnel in the mine. The cost to stabilize the mine adequately for personnel entrance under applicable safety regulations would be very substantial.

23. **The original field reports must be provided as appendices in the NFA proposal. (Additional information needed for adequate review)**

    Response: Copies of original field reports are included as Attachment C to this section.

Site 28-10, OU 1332

24. **The "slag" around the shaft near the top of the hill must be sampled and analyzed for RCRA hazardous constituents. (Best Professional Judgment)**

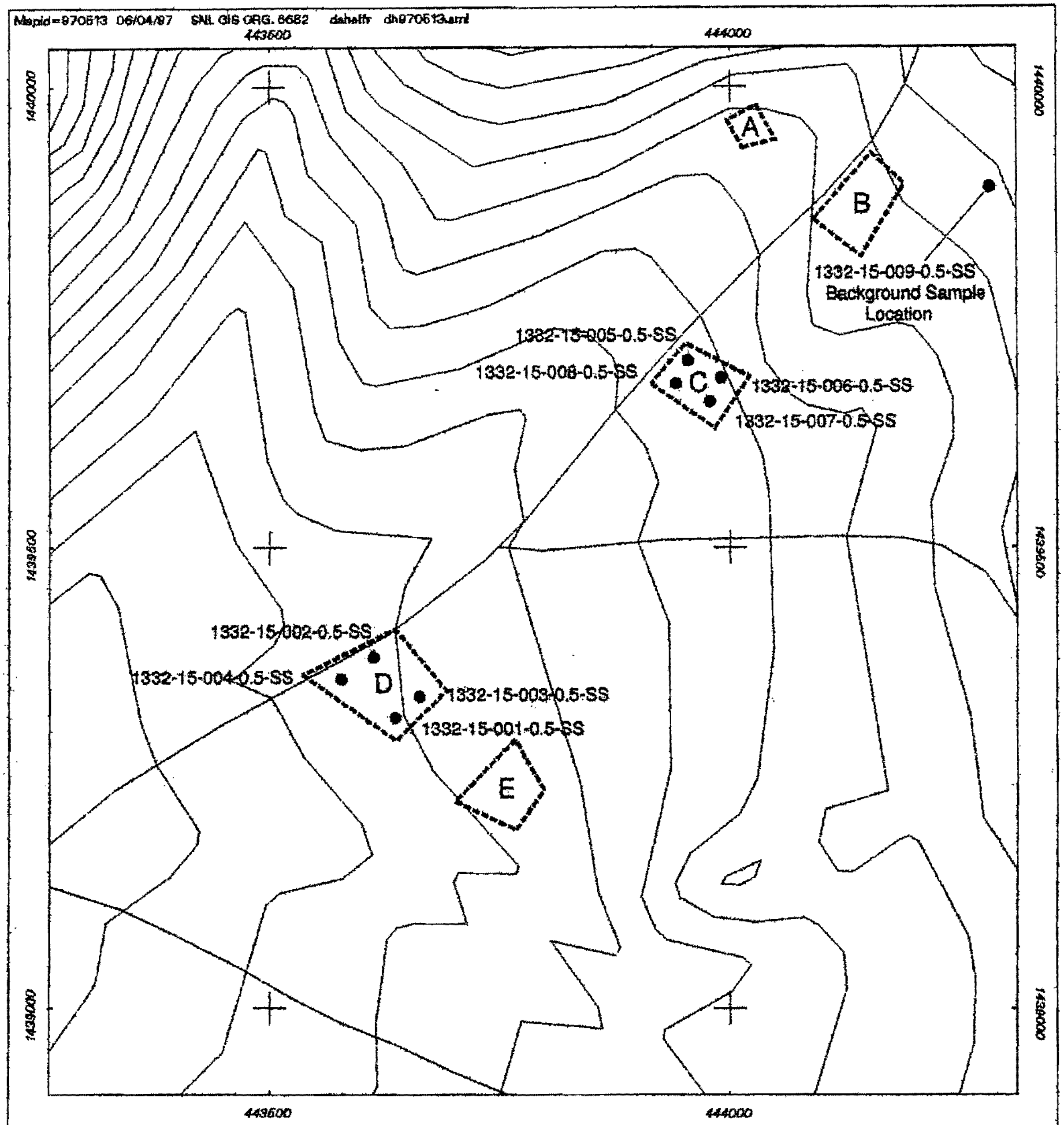
    Response: The slag will be analyzed for RCRA metals and gamma spec.

25. **A modern road leads to what may be a backfilled portal or open cut near the base of the eastern side of the hill. This "working" must be dug out with a back hoe and inspected for evidence of previous testing, waste disposal or waste storage. If such evidence is found, then the site must be sampled and further characterized. (Best Professional Judgment)**

    Response: The disturbed area will be investigated as requested.

ATTACHMENT A

CORRECTED SITE MAP



Legend

- Sample Location
- Road
- 10 Foot Contour
- Disturbed Area

Note: Areas A,B,C,D, & E are identified in aerial photographs, indicating potential areas of excavation

Figure 1
ER Site 15
Trash Pits

0 87.5 175
Scale in Feet

0 21 42
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

ATTACHMENT B

RESULTS OF RADIATION SURVEYS

Radiation Survey of KAFB/DOE Controlled Areas, Kirtland Air Force Base, Albuquerque, NM

Douglas M. Minnema
Reactor Applications Division, 6451
and
George E. Tucker
Health Physics Division, 3212
Issued August 18, 1989

INTRODUCTION

Sandia National Labs (SNL) has performed a number of outdoor tests on weapons components and systems over the past forty years. Some of these tests involved the inclusion of radioactive material, primarily natural or depleted uranium. Increased concern over environmental issues, coupled with decreased acceptable limits, has resulted in reevaluating the test areas for potential low level contamination. As a result of this concern, SNL has performed a radiation survey of selected sites on Department of Energy (DOE), Forest Service, and Air Force areas on Kirtland Air Force Base (KAFB), Albuquerque, New Mexico. The sites studied were selected based upon input from three sources: KAFB site maps, the results of an EG&G helicopter survey of April, 1980, and interviews of selected SNL staff. The KAFB maps indicated several sites that were identified by an inspection performed by the Defense Nuclear Agency and a private firm contracted by the U.S. Air Force (ref. 1 & 2). These sites consisted of dirt mounds, test sites, and old mine diggings. The helicopter survey identified areas of above background radiation levels in the area. The interviews helped identify other sites that were known locations of past tests.

INSTRUMENTATION

The surveys were performed using SNL's mobile radiation measurement lab, consisting of a computerized multichannel analyzer, a portable intrinsic germanium gamma spectrometer, and various other portable instruments, housed in a trailer. The gamma spectrometer could be operated at distances up to 300 meters from the trailer, allowing the radiation spectra at each site to be measured directly. Also, soil and debris samples could be analyzed with the spectrometer mounted within a lead shield in the trailer. For the more inaccessible sites, a portable multichannel analyzer and battery pack were used with the spectrometer to acquire the spectra.

Each site was studied according to its particular situation. Horizontal mine shafts were entered and inspected visually and with a portable high sensitivity radiation meter, and spectra were acquired at any locations within the shaft above local background. The spectrometer was lowered into vertical shafts, or a sodium-iodide (NaI) detector was used, depending upon the condition of the shaft. Dirt mounds were surveyed at several locations around and on the top. Surface areas were evaluated by mounting the spectrometer on a tripod and analyzing spectra at several locations within the identified area. If the area surveys showed above background readings or isotopes not normally associated with background, grab samples of soil and debris were also collected and analyzed as appropriate.

The germanium spectrometer is very sensitive for most of the uses described here. Surface contamination can be detected down to levels of approximately 0.2 picoCuries per gram (pCi/g) of soil, and individual contributors of a radiation field can be identified at levels of roughly 5% of the total field. The spectrometer's resolution is sufficient to identify individual peaks that are less than 0.2% apart in gamma energies. This sensitivity is extremely good for looking at surface contamination and sources that may have been disposed of in mines. The technique is more limited in looking for buried sources due to attenuation of the radiation in the soil cover. A stronger radiation source would be required to penetrate greater than roughly 1 meter of cover soil with sufficient intensity to be detected by the spectrometer, raising the minimum detectable level to the equivalent of a few microCuries per gram for buried sources. This presented a problem for only one site consisting of 3 covered trenches of unknown depth, since all other sites had minimal or no cover. As an example of the spectrometer's sensitivity and accuracy, Cesium-137 from atmospheric weapons testing fallout was observed in almost all of the surface spectra at levels averaging roughly 0.3 to 0.5 pCi/g, agreeing well with the average found from SNL's environmental monitoring program of 0.388 pCi/g (ref. 5).

IDENTIFICATION OF SITES

The KAFB map "Radioactive Contaminated Sites, Kirtland Air Force Base", tab #C1.1a (ref. 3), identified a total of 6 dirt mounds (DM-1 through 6) and 6 mine shafts (MS-A through F) that the USAF contractor's inspection had found to be either unposted, or posted with various warning signs with no documented explanation for the purpose or contents of the location. During our investigations of these sites, 4 additional shafts (MS-G through J) were found and included in the study, and two shafts were identified at sites MS-B through D, rather than the single shafts indicated on map C1.1a, and all were included in the study. Also, the site identified as dirt mound DM-3 on map C1.1a was actually a group of 3 old burn pits.

The EG&G helicopter survey of April, 1981 (ref. 4), was consulted as another possible source for locating sites. One site in particular, listed as 'Area 5' in their survey (not to be confused with SNL Tech Area V) was identified as having higher than normal levels of uranium daughter products. This area is directly south of the southern boundary of Manzano Base. Investigations indicated that there were no known tests conducted in this area, so this site was also included in the survey.

Interviews with SNL personnel helped to identify another site of possible contamination, the "Pendulum Site" located directly east of Manzano Base. At this site weapon penetration tests had been conducted in a protected bunker until a test device exploded, destroying the bunker and potentially spreading depleted uranium into the surrounding area. Although this site was cleaned at the time, it was included in this survey. Some other sites were suggested as having potential for contamination, however these sites are currently in use and are monitored by the Health Physics division, and so were not included in this survey.

RESULTS OF THE SURVEY

The results of the survey can be divided into groups based upon the type of site studied. None of the 11 mines surveyed showed any signs of having been used for radioactive waste disposal. The radiation spectra showed nothing more than variations in background levels due to the types of rocks found at each location. Visual inspection of the horizontal shafts suggest that these mines were mainly exploratory shafts from prospectors working the area, however a few show signs of commercial production before they were abandoned. The vertical shafts show similar indications that they were also developed by prospectors, although these were not entered for visual inspection due to hazardous conditions. Only one shaft requires special mention, the one labeled as MS-B on map C1.1a. There has been some recent activity at this mine of unknown intent. For unknown reasons the entrance was posted with a radiation warning sign. This study, however, indicated that the sign is unwarranted and should be removed. It should be noted that all of these mines are in poor repair, and represent conventional safety hazards that should be appropriately fenced and posted to prevent an accident. The shafts are easily accessible and some are hidden from view by underbrush, enhancing the possibility of somebody stumbling into them unknowingly.

The KAFB maps also identified 6 dirt mounds that were listed as 'possible burial sites'. As mentioned, one of these sites turned out to be an old burn test site with 3 pits, labeled DM-3 on map C1.1a. One of these pits was locally contaminated with ceramic thoria thermocouple insulation debris from a burn test. This debris was confined to within one pit, and SNL Health Physics has cleaned up this site and disposed of the debris. Survey and grab samples of the surrounding area and the other pits show no other contamination present. Two other mounds in the same general area, labeled as DM-1 and DM-2, were also surveyed. Radiation spectra at these mounds show nothing unusual, and the dirt mounds are not high enough to significantly shield any sources. These sites are fenced with two sets of signs posted. The older, faded signs label the area as an explosive test area, and the newer signs label the area as a radiation area. These sites are most likely disposal sites for old explosive ordinance removed from the area, and are believed to be clean of radioactive contamination. The remaining 3 sites, DM-4, 5, and 6, are located in the Lawrence Canyon area. These sites are actually located roughly 600 meters east of their recorded positions on the base maps. These mounds line up directly with the old 155mm gun site north of their location, and were used as targets when that facility was in operation. Radiation spectra show nothing unusual at these mounds, and they are believed to be clean also.

The 'area 5' location reported in the EG&G helicopter survey was also investigated. The site was found to be a natural lava mound formed by an uprising of a brown lava rock. Apparently as the brown rock cooled it fractured, and a darker metallic lava was pushed up through the fissures and cooled in place. Radiation levels in the area were found to be roughly twice the normal background. Since no man-made source could be found, the rocks were analyzed, and the metallic rock was found to contain natural uranium at levels roughly four times the concentrations in the brown lava. This is a completely natural occurrence and not caused by any practices of KAFB or SNL personnel, therefore cleanup of the site would be both impractical and unnecessary. There may well be other similar occurrences in the area, although none were positively identified. The presence of natural uranium deposits probably explains why the helicopter survey indicated slightly higher background levels in and around the mountainous areas than those observed on the mesa.

The next site surveyed was the Pendulum Site. Several years ago penetration tests were performed inside an earth covered bunker built into the side of a small hill using devices with depleted uranium loadings. The last test resulted in an explosion that blew the roof off the bunker and destroyed the facility. This area was studied for possible uranium contamination with a series of soil samples. Out of 8 samples, only one showed any signs of contamination, and only at a level of 60 pCi/g, compared to the natural uranium average background concentration of 0.9 pCi/g reported in the SNL environmental monitoring program (ref. 5). The contaminated area was a small pile of vermiculite, and was cleaned up easily. This site is now believed to be clean of contamination.

One other site was also found through the interviews, a series of 3 filled trenches east of Pennsylvania Road across from the NATO Evaluation Site, near a small arroya. This site is on Air Force land, and is vaguely posted as a radiation area, although the signs are roughly 60 meters away from the trenches. (It is not clear whether the signs are intended for the trenches or for a USAF training area further to the east of the site, known to be contaminated with thorium ore.) The trenches are marked with two wooden stakes, apparently indicating the trench ends, and with a yellow metal post in roughly the center of the trenches (this posting corresponds with a 'dated' method for identifying radioactive waste burial areas). There are no other markings or signs, and inquiries to the Air Force have yielded no information. Radiation spectra acquired above the trenches indicate nothing above background; however, the depth of the trenches could severely limit the detection capabilities of the spectrometer due to the amount of cover soil. The trenches are on KAFB property, and the military has been notified of their condition. As a minimum precaution the trenches should be better identified.

CONCLUSIONS

With the exception of the trenches across from the NATO Site, and the two sites that have since been cleaned up, nothing unusual was found at any of the sites. These sites should be considered clean of any radioactive contamination and removed from the maps, including the old burn site and the Pendulum site, since they have been cleaned up as required. All radiation signs should be removed to avoid confusion, and the two mounds believed to be explosives disposals should be either cleaned up or reposted as such. It is further recommended that the mine shafts be sealed off and labeled to reduce the hazardous conditions that exist at these sites.

REFERENCES

1. "Radioactive Waste Survey", August 16, 1971, performed by the Defense Nuclear Agency, Headquarters Field Command, KAFB.

2. "Installation Restoration Program, Phase I Records Search, Hazardous Materials Disposal Sites, KAFB", performed by Engineering-Science, 57 Executive Park South, NE, Suite 590, Atlanta, GA, 30329 (Draft report only).

3. "Radioactive Contaminated Sites, Kirtland Air Force Base", a base map, tab # Cl.la, revised to 9/30/82.

4. "An Aerial Radiological Survey of the United States Department of Energy's Sandia National Laboratories and Inhalation Toxicology Research Institute, Albuquerque, New Mexico", P. K. Boyns, project scientist; date of survey, April, 1981; The Remote Sensing Laboratory operated for the U.S. DOE by EG&G Energy Measurements Group.

5. "1982 Environmental Monitoring Report, Sandia National Laboratories, Albuquerque, New Mexico", Gloria Chavez Millard, Charles E. Gray, Theodore N. Simmons, Bill L. O'Neal. SAND83-0789, printed April 1983.

INSTALLATION RESTORATION PROGRAM

PHASE I – RECORDS SEARCH, HAZARDOUS MATERIALS DISPOSAL SITES

KIRTLAND AFB, NEW MEXICO

PREPARED FOR

UNITED STATES AIR FORCE AFESC/DEV

Tyndall AFB, Florida

NOVEMBER, 1981

DM-3 were also fenced. These three mounds were resurveyed during the fall of 1980 with no indication of radiation levels above background.

Mine Shafts

Two horizontal and four vertical mine shafts have been identified as possible radioactive burial sites. The mine shafts are shown as MS-1 through MS-5 on Figure 4.16. In a 1971 survey of potential radioactive burial sites on the former Sandia Base, several of these mine shafts exhibited radiation levels of 2 to 3 times typical background levels. There is no indication of what, if anything, is contained in the mine shafts. A more recent survey in 1980 with the fidler probe indicated no increase above background radiation levels at mine shafts MS-2, MS-4, MS-5, and MS-6. The other two areas (MS-1 and MS-3) were not rechecked.

EVALUATION OF PAST DISPOSAL ACTIVITIES AND FACILITIES

The review of past operation and maintenance functions and past waste management practices at Kirtland AFB has resulted in the identification of 31 sites containing hazardous waste materials and having the potential for migration of contamination off the base boundaries. Other sites were reviewed and eliminated from further evaluation based on the logic presented in the decision tree shown in Figure 4.1. Three sites (RB-1, RB-3 and the chemical waste landfill) are located on DOE owned property, not Kirtland AFB property and have been tabulated separately from the other 31 sites (Appendix I).

The 34 sites have been assessed using a rating system which takes into account characteristics of potential receptors, pathways of migration of contaminants, waste characteristics, and specific characteristics of the site related to waste management practices. The details of the rating procedure are presented in Appendix G and the results of the assessment are summarized in Table 4.14 for sites on Kirtland AFB and Table 4.15 for the three sites on DOE property. The sites are listed in order of ranking, based on the rating scores developed for the individual location. The rating system is designed to indicate the relative need for more detailed site assessment and/or remedial action.

RB-10 is an open site used for disposal of low level radioactive contaminated test animals and tissues. The site is located by the Lovelace Facility and is within 500 feet of the base boundary. The nearest active drinking water well is over three miles away and the ground-water depth in this area is believed to be about 50 feet (subject to confirmation). The RB-10 site received a rating score of 32.

b) Radioactive liquid holding tanks (RB-4, 5, 6, 8 and 9), the dirt mounds and the mine shafts appear to pose little potential for water contamination problems. RB-4, 5, 6, 8 and 9 are emergency underground holding tanks which would only receive contaminated material (low-level radioactive liquid waste) in the event of an emergency. The waste material would then be removed from the tanks and disposed of at another location. The rating score for these sites was 23.

Recent investigations of the dirt mounds and mine shafts have not detected any radiation levels above background level and no evidence has been found to indicate hazardous materials are present at these locations.

3) Fire Training Area

a) The main base fire training area (located by the FAA tower) ranks high as a potential contamination site because of the large quantity of JP-4, foam and waste chemicals that were used at the old fire training pit and the very permeable soil conditions. Fire training procedures have changed; the use of waste chemicals has been eliminated, fire training is conducted less frequently and a concrete liner has been constructed in the pit. However, the past practice have probably left chemical materials in the soil. Therefore, this site received a rating score of 50.

b) The old fire training area by Manzano has a rating score of 35 and is not considered to have as great a potential for contaminant migration as the main base fire training area. The Manzano fire training area was used less frequently than the main base site and no waste chemicals were known to be burned at the site.

Ref 41

United States Government **Department of Energy**

memorandum

Albuquerque Operations Office

Site 28 (Mites near Frust. Site)

DATE: JUL 26 1989

REPLY TO ATTN OF: MSD:ESHB:BHY

SUBJECT: Radiological Survey Reports on the Frustration and No-Name Abandoned Mine Sites.

TO: P. M. Stanford, Controller, 0100, SNLA

It is the Department of Energy's (DOE) understanding that Sandia National Laboratories (SNL) completed radiological surveys of the above areas around two-years ago. The old mine sites were used as SNL experimental stations. It is also our understanding that reports were written on the results of the surveys and the areas are clean of radioactive materials and contamination. Due to proposed land use changes in that area, it is paramount that the mine areas be officially cleared, since both sites are still posted with radioactive area signs.

We need copies of the previous radiological reports. DOE conducted a new survey on the sites due to changing survey requirements, but having previous reports will substantiate any new information.

Please contact Bennett H. Young of my staff at 846-8211, regarding the status of these much needed radiological reports by August 1, 1989.

Sincerely,

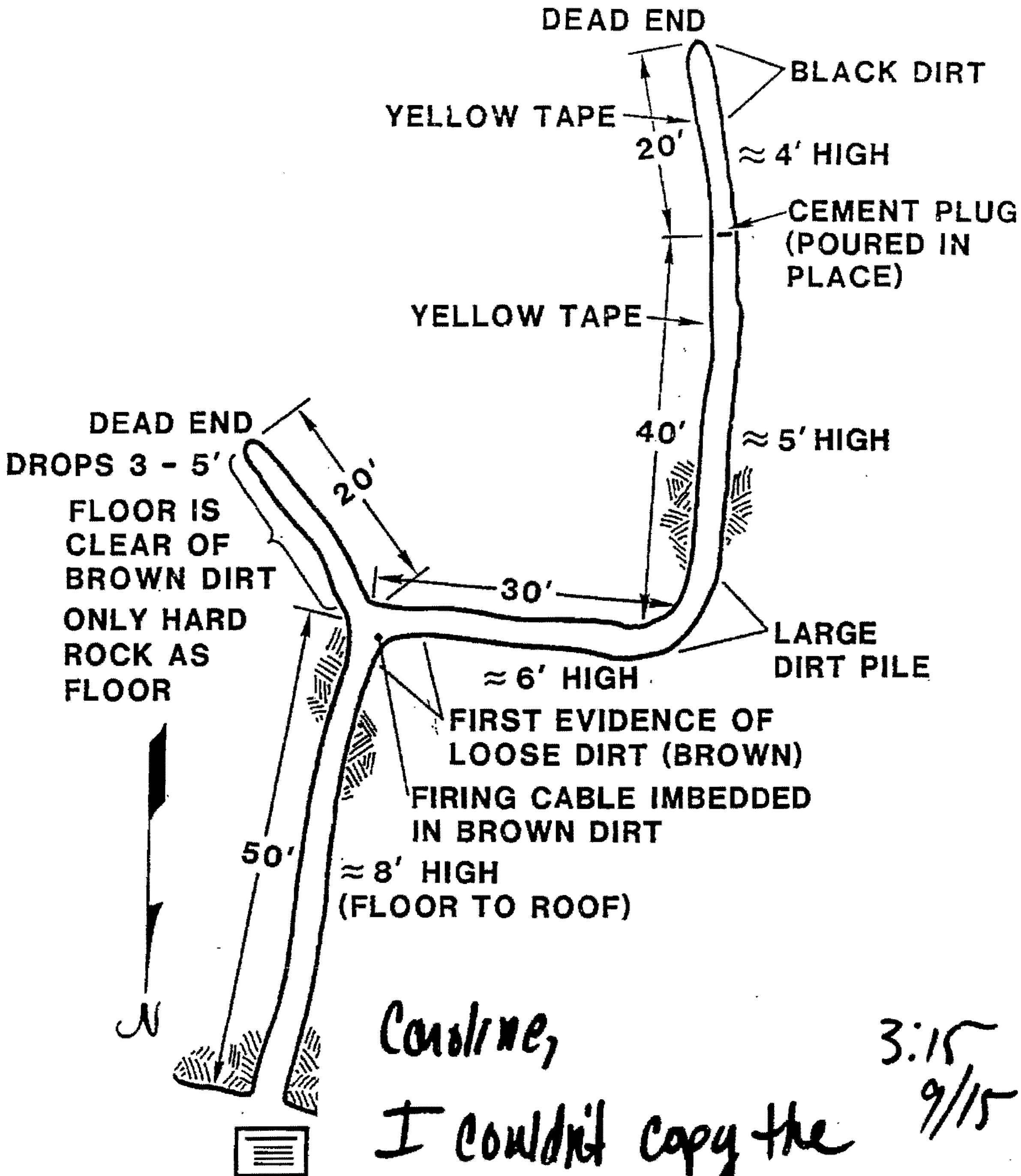
AR Chernoff

Albert R. Chernoff
Director, Management
Support Division

cc:
G. Tucker, 3312, SNLA
J. Phelan, 3314, SNLL,
H. Davidson, 1606 ABW/DEEU
B. Dow, 1606 ABW/DEEU
B. Young, MSD
P. Boehme, MSD

Check on who still owns/claims mines from BLM next to Price Club

Ref 41



Caroline,

3:15
9/15

I couldn't copy the map. But I'm sure that someone else could shrink it in the record center.

Veronica

ER 1297-28

INDUSTRIAL HYGIENE SERVICES

Laboratory Services and Chain of Custody Form

SF 2040-HA(5-88)

Page _____ of _____

Submitted by	Org	For Zone I.H.	Date Submitted
W. A. DURAND	B202		11 13 89 (Mo. Day Yr.)

Lab Log No.	Report Date	Analyst
891947 to	02 05 90 (Mo. Day Yr.)	GRAY / Thompson

Contaminant	Contaminant Code (CAS)	Analytical Method No.
Uranium		Fluorometric / γ Scan

Sample Type: ☐ Air ☐ Water ☒ Soil ☐ Veg. ☐ Oil ☐ Urine ☐ Blood ☐ Prod. I.D. ☐ Qual./Quan. ☐ Swipe ☐ Misc.

Reference: Employee ______ Building/Room 4 Pier 714

Analysis Requested: TOTAL URANIUM Priority: ☐ Rush ☒ Usual

Log No.	Sample Description	Results	Units
891947	MINE SHAFT SOIL 000295	See attached for	
		γ's detected. No	
		^{234}Th or ^{234}Pa detected which	
		would indicate U.	
		No Uranium detected by	
		fluorometric analysis above bkg.	
Charlie –		2.4 ug/g ± .2 ug/g	
I was looking for a Total		Uranium	
number			

(Continue entries on additional sheets; attach together.)

Relinquished By: W Durand Date/Time 11-13-89 5:35 Received By: K. Greulich Date/Time 11/13/89 3:35 pm

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Disposal Instructions Toss Disposal By: CMG Date/Time 3/5/90 11 am

Approved by: Charles Gray (Chem. Lab) 2/5/90 (Date) ______ (3311 Supervisor) ______ (Date)

REV 4] ER 1297-28

INDUSTRIAL HYGIENE SERVICES

Laboratory Services and Chain of Custody Form

SF 2040-NA(5-88)

Page ____ of ____

Submitted by	Org.	For Zone I.H.	Date Submitted (Mo. Day Yr.)
W A DURAND	3202		11 13 89

Lab Log No.	Report Date (Mo. Day Yr.)	Analyst
891947 to	02 05 90	GRAY / Thompson

Contaminant	Contaminant Code (CAS)	Analytical Method No.
Uranium		Fluorometric / γ Scan

Sample Type: ☐ Air ☐ Water ☒ Soil ☐ Veg. ☐ Oil ☐ Urine ☐ Blood ☐ Prod. I.D. ☐ Qual./Quan. ☐ Swipe ☐ Misc.

Reference: Employee ______ Building/Room Area III

Analysis Requested: TOTAL URANIUM   Priority: ☐ Rush ☒ Usual

Log No.	Sample Description	Results	Units
891947L	MINE SHAFT SOIL 000255	See attached for γ's detected. No ^{234}Th or ^{234}Pa detected which would indicate U.	
		No Uranium detected by fluorometric analysis above bkg.	

(Continue entries on additional sheets; attach together.)

Relinquished By: [signature] Date/Time 11-13-89 5:35 Received By: K. Greulich Date/Time 11/13/89 3:35 pm

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Disposal Instructions Toss Disposal By: [initials] Date/Time 2/5/90 11:20am

Approved by: Charles Gray (Chem. Lab) 2/5/90 (Date) ______ (3311 Supervisor) ______ (Date)

Ref 41

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                                     *
*          G A M M A   S P E C T R U M   A N A L Y S I S              *
*                                                                     *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

CANBERRA SPECTRAN-F V4.0

Division 3313 Radiation Diagnostic Lab 01-FEB-90 13:41:29

A N A L Y S I S   P A R A M E T E R S

MCA Unit Number: 1 / ADC Unit Number: 1.1
Detector Number: 1 / Geometry Number: 30
Spectrum Size: 4096 channels from MCA Region FULL
Order of Smoothing Function: 5
Number of Background Channels: 4 on each side of peak
Peak Confidence Factor: 95.0%
Multiplet Sensitivity: 4
Identification Energy Window: +- 2.00 keV
Error Quotation: 1.00 sigma uncertainty

Environmental Background Subtracted
LLD Calculation Performed
Multiplet Analysis NOT Performed

Regular Output
Spectral data read directly from Multichannel Analyzer AN0
Analyzed by: djt

Sample Description: 90-007
Geometry Description: Marinelli Beaker
Sample Size: 4.7700E+02 gm / Conversion Factor: 1.0000E+00
Standard Size: 8.9000E+02 gm
Analysis Library file: ANL003

COLLECT started on 29-JAN-90 at 13:50:00

COLLECT Live Time: 6000. seconds
Real Time: 6009. seconds
Dead Time: 0.15 %

Decayed to 0. days, 0.0000 hours BEFORE the start of COLLECT

Energy Calibration performed 5-OCT-89
Efficiency Calibration performed 10-OCT-89

Ref 41

P E A K   A N A L Y S I S

PK	Centroid channel	Energy keV	FWHM keV	Backgnd counts	Net Area counts	Error %	Nuclides
1	127.23	63.62	1.2	1076.	221.	22.7	TH-234
1B		63.44			43.	32.3	
2M	154.51	77.27	1.4	2596.	2471.	4.3	
3M	174.46	87.25	1.1	2211.	682.	12.3	CD-109
4	186.20	93.13	1.3	943.	450.	10.5	TH-234
4B		92.75			54.	27.1	
5	258.51	129.31	1.3	783.	213.	19.8	CS134M,PU-239
6	372.11	186.15	1.7	631.	557.	7.7	RA-226
7	418.60	209.41	1.4	551.	378.	10.2	U-237,NP-239
8M	477.43	238.85	1.3	990.	4063.	2.1	PB-212
8B		238.84			48.	23.9	
9	540.30	270.30	1.2	402.	325.	10.6	
10	590.61	295.47	1.4	392.	912.	4.6	PB-214,GA-73
11	600.31	300.33	1.2	414.	186.	17.6	PB-212
12	655.89	328.13	1.6	390.	164.	19.7	LA-140
13	676.88	338.63	1.5	321.	671.	5.5	AC-228,CS-136
14	704.05	352.22	1.5	273.	1609.	2.9	PB-214
14B		351.99			24.	32.8	
15	926.31	463.41	1.5	253.	195.	14.5	CS-138
16	1021.78	511.16	1.8	221.	495.	6.4	TL-208,NA-22,
16B		511.07			116.	10.8	ANN-RD
17	1166.64	583.62	1.4	175.	1132.	3.5	TL-208
18	1218.90	609.75	1.5	188.	1095.	3.6	XE-135,BI-214
18B		608.59			14.	39.6	
19	1454.71	727.69	1.8	164.	257.	9.9	BI-212
20	1536.72	768.70	1.4	103.	90.	18.8	
21	1589.97	795.32	1.6	144.	95.	22.5	CS-134
22	1721.38	861.03	1.9	88.	148.	12.3	BI-212
23	1822.93	911.81	1.8	131.	762.	4.3	AC-228
24	1929.96	965.32	0.9	149.	75.	26.5	
25	2241.53	1121.08	1.8	167.	280.	9.6	BI-214,SC-46, TA-182
26	2476.84	1238.70	2.3	224.	65.	40.1	BI-214,CO-56
27	2817.20	1408.81	1.2	21.	54.	18.7	
28	2922.88	1461.62	2.0	54.	3702.	1.7	K-40
29	3177.40	1588.80	1.3	25.	54.	18.9	
30	3242.93	1621.54	1.3	14.	12.	51.3	BI-212
31	3261.75	1630.95	2.2	21.	32.	27.9	
32	3278.13	1639.13	0.8	15.	17.	43.1	
33	3460.99	1730.49	2.2	12.	44.	19.6	
34	3531.23	1765.58	2.5	10.	222.	7.2	BI-214

ror Quotation at 1.00 sigma
.eak Confidence Level at 95.0%

M - Possible Multiplet
B - Environmental Background peak

Background Subtraction performed using file BK0001
Background Description: 100 min BKG
Background COLLECT started on 12-OCT-89 at 14:26:00

Ref 41

Division 3313 Radiation Diagnostic Lab 01-FEB-90 13:41:29

Sample: 90-007
Data collected on 29-JAN-90 at 13:50:00
Decayed to 0. days, 0.0000 hours BEFORE the start of COLLECT.

RADIONUCLIDE ANALYSIS REPORT

Nuclide	Activity Concentration in pCi /gm Measured	Error	Decay corrected	Error
AM-241	LLD<4.73E-01		LLD<4.73E-01	
CO-57	LLD<3.42E-02		LLD<3.42E-02	
CE-144	LLD<2.86E-01		LLD<2.86E-01	
CR-51	LLD<2.61E-01		LLD<2.61E-01	
PB-214	1.16E+00	+- 3.67E-02	1.16E+00	+- 3.67E-02
SB-125	LLD<9.10E-02		LLD<9.10E-02	
BE-7	LLD<2.84E-01		LLD<2.84E-01	
TL-208	5.39E-01	+- 1.87E-02	5.39E-01	+- 1.87E-02
CS-134	LLD<6.48E-02		LLD<6.48E-02	
BI-214	9.73E-01	+- 3.58E-02	9.73E-01	+- 3.58E-02
RU-106	LLD<3.10E-01		LLD<3.10E-01	
CS-137	LLD<4.15E-02		LLD<4.15E-02	
I-212	1.07E+00	+- 1.05E-01	1.07E+00	+- 1.05E-01
R-95	LLD<6.76E-02		LLD<6.76E-02	
CO-58	LLD<3.72E-02		LLD<3.72E-02	
MN-54	LLD<3.80E-02		LLD<3.80E-02	
AC-228	LLD<1.60E-01		LLD<1.60E-01	
ZN-65	LLD<1.21E-01		LLD<1.21E-01	
NA-22	LLD<5.54E-02		LLD<5.54E-02	
CO-60	LLD<4.66E-02		LLD<4.66E-02	
NA-24	LLD<4.27E-02		LLD<4.27E-02	
K-40	3.14E+01	+- 5.32E-01	3.14E+01	+- 5.32E-01
Total	3.51E+01	+- 5.45E-01	3.51E+01	+- 5.45E-01

Error Quotation at 1.00 Sigma
LLD Confidence Level at 95.0%

Ref 41

PEAKS NOT IDENTIFIED

Centroid channel	Energy keV	Net Area counts	Error %	Gammas/sec
127.23	63.62	177.	29.3	2.55E+00
154.51	77.27	2471.	4.3	1.80E+01
174.46	87.25	682.	12.3	3.63E+00
186.20	93.13	396.	12.4	1.84E+00
258.51	129.31	213.	19.8	7.40E-01
372.11	186.15	557.	7.7	2.03E+00
418.60	209.41	378.	10.2	1.43E+00
477.43	238.85	4015.	2.1	1.59E+01
540.30	270.30	325.	10.6	1.35E+00
590.61	295.47	912.	4.6	3.97E+00
600.31	300.33	186.	17.6	8.16E-01
655.89	328.13	164.	19.7	7.57E-01
676.88	338.63	671.	5.5	3.16E+00
926.31	463.41	195.	14.5	1.14E+00
1021.78	511.16	379.	9.0	2.40E+00
1536.72	768.70	90.	18.8	8.16E-01
1589.97	795.32	95.	22.5	8.92E-01
1822.93	911.81	762.	4.3	8.13E+00
1929.96	965.32	75.	26.5	8.37E-01
2476.84	1238.70	65.	40.1	9.11E-01
2817.20	1408.81	54.	18.7	8.35E-01
3177.40	1588.80	54.	18.9	9.15E-01
3242.93	1621.54	12.	51.3	2.15E-01
3261.75	1630.95	32.	27.9	5.58E-01
3278.13	1639.13	17.	43.1	2.92E-01
3460.99	1730.49	44.	19.6	7.79E-01
3531.23	1765.58	222.	7.2	4.01E+00

Ref 41 ER 1297-28

DATE: July 27, 1989

TO: Distribution

Charlotte Gilmer

FROM: Charlotte Gilmer, 132

SUBJECT: Two Mines in Sol se Mete Canyon

Reference: Memo, H. C. Bohannon to P. M. Stanford, dtd 7/17/89, same subject

---

Attachment: Attached for your information is a copy of the referenced memo requesting that a meeting at the subject mines be set up to determine the environmental/safety issues concerned with the closure of the mines.

Action requested: Please coordinate the requested meeting with the proper Sandia personnel and Deborah Garcia of DOE:MSD. Please notify Michael Norte, Organization 7821, at 6-6367, of the meeting time.

Also, please advise me of the meeting and attendees for our file information.

CG:132

Distribution:
3200 N. R. Ortiz
3202 G. J. Smith
7821 M. E. Norte
132 File (864)

Ref 41 1271-28

INDUSTRIAL HYGIENE SERVICES

Laboratory Services and Chain of Custody Form

SF 2040-NA(5-88)

Page ____ of ____

Submitted by:	Org:	For Zone I.H.:	Date Submitted
N. DURAND	3202		06 27 89 (Mo. Day Yr.)

Lab Log No.	Report Date	Analyst
890811 to 890815	07 10 89 (Mo. Day Yr.)	Greulich / Thompson

Contaminant	Contaminant Code (CAS)	Analytical Method No.
Gamma Scan		γ Scan

Sample Type
☐ Air ☒ Water ☒ Soil ☐ Veg. ☐ Oil ☐ Urine ☐ Blood ☐ Prod. I.D. ☐ Qual./Quan. ☐ Swipe ☐ Misc.

Reference: Employee ______ Building/Room ______

Analysis Requested: Gamma Scan Priority: ☐ Rush ☒ Usual

Log No.	Sample Description	Results	Units
~~SNL 000282~~	~~MW-2~~		
890811	SNL 000283 MW-2A	See Attached Sheets for data	
890812	SNL 000287 MW-3A	↓	↓
890813	SNL 000291 BW-3		
890814	SNL 000280 MW-1A		
890815	SNL 000295 Mine Soil		
		9/23/89	

Sample obtained from unnamed mine adit with buried radiation warning sign on 6/20/89 at the very end behind the concrete plug.

J. Phelan (3202)

(Continue entries on additional sheets; attach together.) [illegible]

Relinquished By: Nicholas Durand Date/Time 6-27-89 1:20 Received By: K. Greulich Date/Time 6/27/89 1:20 pm

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Relinquished By: ______ Date/Time ______ Received By: ______ Date/Time ______

Disposal Instructions Keep temp. Disposal By: ______ Date/Time ______

Approved by: Charles Gray 7/10/89
Chem. Lab Date ______ 3311 Supervisor ______ Date

Ref-41

```
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                                                                       *
*           G A M M A   S P E C T R U M   A N A L Y S I S               *
*                                                                       *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
```

CANBERRA SPECTRAN-F V4.0

Division 3313 Radiation Diagnostic Lab 06-JUL-89 10:40:58

A N A L Y S I S   P A R A M E T E R S

MCA Unit Number: 1 / ADC Unit Number: 1.1
Detector Number: 1 / Geometry Number: 30
Spectrum Size: 4096 channels from MCA Region FULL
Order of Smoothing Function: 5
Number of Background Channels: 4 on each side of peak
Peak Confidence Factor: 95.0%
Multiplet Sensitivity: 4
Identification Energy Window: +- 1.00 keV
Error Quotation: 1.00 sigma uncertainty

Environmental Background Subtracted
Multiplet Analysis NOT Performed

Regular Output
Spectral data read directly from Multichannel Analyzer ANO
Analyzed by: djt

Sample Description: SOIL 890815
Geometry Description: ~~783 GM~~ MARINELLI STD
Sample Size: 5.9600E+02 gm / Conversion Factor: 1.0000E+00
Standard Size: 7.8300E+02 GM
Analysis Library file: ANL000

COLLECT started on 6-JUL-89 at 08:32:00

COLLECT Live Time: 6000. seconds
Real Time: 6013. seconds
Dead Time: 0.22 %

Decayed to 0. days, 0.0000 hours BEFORE the start of COLLECT

Energy Calibration performed 30-JAN-89
Efficiency Calibration performed 12-FEB-87

Ref 41

Division 3313 Radiation Diagnostic Lab 06-JUL-89 10:40:58

P E A K   A N A L Y S I S

PK	Centroid channel	Energy keV	FWHM keV	Backgnd counts	Net Area counts	Error %	Nuclides
1	126.68	63.37	1.8	1380.	160.	35.7	TH-234
2	149.38	74.72	1.1	2711.	410.	19.2	TL-208
2B		74.95			212.	10.9	
3	167.81	83.95	0.9	695.	148.	23.3	TL-208
3B		84.73			54.	31.6	
4	186.00	93.04	1.4	1130.	419.	12.0	TH-234
4B		92.69			58.	24.7	
5	258.27	129.20	1.3	856.	266.	16.2	PU-239
6	371.68	185.94	1.7	655.	649.	6.7	~~RA-226~~
6B		185.56			44.	21.2	
7	418.17	209.20	1.5	699.	383.	11.0	NP-239
8M	476.93	238.59	1.3	1254.	4867.	1.9	PB-212
8B		238.73			65.	21.6	
9	540.30	270.30	1.5	448.	291.	11.8	
10M	590.11	295.21	1.3	881.	1253.	5.2	PB-214
11	655.52	327.94	1.3	350.	219.	13.8	LA-140
12	676.17	338.27	1.4	457.	841.	5.2	AC-228
13	703.32	351.85	1.3	383.	1736.	2.9	PB-214
14	818.41	409.43	1.7	293.	138.	20.0	CS-138
15	925.35	462.92	1.6	204.	216.	11.6	CS-138
16	1020.73	510.64	1.6	294.	484.	7.1	TL-208, NA-22, ANN-RD
17	1165.37	582.99	1.7	188.	1259.	3.2	TL-208
18	1217.54	609.09	1.4	219.	1267.	3.3	BI-214
19	1453.44	727.09	1.6	105.	290.	7.6	BI-212
20	1534.68	767.72	1.5	108.	102.	16.7	
21	1588.68	794.73	1.8	143.	182.	12.5	
22	1719.37	860.10	1.3	190.	154.	16.6	BI-212
23	1820.96	910.92	1.7	173.	868.	4.2	AC-228
24	1927.81	964.36	1.4	151.	106.	19.1	
25	2239.35	1120.19	2.0	164.	285.	9.4	BI-214, SC-46
26	2753.76	1377.47	2.0	53.	73.	19.0	BI-214
27	2919.84	1460.52	1.9	56.	4256.	1.6	K-40
28	3174.26	1587.76	2.3	41.	52.	23.6	
29	3258.81	1630.05	2.3	20.	43.	22.8	
30	3456.78	1729.05	1.4	18.	59.	17.4	
31	3527.16	1764.24	2.1	15.	226.	7.2	BI-214
32M	3693.64	1847.49	1.5	25.	36.	29.8	

Error Quotation at 1.00 sigma
Peak Confidence Level at 95.0%

M - Possible Multiplet
B - Environmental Background peak

Background Subtraction performed using file BK0001
Background Description: 100 min BKG
Background COLLECT started on 14-OCT-88 at 09:06:00
Background Live Time = 6000. seconds

ER1297 Ref. 91

Division 3313 Radiation Diagnostic Lab 06-JUL-89 10:40:58

Sample: SOIL 890815
Data collected on 6-JUL-89 at 08:32:00
Decayed to 0. days, 0.0000 hours BEFORE the start of COLLECT.

RADIONUCLIDE ANALYSIS REPORT

Nuclide	Activity Concentration in PCI /gm Measured	Error	Decay corrected	Error
K-40	2.90E+01	+- 4.68E-01	2.90E+01	+- 4.68E-01
RA-226	2.91E+00	+- 2.18E-01	2.91E+00	+- 2.18E-01
TH-234	1.44E+00	+- 2.10E-01	1.44E+00	+- 2.10E-01
TL-208	3.01E+01	+- 1.25E+01	3.01E+01	+- 1.25E+01
TL-208	3.66E+01	+- 1.49E+01	3.66E+01	+- 1.49E+01
Total	1.00E+02	+- 1.95E+01	1.00E+02	+- 1.95E+01

Error Quotation at 1.00 Sigma

Ac 228, naturally occurring, more likely @ 129

Ref 41

PEAKS NOT IDENTIFIED

Centroid channel	Energy keV	Net Area counts	Error %	Gammas/sec
126.68	63.37	160.	35.7	2.36E+00
258.27	129.20	266.	16.2	9.27E-01
418.17	209.20	383.	11.0	1.38E+00
476.93	238.59	4803.	2.0	1.83E+01
540.30	270.30	291.	11.8	1.19E+00
590.11	295.21	1253.	5.2	5.38E+00
655.52	327.94	219.	13.8	1.01E+00
676.17	338.27	841.	5.2	3.96E+00
703.32	351.85	1736.	2.9	8.42E+00
818.41	409.43	138.	20.0	7.50E-01
925.35	462.92	216.	11.6	1.30E+00
1020.73	510.64	484.	7.1	3.18E+00
1165.37	582.99	1259.	3.2	9.29E+00
1217.54	609.09	1267.	3.3	9.72E+00
1453.44	727.09	290.	7.6	2.61E+00
1534.68	767.72	102.	16.7	9.63E-01
1588.68	794.73	182.	12.5	1.77E+00
1719.37	860.10	154.	16.6	1.61E+00
1820.96	910.92	868.	4.2	9.53E+00
1927.81	964.36	106.	19.1	1.22E+00
2239.35	1120.19	285.	9.4	3.74E+00
2753.76	1377.47	73.	19.0	1.12E+00
3174.26	1587.76	52.	23.6	8.92E-01
3258.81	1630.05	43.	22.8	7.47E-01
3456.78	1729.05	59.	17.4	1.08E+00
3527.16	1764.24	226.	7.2	4.20E+00
3693.64	1847.49	36.	29.8	6.94E-01

ATTACHMENT C

ORIGINAL FIELD REPORTS

RECORD

KAFB/DOE PROPERTY
RADIATION SURVEY
11/8/82 -

1/5/83 Completed i[redacted]tial analysis of first spectrum ta[redacted]en at far end of remote mine (MS-[redacted]), see 12/21/82. Spectra shows only ura[redacted]ium-radium daughters Pb-214 & Bi-214, alo[redacted] with K-40. All are of magnitudes ex[redacted]ected in natural material so there are no su[redacted]ses. Mine appears to be clean of man-m[redacted]de materials.

Completed i[redacted]tial analysis of second spectrum taken [redacted] exposed black rock layer (see 12/21/82) in [redacted]S-I. Spectra shows only U-Ra daughters [redacted] Th-232 daughters & K-40 at slighty higher le[redacted]ls than in above mentioned spectrum. Nothi[redacted] unusual observed, probably due to different [redacted]ock contents.

1/6/83 Return to suspicious mine site to redo spectra run on 12/20/82 at lower and upper shafts. Ran ~~lowe~~ spectra at lower shaft ~~bt~~ behind cement block for 1000 seconds, equipment worked well. Moved to upper shaft for another spectra, but on the way up hill detector got snow on connectors (I slipped) and equipment would not function properly. Suspect moisture in connections and could not dry out good enough, so ~~g~~ quit for evening.

1/7/83 Entered spectrum ND-6 #9 from lower shaft behind cement block taken 1/6/82 into TN-4000 for analysis. All peaks (22 total) have been identified as being from U-Ra daughters, Th-232 daughters, and K-40; however there are some differences from the levels observed in the other mines. The K-40 and Th-232 levels appear to be much higher and the Uranium daughters appear to be somewhat lower than the other mines surveyed so far. Note that this does not imply man-induced contamination, since this kind of variation is very common, whereas man-induced contamination (even Th-232 & U-238) would have a significantly different spectral signiture that that observed here.

Returned to upper shaft at suspicious mine & reran spectrum again of 1/6/83. All equipment worked normally.

Toured mortar hill, found vertical shaft ~ 40' deep as the rock falls, very unsafe, may not test or will require special equipment. Labeled this new shaft as MS-J on map.

1/11/83 Traveled to mine MS-G, remote mine found on date 11/8/82 for gathering spectrum. Took road around from Frustration Station and scanned area on way to site, found nothing else. Upon arrival at mine found that right rear tire was flat, and no spare tire or jack (of course!). Proceeded to take spectrum

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS 377TH AIR BASE WING (AFMC)

19 AUG 1993

377 ABW/EM
2000 Wyoming Blvd SE
Kirtland AFB NM 87117-5659

Mr Warren B. Cox
Manager, ER Projects
ER Project Department, 7051
Sandia National Laboratories
Albuquerque, NM 87185

Dear Mr Cox

Reference: Your letter to Ms Nancy R. Morlock, EPA Region VI, dated 30 July 1993, with attachments.

Your letter summarizes the difficulties involved in identifying Kirtland Air Force Base (KAFB) Installation Restoration Program (IRP) sites RW-48, RW-49 and RW-50, in order to correlate them with Sandia National Laboratory (SNL) Environmental Restoration (ER) Program sites. RW-48 and RW-49 are mine adits (horizontal shafts), and RW-50 is a vertical mine shaft.

KAFB Environmental Management Division (EM) personnel have recently completed a detailed investigation of 37 excavations located primarily in the southern portion of the U.S. Forest Service Withdrawal Area. Three excavations are located to the north in Lurance Canyon. The results of this investigation indicate that KAFB site RW-48 is the same as SNL's ER-67, Frustration Instrumentation Site. KAFB sites RW-49 and RW-50 are both part of SNL's ER-28 and are two of the 11 sites surveyed in 1987.

A copy of a memorandum for record, dated 17 August 1993 is attached. This memorandum summarizes the observations made during field investigations to date. In addition, a set of maps, which was provided by Ms Denise Bleakly of SNL, has been updated with the excavation locations. Other man-made features observed during the field investigations were also placed onto the maps. The updated maps will be delivered to Ms Bleakly.

If you have any questions, contact [redacted] at [redacted].

Sincerely

Thomas A. Norris

THOMAS A. NORRIS, Colonel, USAF
Director
Environmental Management Division

Atch
Memorandum

cc: Ms Denise Bleakly, SNL Dept 7053 (w/maps)
Mr John Gould, DOE/AC/KAO

Memo for Record 17 August 1993

Subject: Kirtland Air Force Base Abandoned Mine Sites

To: [redacted]

1. On 2 August 1993, the subject sites were visited by [redacted], [redacted], and the undersigned, 377 ABW/EM. The subject sites and adjacent mines were revisited on August 4, 6, 10, and 13, 1993 by [redacted]. The purpose of these visits was to gather detailed site information to aid in determining the final disposition of these sites with respect to agency responsibility. These sites are listed as Kirtland AFB SWMUs RW-48, RW-49 and RW-50, and are described in the Management Action Plan (MAP) as Mine Shaft 1, Mine Shaft 2 and Mine Shaft 3. In addition, detailed inspections were made of all observed adits, pits, trenches and shafts to assist Sandia National Laboratories (SNL) in determining which mines are the 11 surveyed in 1987 (part of the Comprehensive Environmental Assessment and Response Program (CEARP)) and identified as SNL's ER-28. SNL presently has 33 sites listed under ER-28, based on an earlier report issued in 1984, and is waiting to identify which of these 33 sites were the 11 surveyed by CEARP.

2. RW-48 is described as Mine Shaft 1 in the MAP and as Site MS-4 in the IRP Phase 1 Report. It consists of one adit that is part of the mine workings previously known as the Frustration Mine. The old mine workings at this site were developed along a set of north-northwesterly striking fracture-filling hydrothermal vein deposits in faulted and brecciated Precambrian granite and granite gneiss. The veins dip steeply to the northeast. The mineralization observed consists primarily of coarsely crystalline fluorite (CaF_2), with minor galena (PbS) and quartz (SiO_2).

a. There are two adits (horizontal shafts) at this site. The lower adit is KAFB SWMU No. 48 and SNL's ER No. 67. This adit extends to the north-northwest for approximately 70 feet. At 50 feet from the portal, there is a drift that extends 45 feet to the northeast. A steel door and door frame were installed at the portal, and there is a door just before the drift. Remnant furniture, equipment and other structural features indicate that this adit was used as an instrumentation site. Records indicate that a seismic recording station was set up at this site to record ground movements during explosives tests elsewhere on the base. Outside the portal of the lower adit is an approximately 10 ft. X 8 ft. fenced area that once housed a transformer. There is reported to be a debris burial area designated as ER-15 associated with activities at the Frustration Site. As of this date, however, this site has not been located in the field.

b. In addition to the lower adit, a number of other workings constitute the Frustration Mine. These other workings are not part of RW-48, ER-67 or ER-28. An upper adit extends to the northwest for a distance of approximately 60 feet. The portal of this adit is located approximately 75 vertical feet above the lower adit. There is a winze that trends back to the southeast at an angle of 45° located 35 feet from the portal of the upper adit. The winze is approximately 25 feet long and does not connect to the lower adit. There is a section of radio tower in the winze that appears to have been used as a ladder to gain access to the bottom of the winze. The adit between the winze and 12 feet from the face is stoped (excavated) to the surface. On the surface, this stope appears as a narrow, deep trench up to 75 feet deep. The adit then extends 12 feet beyond the stope. On the ground surface between the

Atch

two adits, the vein has been trenched to a depth of one foot to two feet. There are two small prospect pits located 150 feet and 250 feet east of the main workings and a shallow shaft near the crest of the hill, 200 feet east of the open stope described above. All of the excavations described above are on the south-facing slope of a narrow ridge which protrudes from the main escarpment of the Manzano Mountains. This slope contains scattered five-inch (155 mm) projectiles. In addition to the mine workings, there is a buried cable line that traverses the ridge from northeast to southwest and a small borrow pit that was used to provide fill for repairing washouts in the access road. A black, polyurethane-clad cable was observed on the surface. It follows the base of the mountains to the KAFB southern boundary, where it turns westward. At least 6,000 feet of cable was observed. There are a few other very small pits that actually may be impact craters from the five-inch projectiles.

c. There are also some mine workings located northeast of the Frustration Site on the north-facing slope of the ridge. These workings are developed along a similar deposit as at the Frustration Mine. The mineralization is also similar, except that some minor barite ($BaSO_4$) and malachite [$Cu_2(CO_3)(OH)_2$] was also observed. There is a short trench, approximately 6 feet deep near the top of the ridge. This trench is not one of the present ER-28 sites or any KAFB site. A decline adit extends to the southeast for approximately 50 feet. The portal to this decline is 45 vertical feet below the trench. There is a shaft located 40 vertical feet below the decline. The actual depth of the shaft can not be determined because it is filled with water below 50 feet. Drifts at the 30-foot and 45-foot levels can be observed heading to the southeast. The decline and shaft are two of the present ER-28 sites and are likely to be two of the 11 sites surveyed by CEARP. A short adit extending to the southeast is located along the same vein system near the base of the ridge. The portal has been trenched for approximately 10 feet. There is a prospect pit located 250 feet east of the main workings and a prospect pit near the base of the ridge 1,100 feet west of the lower adit. There is some unidentified lightweight burn slag located on the tailings dump of the shaft. Otherwise, there is no indication of post-mining activities or that any material was disposed of at this site. The short adit and prospect pits are not part of ER-28 and are not part of any KAFB sites.

3. RW-49 is described as Mine Shaft 2 in the MAP and as MS-5 in the IRP Phase I Report. It consists of one adit that is part of the mine workings associated with a mine of unknown name. The ore deposition at this site is the same as that at the Frustration Mine, except that galena was not observed in the veins or in any of the tailings material on the associated mine dumps. It is located approximately 2,600 feet southeast of the Frustration Mine.

a. There are two adits at this site. The lower adit is KAFB SWMU No. 49 and part of the present ER-28. It is described in detail in other reports and was previously posted as contaminated by radiation. In addition, it is easily accessed and, therefore, is likely to be one of the 11 surveyed sites. This adit extends to the south-southwest to a point 50 feet from the portal before turning to the southeast for 20 feet. At the turn in the adit, a drift extends to the west for 30 feet and then turns to the south for a distance of 60 feet. There is a large concrete plug located 20 feet from the face of the drift. This plug nearly blocks the drift and appears to have moved after it was placed. There are piles of brown soil located at the entrance to the drift, at the turn in the drift, and in front of the concrete plug. The soil behind the plug is black. It appears the soil was brought into the mine in burlap or canvas sandbags that have since rotted away. The yellow tape used to seal the bags is all that remains. It is possible, however, that the bags were cut and the soil was dumped onto the piles. The concrete plug acted as a Klotz device to attenuate the gas pressure and shock waves from detonations, as did the piles of soil. Two-conductor black detonation cable is visible protruding from the first soil pile. The radiation hazard sign previously posted at the portal has been removed. This evidence suggests that some type of explosive ordnance test(s) was conducted in this adit. On some old maps, this site is shown as a second Frustration Site. It is likely that, during tests, ordnance was detonated in this adit, and ground motion was measured at the RW-48 Site.

b. In addition to the lower adit, there is an upper adit, the portal of which is located approximately 60 vertical feet above the lower adit and is not part of RW-49. This upper adit extends to the south for 15 feet and then turns to the southeast for 15 feet. A short (< two ft.) drift extends to the south four feet from the adit face. Another short drift extends to the southwest from just beyond the portal. Although a section of two-conductor black detonation wire was observed on the slope below this adit, there is no indication of any post-mining use or disposal. There is a 1.5-inch-diameter pipe protruding from the portal that was apparently used for draining water. Mud and algae in the adit indicate that it is often saturated. What remains of an abandoned road continues up the south side of the canyon to the east for a distance of approximately 1,800 feet, where it crosses to the north side, continuing up-slope for 400 feet. The road dead ends at a leveled pad of unknown origin or use. There are remnants of an "outhouse" latrine located 100 feet west of this pad. In the area where the road crosses the canyon, there are numerous five-inch and scattered three-inch projectiles on the surface. There is another small prospect pit or caved adit adjacent to this old road approximately 1,000 feet east of the two main adits. Scattered projectiles were observed between the adits and the area of abundant projectiles. The upper adit and the prospect pit are not part of ER-28 and are not part of any KAFB sites.

c. There is a third adit located approximately 1,800 feet southeast of the other adits at an elevation of approximately 7,340 feet. This adit extends 550 feet to the east. Near the face, the adit intersects a steeply dipping fault. Drifts, each 10 feet long, extend from the adit in opposite directions along the fault. Most of the adit contains a plated wooden skid-type track. No mineralization of economic interest was observed in any of the workings, and there was no evidence of post-mining activity or disposal. There are two small prospect pits located on either side of the canyon leading to this adit and the ruins of a cabin located 500 feet west-northwest of the adit. This canyon and adjacent slopes contain scattered five-inch and three-inch projectiles. The adit is part of the present ER-28 but the prospect pits are not. None of these workings are part of any KAFB sites.

4. RW-50 is described as Mine Shaft 3 in the MAP and as MS-6 in the IRP Phase I Report. It is located on the south side of Lurance Canyon, approximately three miles north-northeast of the RW-48 Frustration Mine Site, and consists of a shaft that is part of the workings known as the Blackbird Mine. The ore deposition at this site is the same as that at the Frustration Mine, having formed along a steeply dipping fault zone in Precambrian granitic rocks, except that very little galena was observed in the tailings material on the dump.

a. In addition to the shaft, there are two trenches at this site. The shaft is KAFB SWMU No. 50 and part of ER-28. It is at least 50 feet deep, based on a New Mexico Bureau of Mines and Mineral Resources report dated 1946.

It is not possible to determine the exact depth due to caving near the collar. This report also describes a drift at a depth of 42 feet extending from the shaft toward the southeast for 87 feet with stopes to the surface. There is abundant timbering at the collar, indicating that there was once a headframe over the shaft. An old truck frame mounted near the collar is all that remains of a makeshift hoisting winch. There are also concrete pads and scrap lumber piles near the shaft. There is no visible evidence, however, of any post-mining activity or disposal. Based on earlier reports and easy access, the shaft is likely to be one of the 11 surveyed sites.

b. The two trenches, which are not part of RW-50, are located immediately southeast of the shaft. The closest trench is up to six feet deep and was formed by the collapse of the stopes described in the 1946 report. The other trench is approximately three feet deep and 25 feet long. It was excavated to explore the mineralized zone at the surface. The trenches are not part of ER-28 and are not part of any KAFB site.

5. There are three other areas with mine excavations located south and west of the Frustration Mine. Two of these excavations are part of the present ER-28. None of these excavations are part of any KAFB site.

a. There is a small hill located 2,000 feet west of the Frustration Mine. The west side of this knoll houses a building and support structures used during laser tests at the Sandia Optical Range. Three adits were driven to explore a mineralized zone similar to that at the Frustration Mine near the base of the northwest quadrant of this hill. All three adits are caved, but appear to have been less than 15 feet in length. None of the adits are part of ER-28. A shaft on the north slope near the summit of the hill is approximately 50 feet deep. There are numerous 4.2-inch mortar round shipping canisters on the ground in an area just south of this shaft. A small amount of unidentified slag material was observed at the collar of the shaft. The shaft is part of the present ER-28 and is likely to be one of the 11 surveyed sites. There is a caved shaft and caved adit located on the east side of the hill. These workings are in an epidote-rich granite gneiss similar to rocks elsewhere in the region which contain low levels of thorium and uranium. They are not part of the present ER-28. With the exception of the slag observed at the deep shaft, there is no evidence of post-mining activities or disposal at any of these excavations.

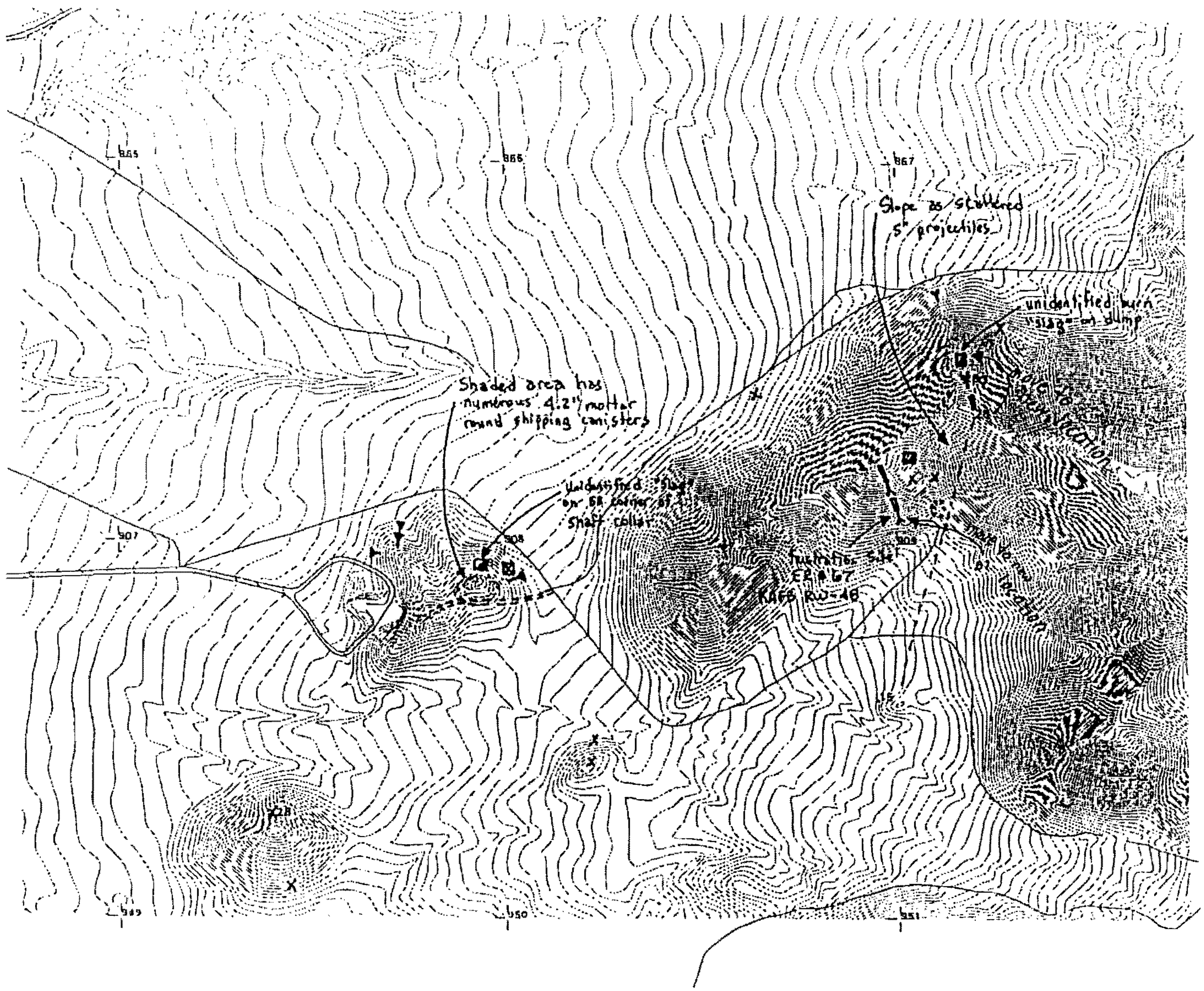
b. Two prospect pits are located on a hill approximately 3,700 feet to the southwest of the Frustration Mine. The pit on the north slope may be a caved adit and is one of the present ER-28 sites. The other prospect pit is located near the base of the south slope. Two prospect pits are also located on a small rock knoll 2,000 feet southwest of the Frustration Mine. None of these four prospect pits show evidence of post-mining activities or disposal.

c. The third area lies just north of KAFB's southern boundary and is centered 3,400 feet southwest of the Frustration Mine. It consists of a south-trending decline located approximately 1,000 feet north of a south-southwest-trending adit, a trench, and two prospect pits. The decline is 25 feet long. The adit was not entered because of caving at the portal. A two-conductor detonation wire was observed leading up to the adit. This indicates that this adit may have been used to conduct tests associated with the Frustration Site. Otherwise, no evidence of post-mining activities or disposal was observed. The adit is one of the present ER-28 sites and is likely to be one of the 11 surveyed sites.

6. In summary, 37 separate excavations were examined. All but three were in the South Coyote Test Range area. The 37 excavations include shafts, pits, trenches, and adits. They can be grouped, for convenience, into six areas as described above. Eight of these excavations are part of SNL's ER-28. Six of these eight excavations are likely to be part of the 11 surveyed sites. One excavation is SNL's ER-67. I believe that this site is also one of the 11 surveyed sites, and, therefore, only 10 surveyed sites will be on SNL's final list for ER-28. KAFB RW-48 site is definitely SNL's ER-67, and RW-49 and RW-50 are part of SNL's ER-28. All evidence and available records indicate that RW-49 and RW-50 are two of the 11 surveyed sites and should be part of SNL's final ER-28.

[redacted]

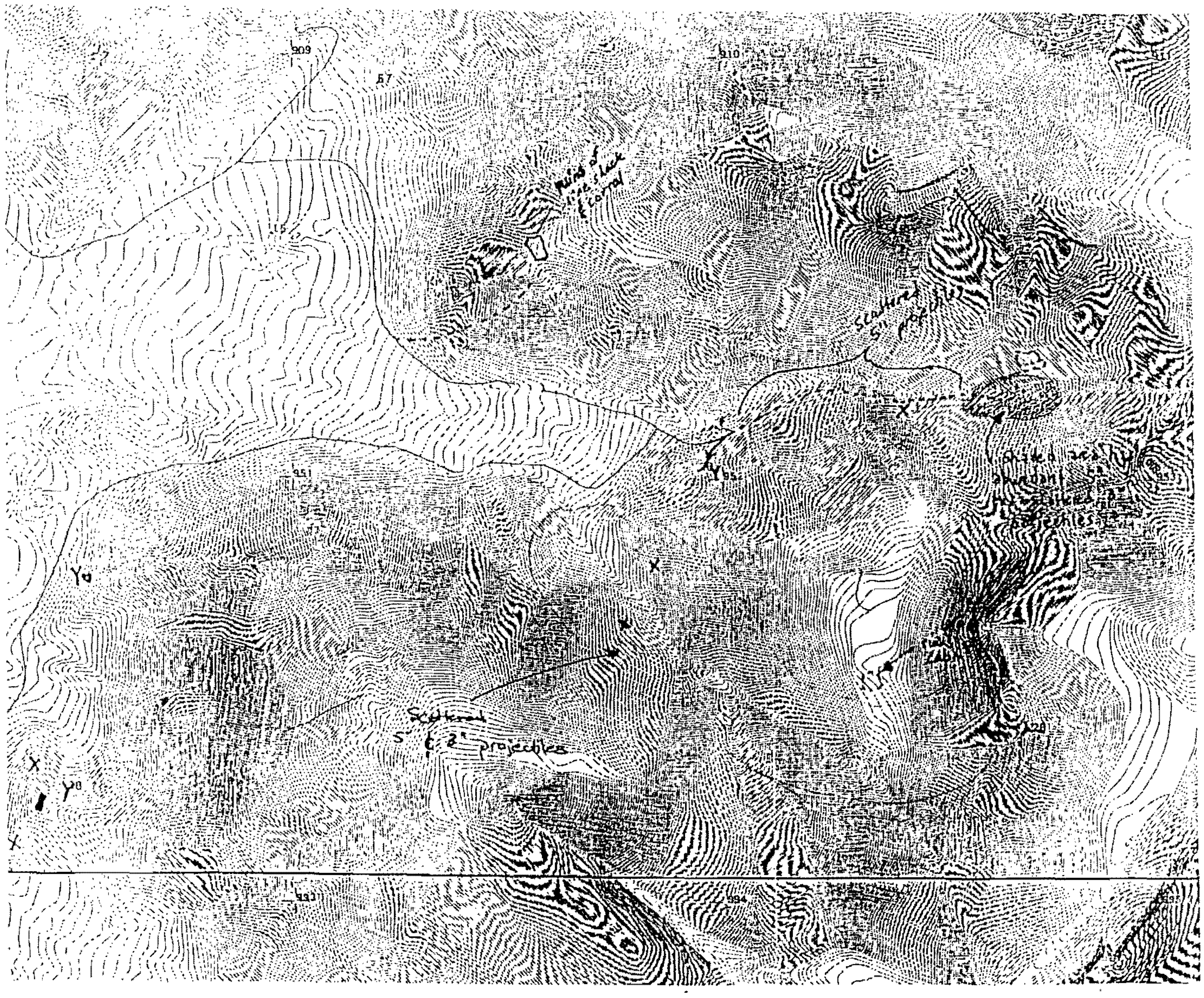
IRP Program Geologist



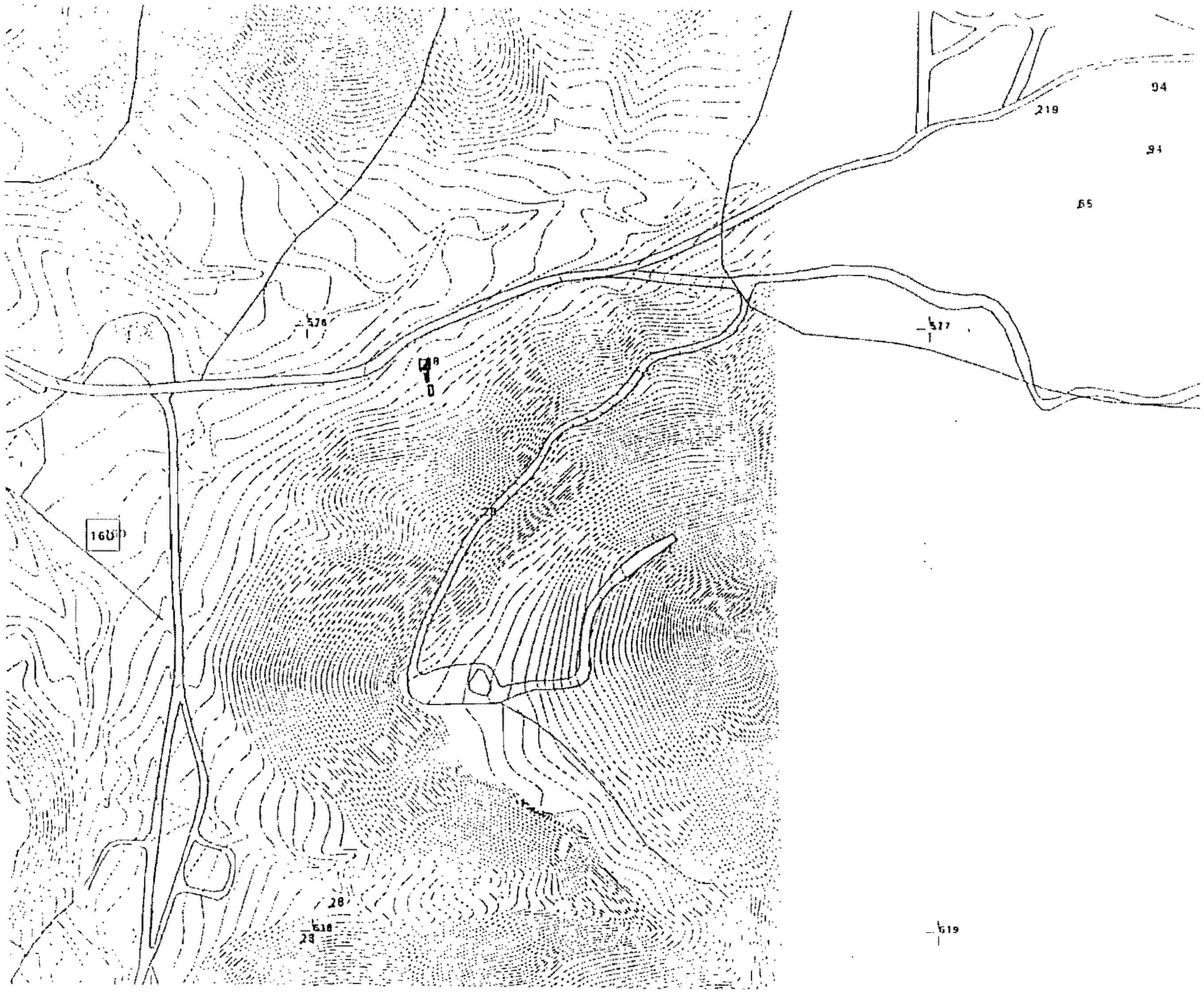
X - prospect pit <5' deep
- shaft ≥ 5' deep
- trench <5' deep
- trench ≥ 5' deep
- borrow pit <5' deep
— — — — buried cable
- open adit
- caved adit
- caved shaft
= = = = - road
- decline
- incline

5' Contours
2000' between tic marks
1" = 500'

8/4/93
SNL ER GIS



2000' between ticks
5' Contours
8/4/93
SNL LRGIS



2000' between tics

5' contours

8/4/95
SNL CP GIS

Ref 165

Notes to File

Interview with [redacted] on October 27, 1993

Frustration sites and mine near frustration site.

Site numbers 67,15, and 28

Site 15/67/28

Walter indicated that there was no explosives tests associated with frustration site. It was a seismic station and explosions would have damage the equipment. The white-metal door was recognized as the door to the frustration site.

He was not sure about the dump. Maybe it was waste from field activities in the area. Did not recall any rad work in the area.

Site # 28

He recalls detonating waste RDX, Comp 4 and detcord in a mine that you could drive up to. They load the explosives into the mine directly from the truck. The explosives were detonated in a side shaft so rock debris would be thrown against the mine wall and not out the front of the mine. The mine is identified as MS-B on the attached map. This mine is also identified as the mine with a large concrete block inside. Behind the block, he found debris and detonating wire. Yellow tape was also found in this mine. See attached letter. The mine opening is nearly closed in with soil at the time of the visit. No attempt to enter the mine was made on this trip.

Except from the interview with [redacted] conducted by [redacted]

The tour was at mine 28-2 when this conversation took place.

[redacted]: They would bring old explosive, unburned explosives out there and stack it in there and then they would, every few weeks or few months, travel over here and use them. Burn em, shoot em, or something like that.

[redacted]: Um hum and that was a Sandia operation?

[redacted]: Yeah.
This was driven up here.

The interview tape stopped here due to low battery. We were at the road into 28-2 at the time and he remembered that they would drive up and off-load the explosives from the back of the truck into the mine.

(Reference - 16)

SA-0237-...

S V28

Telephone conversation March 8 1985

[redacted] - [redacted] Area V.

When [redacted] did his survey he found no radioactive material in the mines. He does understand that there are suppose to be 100-150 old mines on the base. They only surveyed 25 of these mines

at Illustration site if you continue on road there is an adit. Part way in the tunnel is a concrete block. He called [redacted] of safety + with her in attendance he crawled behind the concrete block and it was 15-20" thick + that a small 10' room was all that was behind. However yellow tape (Sandia type) was in the room! Therefore some Sandia experiment must have taken place. He has done a survey of "old timers" + has not found how this tunnel was used. 516 28 -8

Beyond this mine in next canyon over half way up canyon wall is 900' long adit with old rail track etc. This is the largest working [redacted] has found

Around the Illustration site are lots of shells, shrapnel, etc.

[redacted] did find one mine >100' deep at which at the 30-40' level there was a yellow metal can. Because of safety problems did not recover the can. 67✓

They did find slight contamination at an old test site which they cleaned up

In the Madera Canyon 155 gun site they did fire shells containing short half life radionuclides. They may

(Reference 16)

have lost two shells - however radionuclides should have decayed by now.

They went into the Pendulum site from the north. Did find one small spot of U contamination. Had heard that there was lots of U at this site but just didn't find any.

Near golf course there are three trenches marked with posts. He has people who tell him that in the late 50's or early '60 earth moving equipment worked in the area + people were fully evicted out. So far no permission from Kirtland to continue trying to determine what it is.

He will take us to this site - difficult to find. Agreed to try to set up a meeting

He says there have been reports of shells in old mine shafts, but he didn't find any.

It would also appear possible that there may be live shells lying about. - also warns of snakes.

28

SANDIA NATIONAL LABORATORIES
Record of Verbal Communication

Date 2/27/9
Time 1515

FROM: [redacted] of ([redacted]) [redacted]
TO: [redacted] of [redacted]
SUBJECT Survey of a Mine shaft Location on KAFB Property
LOCATION:

☒ By Telephone
☐ By Radio
☐ In Person

☒ Received the following ☐ Issued the following ☐ Had the following

☐ INSTRUCTIONS: ☐ AUTHORIZATION: ☒ INFORMATION: DISCUSSION:

I called [redacted] to follow up on a note from [redacted] (7512), which stated that [redacted] was aware of elevated radiation readings in a mine shaft with a concrete wall inside of it. The "elevated reading" were observed when an instrument probe was inserted between the concrete wall and the rock wall. (This mine is ER Site 28-2)

After several phone messages, we got together on the phone and discussed. [redacted] did not actually go into the mine, one of ~~the~~ his co-workers did, but he recalled their task of checking out the mines. [redacted] mentioned that the readings behind the concrete wall were higher than in the mine itself, but not necessarily above background. I mentioned that [redacted] did collect gamma spectrometer readings in the same location and reported nothing out of "natural background range." [redacted] said he was aware of [redacted] survey; infact the same co-worker who noted the elevated readings showed [redacted] the mine location. We discussed [redacted] survey results, and [redacted] ~~we~~ concluded that if [redacted] readings indicated background, then there is no man-induced radioactive contamination in that mine. [redacted] is not aware of other "suspect mine locations" where radioactive material may have been disposed of or dumped.

Signed: [redacted]

COMMUNICANTS' COPIES

☒ [redacted] 7714 *
☒ [redacted] 7585
☐ ORIGINAL TO RECORDS CENTER

OTHER COPY DISTRIBUTION

☒ ER Site 28 Files (Background)

* Reviewed and approved - no changes - 2/28/95

SANDIA NATIONAL LABORATORIES

ALBUQUERQUE, NEW MEXICO 87185

TO: [redacted], 7714

FAX#: 844-6806

MESSAGE: [redacted] - attached is a copy of a telecon form I filled out to document our phone conversation yesterday. I would greatly appreciate it if you would take a few minutes and review it. If you want me to make any changes just give me a call or fax me the changes. Thanks for your info and help!

FROM: [redacted]

ORGANIZATION: 7585

PHONE #: [redacted] FAX #: [redacted]

NUMBER OF PAGES SENT: 2 (INCLUDING COVER SHEET)

Logbook #0651

Property of SANDIA NATIONAL LABS
ORG 7724

Address PO BOX 5800
ALB., NM 87122

Telephone ATT: RECORDS CENTER
844-8519

[redacted]

ER Project Dept. 7585
Phone: 505 [redacted]

Field Log Book #0051

This Book is manufactured of a High Grade 50% Rag Ledger Paper having a Water Resistant Surface, and is sewed with Nylon Waterproof Thread.

INDEX

[redacted]

1454 @ MS-C 28-3
~~1 vertical shaft~~
1 vertical shaft ~ 30' deep
and 1 horizontal shaft, ~ 30'
long. [redacted] taking GPS reading
right between the 2 shafts.
Shafts ~ 15' apart.

1508 @ The Blackbird Mine MS-D 28-4
One main, large vertical shaft
~ 15 to 20' in diameter
with lots of timber and
shoring. A much smaller
vertical shaft is located
~40' south. Both are
caved in and in very
poor shape. Steve said
main shaft looks more
caved in than 4 years
ago when he saw it.

1530 @ MS-E 28-5 general area.
Can not find the mine - did
find a pile (small) of what
looks like mine tailings - which
is what [redacted] marked on
the map for this location
with [redacted]. We
scouted the area pretty
well and didn't find anything
else

1536 After checking maps, we decide
to leave. No GPS reading
taken. Head back to BOM office.

1605 Final Trip ~~[illegible]~~
Mileage: 57.4 miles
Arrive back @ BOM office.

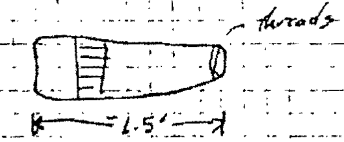
can see into larger room.
Another adit is located E-NE approximately ~150' and ~70' above the lower adit. Drain pipe and moss in shaft indicate water is present frequently - but not saturated now.

Upper adit has a very smooth NE wall - shaft is well formed and looks in good shape. No evidence of post-mining activity, but det. cord does run up towards the upper adit.

*Only 1 GPS reading taken at lower main adit

1200 Crew @ MS-G 28-7. Horizontal adit extends back (south) into hill ~30 feet. 5" mortar shells around the vicinity, one shell @ entrance to adit. GPS reading taken at entrance.

Just south of adit up hill ~20 feet are several mortar shells, rusted.



Up the ridge to the SE-E are many shells; more than 6 [redacted] observed walking the area.

14:29 Arrive @ MS-F + H (28-6 + 8) with crew minus [redacted] (IT) and [redacted] (KAFB), who left before lunch. They had other commitments this afternoon.

@ 28-6: [redacted] getting GPS reading. Vertical shaft ~15' deep, ~5' wide.

1431 @ 28-8 MS-H very shallow, small pit < 4' deep.

Friday 11-4-94

0920 In BOM office preparing for field trip to the Mine Shaft Sites w/ [redacted] will meet [redacted] (KAFB) later in the day out in the field.

Objective: Locate, photograph, survey with GPS unit, and verify the 11 SNL ER site #28s. [redacted] needs to check each location for Cultural Resourse surveys as part of the EA work.

1056 Crew @ #28 MS-10 S; 28-10 location. [redacted] will survey w/ GPS. Survey point on south edge of shaft. Shaft is ~50' deep as per [redacted], can't see bottom.

There is a small caved in shaft just to the east (~80').

Viewing 28-9 MS-1 up on ridge to east. Can see spoils pile [redacted] has been through the mine: a horizontal shaft extends ~700 feet east into the hill w/ some horizontal drifts at the end. No evidence of any post mining activity.

On the 28-10 hill there are numerous adits and small workings. The optical range target structure is actually cut into an adit.

Many "Mortar canisters" (containers that mortars 4.2" came in) are scattered about the hill. That activity was in the 60s as per Chris.

1133 Crew arrives @ 28-2 MS-B 2 adits here. Lower adit is main one here, has concrete block, yellow tape, and det cord. Mine entrance is caved but

National Nuclear Security Administration
Sandia Site Office
P.O. Box 5400
Albuquerque, New Mexico 87185-5400

APR 1 9 2004

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. John E. Kieling, Manager
Permits Management Program
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Road East
Building 1
Santa Fe, NM 87505

Dear Mr. Kieling:

On behalf of the Department of Energy (DOE) and Sandia Corporation, DOE is submitting the Summary Report for Environmental Restoration Project Voluntary Corrective Action (VCA) at Solid Waste Management Unit (SWMU) 28-2. SWMU 28-2 is regulated under the Hazardous and Solid Waste Amendments Module of the Resource Conservation and Recovery Act Permit for Sandia National Laboratories, New Mexico (EPA ID No. NM5890110518).

This report describes the Voluntary Corrective Action conducted to remove depleted uranium contamination from the exterior of the SWMU 28-2 mine. The report includes confirmatory sampling results and a revised risk assessment.

If you have any questions, please contact John Gould at (505) 845-6089.

Sincerely,

Patty Wagner

Patty Wagner
Manager

Sandia National Laboratories/New Mexico
Environmental Restoration Project

SUMMARY REPORT FOR ENVIRONMENTAL RESTORATION PROJECT VOLUNTARY CORRECTIVE ACTION AT SOLID WASTE MANAGEMENT UNIT 28-2 MINE FOOTHILLS TEST AREA

Final
February 2004

United States Department of Energy
Sandia Site Office

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

TABLE OF CONTENTS

TABLE OF CONTENTS (Concluded)

LIST OF FIGURES

Figure

This page intentionally left blank.

LIST OF TABLES

Table

This page intentionally left blank.

LIST OF ANNEXES

This page intentionally left blank.

ACRONYMS AND ABBREVIATIONS

AOP	Analytical Operating Procedure
bgs	below ground surface
COC	constituents of concern
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
g	gram(s)
HE	high explosive(s)
HI	hazard index
HQ	hazard quotient
kg	kilogram(s)
μg	microgram(s)
MDA	minimum detectable activity
MDL	method detection limit
mg	milligram(s)
mrem	millirem
NFA	No further action
NMED	New Mexico Environment Department
pCi	picocurie(s)
QA	quality assurance
QC	quality control
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RFI	RCRA Facility Investigation
RPD	Relative Percent Difference
RPSD	Radiation Protection Sample Diagnostics
SNL/NM	Sandia National Laboratories/New Mexico
SWMU	Solid Waste Management Unit
USFS	U.S. Forest Service
VCA	Voluntary Corrective Action
yr	year

This page intentionally left blank.

1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) Solid Waste Management Unit (SWMU) 28-2 is one of ten mines identified as the Environmental Restoration (ER) SWMU 28 Mine Shafts in the Hazardous and Solid Waste Amendments Module of SNL/NM's Resource Conservation and Recovery Act (RCRA) Permit. The SWMU 28-2 mine was characterized and remediated in two phases. The interior of the mine was characterized in April 1998 (SNL/NM May 1999, Annex A), and the exterior of the mine was characterized and remediated during July and August 2002 as a Voluntary Correction Action (VCA). This report discusses the results of the VCA.

A meeting was held between representatives of the SNL/NM ER Project and New Mexico Environment Department (NMED) on October 28, 2002, to discuss the results of the VCA and preliminary risk assessment (Mignardot October 2002). Based upon the analytical results of the VCA confirmatory sampling, the NMED agreed that the VCA field activities are complete and recommended site restoration activities be conducted at the exterior of the mine.

This page intentionally left blank.

2.0 SITE DESCRIPTION AND OPERATIONAL HISTORY

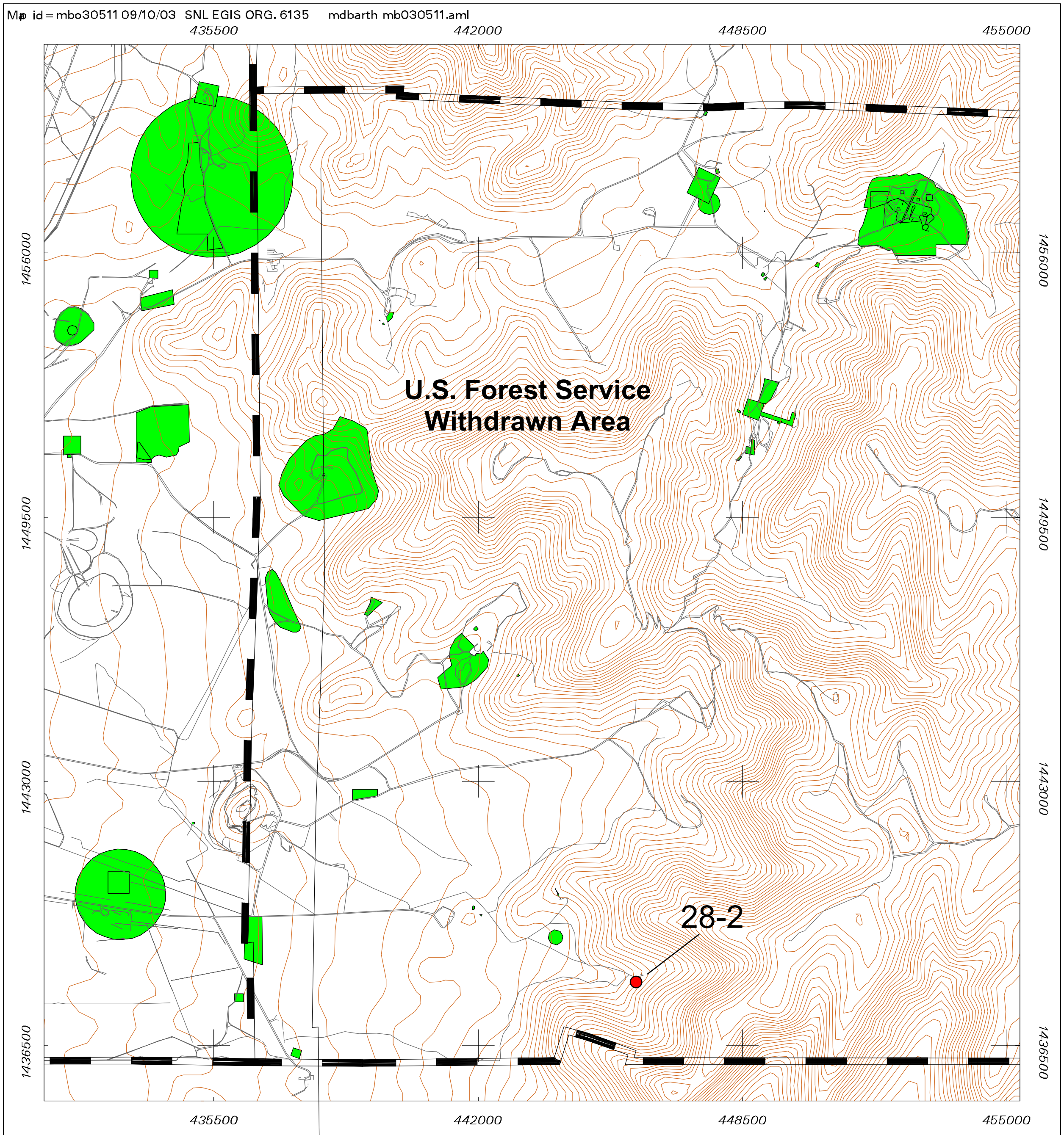
2.1 Site Description

SWMU 28-2, situated in the U.S. Forest Service (USFS) Withdrawn Area near the southeast corner of Kirtland Air Force Base (KAFB) (Figure 2.1-1), consists of two horizontal adits: a lower and an upper. The portal of the upper adit is located approximately 60 feet above the lower adit. The exterior of the lower adit is the portion of the SWMU discussed in this report. The "Proposal for No Further Action [NFA], Environmental Restoration Project Site 28, Mineshafts, Operable Unit 1332, August 1995" (SNL/NM August 1995) and "Environmental Restoration Project Supplemental Information and Summary of Requested Actions at SWMU 28" (SNL/NM May 1999) provide a complete discussion of the physical features and constituents present at SWMU 28-2.

2.2 Operational History

SWMU 28-2 is an abandoned mine where mining activities took place in the early to mid-1900s (SNL/NM August 1995). This mine is classified as a SWMU based upon interviews and a map which indicate that SNL/NM personnel used it for experimental testing and possible disposal activities. In addition, depleted uranium was found immediately beneath the ground surface outside the mine by SNL/NM personnel during gate installation activities in December 2001.

This page intentionally left blank.



Legend

Other Solid Waste Management Units

KAFB Roads

40 Foot Contours

KAFB Boundary

Mine Location

Figure 2.1-1
Location of SWMU 28-2 Mine

0 2000 4000
Scale in Feet

0 480 960
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.04080000A3

3.0 VOLUNTARY CORRECTIVE ACTION ACTIVITIES

Following discovery of depleted uranium outside the entrance to the mine, a VCA plan was developed to characterize and then remove the soil contaminated with depleted uranium. The VCA plan was prepared in July 2002 (Annex B), and the VCA field activities were conducted from July 15 through August 13, 2002. The purpose of the VCA was to render the vicinity of SWMU 28-2 suitable for future recreational or residential use.

3.1 Objectives

The objectives of the SWMU 28-2 VCA were to determine the extent of depleted uranium contamination and to remove and properly dispose of the contaminated soil. Specific elements of the VCA included the following activities:

- Radiation survey of the site to identify anomalies

- Excavation and removal of soil contaminated with depleted uranium

- Confirmatory activities, including:
  - Confirmatory radiation walkover survey of excavated area
  - Confirmatory *in situ* soil gamma spectroscopy measurements of excavated area
  - Confirmatory soil sampling of excavated area

- Waste management measures, including:
  - Waste characterization sampling
  - Disposing of radioactively contaminated soil

- Site restoration

3.2 Chronology of Events

Sampling was conducted inside the mine in April 1998 as part of the RCRA facility investigation (RFI). The details of this investigation are presented in “Environmental Restoration Project Supplemental Information and Summary of Requested Actions at SWMU 28” (SNL/NM May 1999). While installing a barrier at the entrance, depleted uranium contamination was found outside the mine on December 13, 2001. SNL/NM ER Project personnel decided to remove the depleted uranium contamination as a VCA. Prior to executing the VCA, a sampling and analysis plan and a waste management plan were prepared. These plans address the collection of confirmatory soil samples and how to conduct the waste management activities, respectively.

On July 15, 2002, SNL/NM personnel mobilized to the site to start the VCA. Initially, a radiation survey was conducted over the entire site to identify anomalies. Both the anomalies and surrounding soil known to be contaminated with depleted uranium were excavated and removed, and a confirmatory radiation survey was conducted to verify that the site was sufficiently remediated and that cleanup objectives had been met. Five *in situ* soil gamma spectroscopy measurements were taken and eight confirmatory soil samples were collected for metals, high explosives (HE), and radiological analysis by gamma spectroscopy. Following review of *in situ* gamma spectroscopy results, site restoration activities were conducted on October 30 and 31, 2002. The soil contaminated with depleted uranium was immediately loaded into 55-gallon drums. Following completion of the field activities, the drums were transported to the Nevada Test Site for disposal.

Upon completion of field activities, a risk assessment was performed using all the RFI and VCA confirmatory soil sampling data to verify that the site was sufficiently characterized and remediated for the designated recreational land-use scenario.

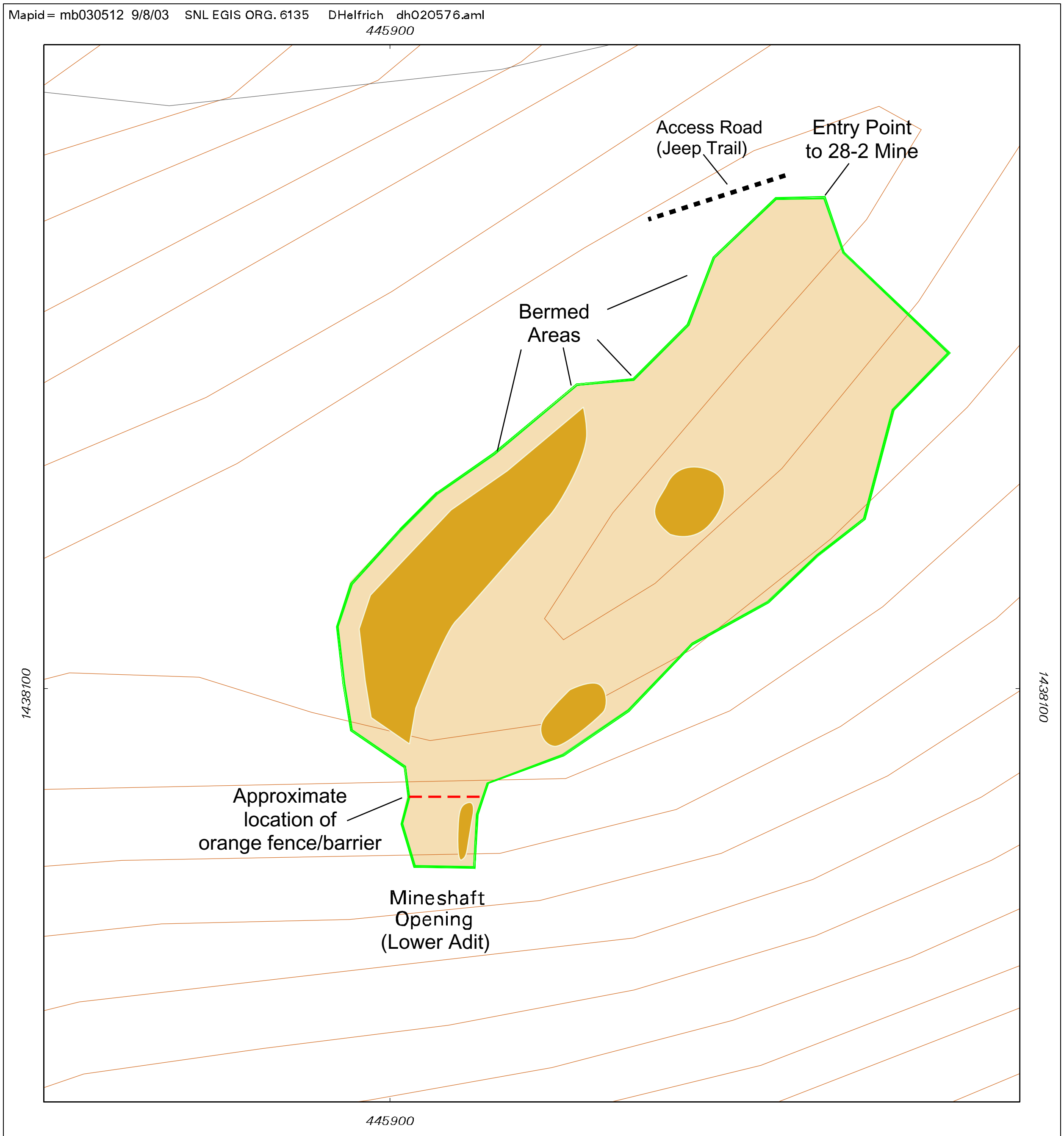
3.2.1 Initial Radiation Survey

On July 15, 2002, a radiation survey was conducted at SWMU 28-2 to determine the extent of DU contamination at the site. The survey was conducted by an SNL/NM radiological control technician (RCT) using an Eberline E-600 meter with a sodium iodide beta/gamma detector. The survey, which began at the entry point to the mine, covered the graded areas leading to and around the entrance to the mine and the bermed areas along the west side of the road. The survey was extended outward until no additional contamination was located (Figure 3.2-1).

3.2.2 Excavation and Removal of Soil Contaminated with Depleted Uranium

The radiation survey, which identified multiple anomalies (e.g., “hotspots”), was used to direct the excavation and removal activities. The approximate locations of the anomalies are shown on Figure 3.2-1. An example of the depleted uranium removed is shown in Figure 3.2-2. Field-screening, using an Eberline E-600 meter with a sodium iodide beta/gamma detector, and visual observations were used to delineate the removal of soil contaminated with depleted uranium. The removal of anomalies started on the access road and proceeded toward the mine. Depending upon the amount of overburden material and/or the size of the rocks present, each anomaly was systematically excavated and removed either manually or by using a backhoe. In areas where large rocks covered the surface, the backhoe was used to remove the rocks so that the soil surface could be scanned. The rocks were stockpiled adjacent to each hotspot and scanned for residual contamination.

Excavation and removal of the contaminated soil continued until either bedrock or an undisturbed soil horizon was encountered. An Eberline E-600 meter with a sodium iodide beta/gamma detector was used to verify that DU-contaminated soil removal was complete. Approximately five cubic yards of soil contaminated with depleted uranium were removed. All of the soil contaminated with depleted uranium was immediately containerized into 55-gallon drums. A final confirmatory radiation survey confirmed that the depleted uranium hotspots had been removed.



Legend

- Unpaved Road
- 5-foot Contour
- VCA Extent of Radiation Survey
- Approximate Extent of Anomalies

Figure 3.2-1
Radiation Survey at the
Solid Waste Management Unit 28-2

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.04080000A4

840857.04080000A5

Figure 3.2-2.
Depleted Uranium removed from the
exterior at Solid Waste Management Unit 28-2

3.3 Voluntary Corrective Action Confirmatory Activities

To verify that the area external to the SWMU 28-2 mine was remediated during the VCA, confirmatory activities were conducted. A final radiation walkover survey was performed by the RCT prior to site restoration. In addition, the *in situ* and confirmatory soil sampling data were evaluated to assess whether residual depleted uranium remained in the soil at the site.

3.3.1 Final Radiation Walkover Survey

After removal of the depleted uranium hotspots was completed, a final radiation walkover survey was conducted over 100 percent of the excavated area using an Eberline E-600 meter with a sodium iodide beta/gamma detector. The walkover survey shows activities only slightly above background levels. These levels were quantified as discussed in Sections 3.3.2 and 3.3.3. The final radiation survey map is provided in Annex C.

3.3.2 Confirmatory *In Situ* Soil Gamma Spectroscopy Measurements of Excavated Area

After the final radiation survey had confirmed that all of the soil contaminated with depleted uranium had been removed, *in situ* soil gamma spectroscopy measurements were taken (Figure 3.3-1). On August 29, 2002, measurements were taken at five locations (S282-GS-001 through S282-GS-005) (Figure 3.3-2). The results of the *in situ* measurements, provided in Annex D, indicate that the activities for uranium-238, the indicator radionuclide, in the remaining soil are slightly above or consistent with the background level of 2.31 pCi/g.

3.3.3 Confirmatory Soil Sampling of Excavated Area

Once the final radiation survey confirmed that all of the soil contaminated with depleted uranium had been removed, confirmatory soil samples were collected. On September 4, 2002, surface (0- to 0.5-foot-bgs) soil samples were collected from eight locations (S282-GR-109-0-S through S282-GR-116-0-SS) (Figure 3.3-2). The quality assurance (QA)/quality control (QC) samples collected included one duplicate and one equipment rinsate blank sample. The eight samples (plus one duplicate) were analyzed for RCRA metals plus beryllium and nickel, HE, and radionuclides by gamma spectroscopy, consistent with previous sampling at SWMU 28-2.

3.4 Results and Conclusions

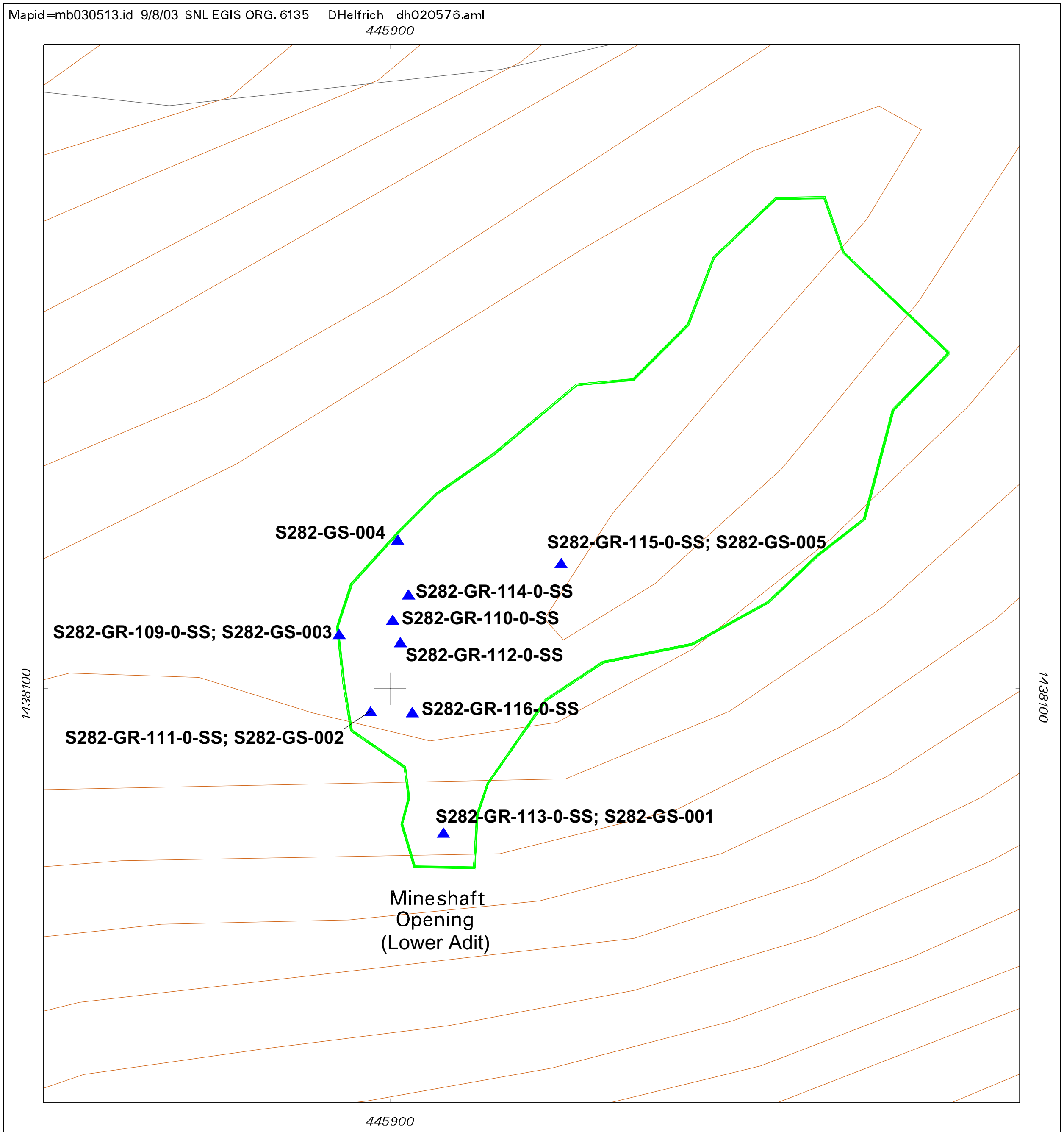
3.4.1 Confirmatory Soil Sampling of Excavated Area

Tables 3.4-1 through 3.4-3 summarize the confirmatory sampling analyses. Tables 3.4-1 and 3.4-3 summarize the metals and gamma spectroscopy analytical results, respectively, for the confirmatory soil samples collected. Annex D contains complete results for the gamma spectroscopy analyses. Table 3.4-2 summarizes the analytical method detection limits (MDLs) for the target analyte list for HE compounds.

This page intentionally left blank.

840857.04080000A6

Figure 3.3-1.
In situ soil gamma spectroscopy measurement at
Solid Waste Management Unit 28-2



Legend

- Sample Location
- Unpaved Road
- 5-foot Contour
- VCA Extent of Excavation

Figure 3.3-2.
In-situ Soil Gamma Spectroscopy Measurement Locations & Confirmatory Soil Sample Locations at Solid Waste Management Unit 28-2

0 10 20
Scale in Feet

0 2.4 4.8
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

840857.04080000A7

Table 3.4-1
Summary of SWMU 28-2 VCA Confirmatory Soil Sampling
RCRA Metals Plus Beryllium and Nickel Analytical Results
September 2002
(Off-Site Laboratory)

Sample Attributes			RCRA Metals plus Beryllium and Nickel (EPA Methods 6010a, and 7470/7471[a]) (mg/kg)				
Record Number[b]	ER Sample ID	Sample Depth	Arsenic	Barium	Beryllium	Cadmium	Chromium
605645	S282-GR-109-0-SS	0.0–0.5 ft	8.80	235	**0.867**	0.335 J (0.490)	14.4
605645	S282-GR-110-0-SS	0.0–0.5 ft	7.80	**348**	**1.06**	0.267 J (0.463)	**20.1**
605645	S282-GR-111-0-SS	0.0–0.5 ft	8.25	**274**	**0.938**	0.439 J (0.455)	14.9
605645	S282-GR-112-0-SS	0.0–0.5 ft	8.15	**424**	**1.19**	0.337 J (0.472)	**22.1**
605645	S282-GR-112-0-DUP	0.0–0.5 ft	9.12	**353**	**1.23**	0.293 J (0.495)	**22.2**
605645	S282-GR-113-0-SS	0.0–0.5 ft	8.39	**973**	**0.863**	0.289 J (0.485)	14.6
605645	S282-GR-114-0-SS	0.0–0.5 ft	7.09	**313**	**0.937**	0.256 J (0.455)	17.4
605645	S282-GR-115-0-SS	0.0–0.5 ft	**16.2**	**1,030**	**1.13**	0.410 J (0.476)	18.4
605645	S282-GR-116-0-SS	0.0–0.5 ft	**15.6**	**1,880**	**0.905**	0.184 J (0.490)	12.5
Quality Control Samples (mg/L)							
605645	S282-GR-117-0-EB	NA	ND (0.00224)	0.000326 J (0.005)	ND (0.000158)	ND (0.000313)	0.000636 J (0.00503)
NMED-Approved Background Concentration—Lower Canyon Area[c]		NA	9.8	246	0.75	0.64	18.8

Refer to footnotes at end of table.

Table 3.4-1 (Concluded)
Summary of SWMU 28-2 VCA Confirmatory Soil Sampling
RCRA Metals Plus Beryllium and Nickel Analytical Results
September 2002
(Off-Site Laboratory)

Sample Attributes			RCRA Metals plus Beryllium and Nickel (EPA Methods 6010a, and 7470/7471[a]) (mg/kg)				
Record Number[b]	ER Sample ID	Sample Depth	Lead	Mercury	Nickel	Selenium	Silver
605645	S282-GR-109-0-SS	0.0–0.5 ft	**236**	**0.147**	10.5	ND (0.159)	ND (0.0884)
605645	S282-GR-110-0-SS	0.0–0.5 ft	**195**	**0.0908**	13.6	0.685	**0.895**
605645	S282-GR-111-0-SS	0.0–0.5 ft	**422**	**0.0676**	11.7	0.217 J (0.455)	ND (0.082)
605645	S282-GR-112-0-SS	0.0–0.5 ft	**272**	**0.0601**	14.2	0.404 J (0.472)	0.186 J (0.472)
605645	S282-GR-112-0-DUP	0.0–0.5 ft	**242**	**0.0763**	13.9	0.669 (0.495)	0.133 J (0.495)
605645	S282-GR-113-0-SS	0.0–0.5 ft	**214**	**0.231**	11.0	0.477 J (0.485)	ND (0.0876)
605645	S282-GR-114-0-SS	0.0–0.5 ft	**182**	**0.0776**	11.5	0.341 J (0.455)	**1.78**
605645	S282-GR-115-0-SS	0.0–0.5 ft	**484**	**0.173**	12.9	0.239 J (0.476)	ND (0.0859)
605645	S282-GR-116-0-SS	0.0–0.5 ft	**145**	**0.578**	9.85	0.242 J (0.490)	ND (0.0884)
Quality Control Samples (mg/L)							
605645	S282-GR-117-0-EB	NA	ND (0.00172)	ND (0.000047)	ND (0.00069)	ND (0.00281)	ND (0.000835)
NMED-Approved Background Concentration—Lower Canyons Area[c]		NA	18.9	0.055	16.6	2.7	<0.5

Note: Values in **bold** exceed background soil concentrations.
[a]EPA November 1986.
[b]Analysis request/chain-of-custody record.
[c]Garcia November 1998.

DUP = Duplicate.
EB = Equipment blank.
EPA = U. S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = The associated value is an estimated quantity; see data validation report (Annex F).
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND ( ) = Not detected at or above the MDL, shown in parentheses.
NMED = New Mexico Environment Department.
RCRA = Resource Conservation and Recovery Act.
SS = Surface soil sample.
SWMU = Solid Waste Management Unit.
VCA = Voluntary Corrective Action.
#J ( ) = The estimated value is less than the laboratory limit shown in parentheses; see the data validation report (Annex F).

Table 3.4-2
Summary of HE MDLs
SWMU 28-2 VCA Confirmatory Soil Sampling
September 2002
(Off-Site Laboratory)

HE (EPA 8330[a])	
HE Compound	MDL (µg/kg)
2-Amino-4,6-dinitrotoluene	18.1
4-Amino-2,6-dinitrotoluene	34.1
m-Dinitrobenzene	34.1
2,4-Dinitrotoluene	55.0
2,6-Dinitrotoluene	48.0
HMX	48.0
Nitrobenzene	48.0
m-Nitrotoluene	24.0
o-Nitrotoluene	24.0
p-Nitrotoluene	24.0
RDX	48.0
Tetryl	22.1
1,3,5-Trinitrobenzene	29.0
2,4,6-Trinitrotoluene	48.0

[a]EPA November 1986.
EPA = U.S. Environmental Protection Agency.
HE = High explosive(s).
HMX = Cyclotetramethylene tetranitramine.
MDL = Method detection limit.
µg/kg = Microgram(s) per kilogram.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.
Tetryl = Trinitro-2,4,6-phenylmethylnitramine.
VCA = Voluntary Corrective Action.

Table 3.4-3
Summary of SWMU 28-2 VCA Confirmatory Soil Sampling
Gamma Spectroscopy Analytical Results
September 2002
(On-Site Laboratory)

Sampling Attributes			Activity (pCi/g) (EPA Method 901.1)							
Record Number[a]	ER Sample ID	Sample Depth (ft)	Uranium-238 Result [b]	Uranium-238 Error[c]	Thorium-232 Result [b]	Thorium-232 Error[c]	Uranium-235 Result [b]	Uranium-235 Error[c]	Cesium-137 Result [b]	Cesium-137 Error[c]
605644	S282-GR-109-0-SS	0.0–0.5	ND (0.765)	NA	**1.08**	0.498	**ND (0.228)**	NA	0.0144	0.0166
605644	S282-GR-110-0-SS	0.0–0.5	**452**	0.617	**1.49**	0.757	**7.12**	1.15	ND (0.0773)	NA
605644	S282-GR-111-0-SS	0.0–0.5	**89.8**	11.9	**1.42**	0.657	**1.51**	0.355	0.118	0.0326
605644	S282-GR-112-0-SS	0.0–0.5	**4.45**	0.854	**1.47**	0.668	**0.244**	0.225	ND (0.0380)	NA
605644	S282-GR-113-0-SS	0.0–0.5	**142**	31.8	**1.63**	0.825	**3.52**	0.742	ND (0.0783)	NA
605644	S282-GR-114-0-SS	0.0–0.5	**2.4**	0.607	**1.77**	0.798	**ND (0.286)**	NA	0.0273	0.02
605644	S282-GR-115-0-SS	0.0–0.5	**89.9**	12.2	**1.28**	0.599	**1.54**	0.343	0.0433	0.0245
605644	S282-GR-116-0-SS	0.0–0.5	ND (0.912)	NA	**1.57**	0.713	**0.191**	0.223	ND (0.0364)	NA
Background Soil Activities—Lower Canyons Area[d]		NA	2.31	NA	1.03	NA	0.16	NA	1.55	NA

Notes: Values in **bold** exceed background soil activities or have an MDA which exceeds background soil activities.
Canyons Supergroup Lurance Canyon subset is used for cesium-137, while uranium-235, uranium -238, and thorium-232 had no subset within the Canyons Area Supergroup.

[a]Analysis request/chain-of-custody record.
[b]Value in parentheses represents the MDA.
[c]Two standard deviations about the mean detected activity.
[d]Dinwiddie September 1997.

ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
MDA = Minimum detectable activity.
NA = Not applicable.
ND ( ) = Not detected at or above the MDA, shown in parentheses.
pCi/g = Picocurie(s) per gram.
SS = Soil sample.
SWMU = Solid Waste Management Unit.
VCA = Voluntary Corrective Action.

Sample numbers are coded to identify specific information regarding the samples. For example, for S282-GR-116-0-SS, "S282" designates a sample collected from SWMU 28-2. "GR-116" indicates that a grab sample was collected from Location 116, "0" indicates that the sample was collected from 0 to 5 inches, and "SS" indicates a surface soil sample. The following sections discuss the results of the VCA confirmatory sampling.

3.4.2 Metals Results

Table 3.4-1 presents the metals analytical results from the VCA confirmatory sampling event. Cadmium, nickel, and selenium concentrations were below the NMED-approved background levels in all confirmatory samples.

Arsenic was detected in two samples (S282-GR-115-0-SS and S282-GR-116-0-SS [Figure 3.3-2]) at levels above the NMED-approved background concentration of 9.8 milligrams (mg)/kilogram (kg). The maximum arsenic concentration from the two samples was 16.2 mg/kg.

Barium was detected in seven samples and the sample duplicate (S282-GR-110-0-SS through S282-GR-116-0-SS [Figure 3.3-2]) at levels above the NMED-approved background concentration of 246 mg/kg. The elevated concentrations ranged from 274 to 1,880 mg/kg.

Beryllium was detected in all of the samples (S282-GR-109-0-SS through S282-GR-116-0-SS [Figure 3.3-2]) at levels slightly above the NMED-approved background concentration of 0.75 mg/kg. The elevated concentrations ranged from 0.863 to 1.23 mg/kg.

Chromium was detected in two samples and the sample duplicate (S282-GR-110-0-SS and S282-GR-112-0-SS [Figure 3.3-2]) at levels slightly above the NMED-approved background concentration of 18.8 mg/kg. The maximum chromium concentration was 22.2 mg/kg.

Lead was detected in all samples (S282-GR-109-0-SS through S282-GR-116-0-SS [Figure 3.3-2]) at levels above the NMED-approved background concentration of 18.9 mg/kg. The elevated concentrations ranged from 145 to 484 mg/kg.

Mercury was detected in all samples (S282-GR-109-0-SS through S282-GR-116-0-SS [Figure 3.3-2]) at levels above the NMED-approved background concentration of 0.055 mg/kg. The elevated concentrations ranged from 0.0601 to 0.578 mg/kg.

Two samples (S282-GR-110-0-SS and S282-GR-114-0-SS [Figure 3.3-2]) contained silver at levels above the NMED-approved background concentration of 0.5 mg/kg. The maximum silver concentration from the two samples was 1.78 mg/kg.

The highest metals concentrations were incorporated into the risk assessment analysis (Annex E).

3.4.3 High Explosive Compounds Results

No HE compounds were detected. The MDLs are presented in Table 3.4-2.

3.4.4 Gamma Spectroscopy Results

Table 3.4-3 presents the gamma spectroscopy analytical results, and Figure 3.3-2 illustrates the associated sample locations. Six of the eight samples contained uranium-238 activities at levels above the NMED-approved background activity of 2.31 picocuries (pCi)/gram (g), with elevated activities ranging from 2.4 to 452 pCi/g.

All eight samples contained thorium-232 activities at levels slightly above NMED-approved background activity (1.03 pCi/g). The highest activity was 1.77 pCi/g, less than twice the NMED-approved background activity.

All eight samples collected indicated uranium-235 activities at levels above the NMED-approved background activity (0.16 pCi/g), including two nondetects with MDAs above background. Detected values range from 0.191 to 7.12 pCi/g.

All cesium-137 activities were below the NMED-approved background activity (1.55 pCi/g).

3.4.5 *In Situ* Gamma Spectroscopy Verification Results

In addition to the confirmatory soil samples that were submitted for laboratory analyses, *in situ* gamma spectroscopy measurements were taken in those areas indicating the highest residual readings (which also corresponded to areas where samples were taken for laboratory analyses). These *in situ* readings more accurately represent the actual post-VCA condition of the site, since each reading represents approximately 10 square meters surrounding the point of interest (versus the approximate 500-g soil sample that was collected at that location). The highest results of these *in situ* readings were 25.1 pCi/g, 0.75 pCi/g, and 9.5 pCi/g for uranium-238, uranium-235, and radium-226, respectively. These concentrations were used in RESRAD modeling for the site. The resulting projected dose for the recreational scenario is 1.6 millirem (mrem)/year (yr) which is well below the 100 mrem/year required by DOE Order 5400.5 “Radiation Protection of the Public and the Environment” for Unrestricted Radiological Release.

4.0 QUALITY ASSURANCE/QUALITY CONTROL RESULTS

The QA/QC field samples collected as part of the VCA confirmatory sampling event included one duplicate and one equipment rinsate blank sample.

This page intentionally left blank.

5.0 DATA VALIDATION

The off-site laboratory results for the September 2002 sampling event were reviewed according to Data Verification/Validation Level 3, as defined in SNL/NM ER Project Data Validation Procedure for Chemical and Radiochemical Data, AOP [Analytical Operating Procedure] 00-03, Rev. 0 (SNL/NM January 2000). Validation qualifications were applied to metals data for soil and aqueous sample results. Barium, selenium, and chromium were detected in one or more blanks and were qualified as "estimated" in associated samples. Trinitro-2,4,6-phenylmethylnitramine was detected in one or more of the blanks associated with the samples. However, the sample results are nondetections and, as a result, no data were qualified. The Data Verification/Validation Level 3 reports are presented in Annex F.

The gamma spectroscopy data from the Radiation Protection Sample Diagnostics (RPSD) Laboratory were reviewed according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). The verification/validation process confirmed that the data are acceptable for use in this VCA summary report for SWMU 28-2.

This page intentionally left blank.

6.0 SITE CONCEPTUAL MODEL

The site conceptual model for SWMU 28-2 is based upon the site history, hydrogeologic setting, and residual constituents of concern (COCs) identified in soil samples collected from the interior and exterior of the mine. This chapter summarizes the nature and extent of contamination and the environmental fate of the COCs.

6.1 Nature and Extent of Contamination

In 1998, 11 soil samples were collected from the interior of the mine and analyzed for metals, HE, and radionuclides by gamma spectroscopy. In addition, eight confirmatory soil samples were collected from the exterior of the mine during the VCA conducted in 2002 and analyzed for metals, HE, and radionuclides. The following is a summary of the analytical results for the interior and exterior soil samples, which are incorporated into the risk assessment (Annex E).

- HE was detected in all of the samples collected in 1998. Ten samples contained 1,3,5-trinitrobenzene at concentrations ranging from 140 to 200 micrograms (μg)/kg. Five samples contained hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX) at concentrations ranging from 150 to 220 μg/kg. No detectable levels of HE were found in the VCA confirmatory samples collected in 2002.

- Arsenic was detected above background concentration levels in two samples collected in 1998 and in two samples collected in 2002 at concentrations ranging from 10.1 to 20.5 mg/kg. Beryllium was detected above background concentration levels in all of the samples collected in 2002 at concentrations ranging from 0.863 to 1.23 mg/kg, compared to the NMED-approved background concentration for beryllium of 0.75 mg/kg. Beryllium was not detected above background concentration levels in any of the samples collected in 1998. Barium was detected above background concentration levels in two samples collected in 1998 and in seven samples collected in 2002 at concentrations ranging from 274 to 1,880 mg/kg. Chromium was detected above background concentration levels in two samples collected in 2002 at a maximum concentration of 22.2 mg/kg. Chromium was not detected above background concentration levels in any of the samples collected in 1998. Lead was detected above background concentration levels in all samples collected in 1998 and 2002 at concentrations ranging from 74.8 to 484 mg/kg, compared to the NMED-approved background concentration of 18.9 mg/kg. Eleven samples collected in 1998 contained detectable mercury above background concentration levels, and all the samples collected in 2002 contained elevated mercury at concentrations ranging from 0.0601 to 1.02 mg/kg, compared to the NMED-approved background concentration of 0.055 mg/kg. Silver was detected above background concentration levels in two samples collected in 2002, but was not detected in any of the samples collected in 1998. The maximum silver concentration was 1.78 mg/kg, compared to the NMED-approved background concentration of less than 0.5 mg/kg.

- Uranium-238 was detected above background activity levels in two samples collected in 1998 and in six samples collected in 2002 with activities ranging from 2.4 to 452 pCi/g. Thorium-232 was detected above background activity levels in three samples collected in 1998 and in all of the samples collected in 2002 with activities ranging from 1.08 to 1.77 pCi/g. All cesium-137 activities for samples collected in 1998 and 2002 were below the NMED-approved background activity level. All of the samples collected in 2002 contained uranium-235 activities or MDAs above the NMED-approved background activity level, ranging from 0.228 to 7.12 pCi/g; all of the samples collected in 1998 had associated MDAs above the NMED-approved background activity levels.

6.2 Environmental Fate

The primary sources of COCs for SWMU 28-2 may have been disposal activities that deposited depleted uranium outside the mine and explosive testing activities that dispersed COCs inside the mine. The primary COC release mechanism to the surface and subsurface soil outside the mine is from degradation of depleted uranium that could have occurred before its removal during remediation activities. The elevated metals and thorium results are thought to be naturally occurring.

Table 6.2-1 summarizes the COCs for SWMU 28-2. All of the actual COCs were retained in the conceptual model and evaluated in the human health and ecological risk assessments.

The air pathway is of primary concern if radioactive dust is present (Figure 6.2-1). However, the final surface radiation survey, conducted by SNL/NM in September 2002, found evidence of slightly elevated radiation levels in portions of the site consistent with the bedrock in this area which contains naturally elevated radionuclide activity. Because the radiation levels are consistent with naturally occurring activities, the air pathway is considered secondary.

The surface soil is considered a primary pathway because most of the potential COCs were deposited on the surface (Figure 6.2-1). This would cause an exposure risk via direct ingestion for the recreational land-use scenario.

The potential effects of wind as a transport mechanism for COCs at the soil surface are moderated by vegetative cover at the site.

The surface-water pathway was not considered because of the potential for COCs to be present at the surface and the presence of an arroyo north of the site is extremely small. On-site drainages are extremely small and surface flows are expected to be infrequent and highly ephemeral in nature. The distance of particle transport during surface flows will depend upon the size of the particle and the velocity of the water.

Infiltrating surface water could provide a transport mechanism for potential COCs located at the surface to infiltrate the vadose zone. Because of both the low COC concentrations and the local climate (very dry, low rainfall, and high evapotranspiration rates), this pathway is considered secondary.

The groundwater pathway is not significant because of the low concentrations of COCs at the surface combined with low precipitation rates. The lack of significant infiltration during rainfall events (high evapotranspiration rates) precludes migration of residual COCs into the aquifer.

Annex E provides additional discussion of the fate and transport of COCs at SWMU 28-2.

Table 6.2-1
Summary of Results for COCs at SWMU 28-2

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Lower Canyons Area[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 was Exceeded[c]
Metals	19 environmental, 2 duplicate	Arsenic	9.8	20.5	8.21	S282-GR-115-0-SS S282-GR-116-0-SS M28-2-GR-006-0-S M28-2-GR-007-0-S
		Barium	246	1,880	469	S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-112-0-DUP S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS S282-GR-116-0-SS M28-2-GR-006-0-S M28-2-GR-007-0-S
		Beryllium	0.75	1.23	0.69	S282-GR-109-0-SS S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-112-0-DUP S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS S282-GR-116-0-SS
		Cadmium	0.64	0.477 J	0.18	None

Refer to footnotes at end of table.

Table 6.2-1 (Continued)
Summary of Results for COCs at SWMU 28-2

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Lower Canyons Area[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 was Exceeded[c]
Metals (cont.)		Chromium	18.8	22.2	12.54	S282-GR-110-0-SS S282-GR-112-0-SS S282-GR-112-0-DUP
		Lead	18.9	484	228.63	S282-GR-109-0-SS S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-112-0-DUP S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS S282-GR-116-0-SS M28-2-GR-001-0-S M28-2-GR-002-0-S M28-2-GR-003-0-S M28-2-GR-004-0-S M28-2-GR-005-0-S M28-2-GR-006-0-S M28-2-GR-007-0-S M28-2-GR-008-0-S M28-2-GR-009-0-S M28-2-GR-010-0-S M28-2-GR-012-0-S M28-2-GR-0010A-0.5

Refer to footnotes at end of table.

Table 6.2-1 (Continued)
Summary of Results for COCs at SWMU 28-2

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Lower Canyons Area[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 was Exceeded[c]
Metals (cont.)		Mercury	0.055	1.02	0.266	S282-GR-109-0-SS S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-112-0-DUP S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS S282-GR-116-0-SS M28-2-GR-001-0-S M28-2-GR-003-0-S M28-2-GR-004-0-S M28-2-GR-005-0-S M28-2-GR-006-0-S M28-2-GR-007-0-S M28-2-GR-008-0-S M28-2-GR-009-0-S M28-2-GR-010-0-S M28-2-GR-012-0-S M28-2-GR-0010A-0.5
		Nickel	16.6	14.2	9.79	None
		Selenium	2.7	0.685 B	0.191	None
		Silver	<0.5	1.78	0.192	S282-GR-110-0-SS S282-GR-114-0-SS

Refer to footnotes at end of table.

Table 6.2-1 (Continued)
Summary of Results for COCs at SWMU 28-2

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Lower Canyons Area[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 was Exceeded[c]
High Explosives	18 environmental, 2 duplicate	1,3,5-Trinitrobenzene	NA	200 J µg/kg	NA	M28-2-GR-001-0-SS M28-2-GR-002-0-SS M28-2-GR-003-0-SS M28-2-GR-004-0-SS M28-2-GR-005-0-SS M28-2-GR-006-0-SS M28-2-GR-007-0-SS M28-2-GR-008-0-SS M28-2-GR-010-0-SS M28-2-GR-012-0-SS M28-2-GR-0010A-0.5
		RDX	NA	220 J µg/kg	NA	M28-2-GR-004-0-SS M28-2-GR-005-0-SS M28-2-GR-006-0-SS M28-2-GR-008-0-SS M28-2-GR-010-0-SS M28-2-GR-0010A-0.5
Radionuclides	19 environmental, 2 duplicate	Uranium-235	0.16 pCi/g	7.12 pCi/g	Not Calculated[e]	S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-113-0-SS S282-GR-115-0-SS S282-GR-116-0-SS (plus 14 samples where MDA exceeds background)
		Uranium-238	2.31 pCi/g	452 pCi/g	Not Calculated[e]	S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS (plus 2 samples where MDA exceeds background)

Refer to footnotes at end of table.

Table 6.2-1 (Concluded)
Summary of Results for COCs at SWMU 28-2

COC Type	Number of Samples	COCs Detected	Maximum Background Limit/Lower Canyons Area[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 was Exceeded[c]
Radionuclides (cont.)		Thorium-232	1.03 pCi/g	1.77 pCi/g	Not Calculated[d]	S282-GR-109-0-SS S282-GR-110-0-SS S282-GR-111-0-SS S282-GR-112-0-SS S282-GR-113-0-SS S282-GR-114-0-SS S282-GR-115-0-SS S282-GR-116-0-SS M28-2-GR-002-0-S M28-2-GR-007-0-S M28-2-GR-009-0-S
		Cesium-137	1.55 pCi/g	0.118 pCi/g	Not Calculated[e]	None

Note: Canyons Supergroup Lurance Canyon subset is used for cesium-137, while uranium-235, uranium -238, and thorium-232 had no subset within the Canyons Area Supergroup.

[a]Dinwiddie September 1997 for radionuclides and Garcia November 1998 for metals.

[b]Average concentration includes all samples and duplicates. For nondetectable results for nonradiological COCs, the MDL is used in the average calculation.

[c]Includes samples with nondetected results where the MDL or MDA exceeds the approved background limit.

[d]An average MDA is not calculated because of the variability in instrument counting error and the number of reported nondetectable activities.

B = Analyte present in associated laboratory method blank.
COC = Constituent of concern.
DUP = Duplicate.
GR = Grab sample.
J = The reported value is an estimated concentration between the MDL and the reporting limit, or is an estimated value.
µg/kg = Microgram(s) per kilogram.
MDA = Minimum detectable activity.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
pCi/g = Picocurie(s) per gram.
RDX = Hexahydro-1,3,5-trinitro-1,3,5-triazine.
S = Soil sample.
SS = Soil sample.
SWMU = Solid Waste Management Unit.

This page intentionally left blank.

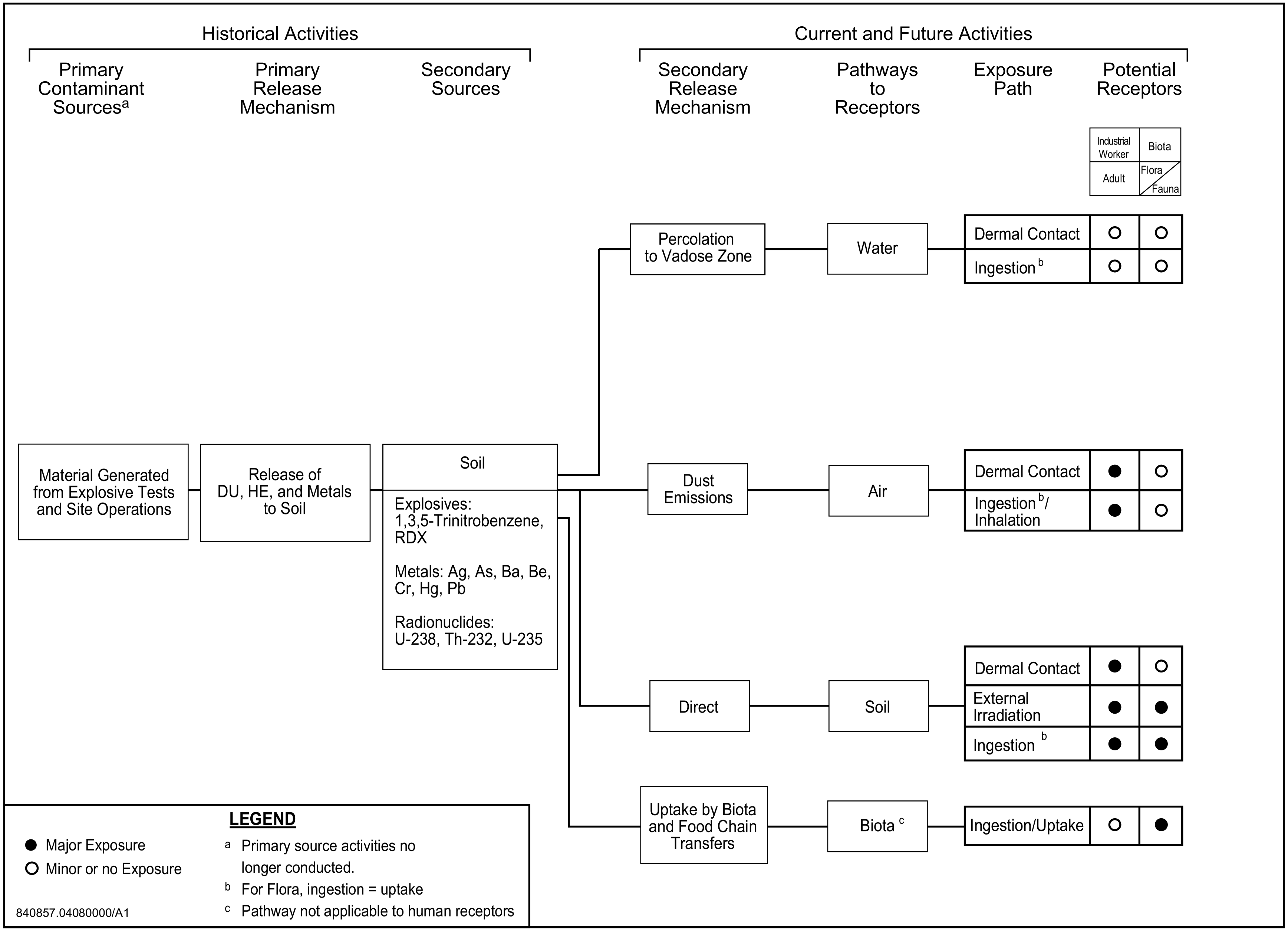


Figure 6.2-1

Conceptual Site Model Flow Diagram for SWMU 28-2

The future land use for SWMU 28-2 is designated as recreational, and the potential human receptor is considered a recreational user of the site. Direct dermal exposure, as well as inhalation and ingestion of particulates suspended by the wind via the air and soil pathways, are considered the primary exposure routes.

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, direct contact with COCs in soil, and direct gamma exposure from radiological COCs. Uptake of COCs into the food chain is not expected to be a significant transport mechanism due to the arid environment.

Sections V through VII of Annex E provide further discussion of the exposure routes and potential receptors at SWMU 28-2.

This page intentionally left blank.

7.0 SITE ASSESSMENTS

Site assessments at SWMU 28-2 include screening assessments followed by baseline assessments (as required) for both human health and ecological risk. The following sections summarize the site assessment results for SWMU 28-2. Annex E contains the risk assessment report.

7.1 Summary

The site assessment concludes that SWMU 28-2 poses no significant risk to 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 28-2 were estimated to be very low. Section 7.2 briefly describes the site risk assessments, which are presented in detail in Annex E.

7.2 Risk Assessments

Risk assessments were performed for both human health and ecological risk for SWMU 28-2. This section briefly summarizes the risk assessment results.

7.2.1 Human Health

SWMU 28-2 has been recommended for recreational land use (DOE et al. October 1995). A complete discussion of the risk assessment process, results, and uncertainties is provided in Annex E. Because COCs are present in concentrations or at activities greater than background levels, it was necessary to perform a human health risk analysis for the site. Besides COC metals, all HE compounds detected above the reporting limits and all radionuclide COCs detected above either background activity levels and/or MDAs were included in this assessment. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects caused by COCs in the soil at the site. The Risk Assessment (Annex E) calculated the hazard index (HI) and excess cancer risk for both recreational and residential land-use scenarios. The excess cancer risk from the nonradiological and radiological COCs is not additive (EPA 1989).

In summary, the HI calculated for nonradiological COCs at SWMU 28-2 is 0.03 for a recreational land-use scenario, which is lower than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The incremental HI risk, determined by subtracting the risk associated with background from potential nonradiological COC risk, is 0.02. The excess cancer risk for nonradiological COCs at SWMU 28-2 is 1E-6 for a recreational land-use scenario. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (NMED March 2000); thus the excess cancer risk for this site (1E-6) is below the suggested acceptable risk value. The incremental cancer risk is 4.05E-7.

For residential land use, using the 95% UCL of the mean concentration for arsenic, the incremental HI and excess cancer risk are 0.49 and 1.50E-7, respectively. Thus, using realistic concentrations in the risk calculations that more accurately depict actual site conditions reduces the incremental HI and estimated excess cancer risks to values below NMED guidelines.

The incremental total effective dose equivalent for radionuclides at SWMU 28-2 for a recreational land-use scenario is 1.8 mrem/yr, which is well below the recommended dose limit of 15 mrem/yr found in the U.S. Environmental Protection Agency's (EPA's) Office of Solid Waste and Emergency Response Directive No. 9200.4-18 (EPA 1997a) and reflected in the document entitled "RESRAD Input Parameter Assumptions and Justification" (SNL/NM February 1998). The incremental excess cancer risk for the recreational land-use scenario for the radionuclide COCs is 2.3E-5.

The residential land-use scenario for this site is provided in the Risk Assessment (Annex E).

The report concludes that SWMU 28-2 does not have the potential to adversely affect human health under recreational and residential land-use scenarios.

7.2.2 Ecological

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

Tables 15, 16, and 18 of Annex E present the results of the ecological risk assessment. Site-specific information was incorporated wherever such data were available. Hazard quotients (HQs) greater than 1 were predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to the use of maximum analyte concentrations measured in soil samples to evaluate risk, the use of wildlife toxicity benchmarks based upon no-observed-adverse-effect-level values, the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse, and the assumption that all food and soil ingested by the wildlife receptors comes from the area of the site. Based upon an evaluation of these uncertainties, ecological risks associated with this site are expected to be low.

7.3 Baseline Risk Assessments

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

7.3.1 Human Health

Because the results of the human health risk assessment summarized in Section 7.2.1 indicate that SWMU 28-2 does not have the potential to adversely affect human health under a recreational and residential land-use setting, a baseline human health risk assessment is not required for SWMU 28-2.

7.3.2 Ecological

Because ecological results of the risk assessment summarized in Section 7.2.2 indicate that SWMU 28-2 has low ecological risk, a baseline ecological risk assessment is not required for SWMU 28-2.

7.4 Surface-Water Assessment

A surface-water assessment to evaluate the potential for erosion from the site was performed at SWMU 28-2 in February 2004, in accordance with guidance developed jointly by Los Alamos National Laboratory and the NMED Surface Water Quality Bureau. SWMU 28-2 received a score of 24, indicating low erosion potential. The COCs detected at SWMU 28-2 are at levels that do not pose a threat to human health or the environment, nor would the COCs adversely affect surface-water quality under a recreational land-use setting. Complete details of the surface-water assessment are presented in Annex G.

This page intentionally left blank.

8.0 NO FURTHER ACTION PROPOSAL

8.1 Rationale

The data collected at SWMU 28-2 and the results of the risk assessment support the recommendation for NFA for this site:

- The potential COCs at the site are present at very low concentrations (metals, HE, and radionuclides) in the confirmatory soil samples.
- The risk assessment concluded that SWMU 28-2 poses no significant risk to human health under both the recreational and residential land-use scenarios, and the site poses no significant risk to the ecological receptors.

8.2 Criterion

Based upon the evidence provided above, SWMU 28-2 is proposed for an NFA decision in conformance with Criterion 5 (NMED March 1998), which states "the SWMU/AOC [area of concern] has been characterized or remediated in accordance with current applicable state or federal regulations and available data indicate that contaminants pose an acceptable level of risk under current and projected future land use."

This page intentionally left blank.

9.0 REFERENCES

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

DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

Garcia, B.J. (New Mexico Environment Department). Letter to M. Zamorski (U.S. Department of Energy, Kirtland Air Force Base) and J.B. Woodard (Sandia National Laboratories/New Mexico) regarding SNL/NM background study approval. November 25, 1998.

IT, see IT Corporation.

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

Mignardot, E. (Sandia National Laboratories/New Mexico), October 2002. "Memorandum to C. Byrd (Sandia National Laboratories/New Mexico Environmental Restoration Project), Meeting with NMED Regarding Preliminary Risk Assessment of SWMU 28-2," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico. October 28, 2002.

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

New Mexico Environment Department (NMED), March 2000. Position Paper, "Assessing Human Health Risks Posed by Chemicals: Screening-Level Risk Assessment," Hazardous and Radioactive Materials Bureau, New Mexico Environment Department, Santa Fe, New Mexico.

NMED, see New Mexico Environment Department.

Sandia National Laboratories/New Mexico (SNL/NM), August 1995. "Proposal for No Further Action, Environmental Restoration Project Site 28, Mineshafts, Operable Unit 1332, August 1995," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

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

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

Sandia National Laboratories/New Mexico (SNL/NM), May 1999. "Environmental Restoration Project Supplemental Information and Summary of Requested Actions at SWMU 28," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2000. "Data Validation Procedure for Chemical and Radiochemical Data, Sandia National Laboratories/New Mexico Environmental Restoration Project, AOP 00-03," Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.

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

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

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

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

U.S. Environmental Protection Agency (EPA), 1997a. "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," OSWER Directive No. 9200.4-18, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

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

Annex A

ANNEX A
Chemical Results of the RCRA Facility Investigation Characterization Sampling Conducted in April 1998

This page intentionally left blank.

Table 1
Summary of SWMU 28-2 RFI Soil Sampling RCRA Metals Plus Beryllium and Nickel Analytical Results, April 1998

Sample Attributes			Methods 6010, and 7470/7471[a] (mg/kg)									
Sample Number	ER Sample ID	Sample Depth (ft)	Arsenic	Barium	Beryllium	Cadmium	Chromium	Mercury	Nickel	Lead	Silver	Selenium
040282-A02	M28-2-GR-001-0-S	0.0-1.0	8.38	153[J]	0.404J [J]	ND (0.002453) [J]	5.60 [J]	**0.411**	6.90 [J]	**168[J]**	ND (0.002914)	ND (0.000891)
040283-A02	M28-2-GR-002-0-S	0.0-1.0	4.58	95.7[J]	0.330J [J]	ND (0.002453) [J]	2.66 [J]	0.0118J	4.48[J]	**222[J]**	ND (0.002914)	ND (0.000891)
040284-A02	M28-2-GR-003-0-S	0.0-1.0	8.50	179[J]	0.318J [J]	ND (0.002453) [J]	6.48 [J]	**0.363**	6.22[J]	**143[J]**	ND (0.002914)	ND (0.000891)
040285-A02	M28-2-GR-004-0-S	0.0-1.0	3.22	207[J]	0.517[J]	0.477J [J]	10.4 [J]	**0.166**	9.42[J]	**281[J]**	ND (0.002914)	ND (0.000891)
040286-A02	M28-2-GR-005-0-S	0.0-1.0	3.90	170[J]	0.479J [J]	ND (0.002453) [J]	9.84 [J]	**0.117**	10.2[J]	**127[J]**	ND (0.002914)	ND (0.000891)
040287-A02	M28-2-GR-006-0-S	0.0-1.0	**20.5**	**531[J]**	0.367J [J]	ND (0.002453) [J]	6.00 [J]	**0.343**	5.87[J]	**301[J]**	ND (0.002914)	ND (0.000891)
040288-A02	M28-2-GR-007-0-S	0.0-1.0	**10.1**	**1,320[J]**	0.423J [J]	ND (0.002453) [J]	11.3 [J]	**1.02**	7.84[J]	**233[J]**	ND (0.002914)	ND (0.000891)
040289-A02	M28-2-GR-008-0-S	0.0-1.0	3.43	179[J]	0.463J [J]	ND (0.002453) [J]	9.60 [J]	**0.104**	9.15[J]	**74.8[J]**	ND (0.002914)	ND (0.000891)
040290-A02	M28-2-GR-009-0-S	0.0-1.0	3.49	59.6[J]	ND (0.001811) [J]	ND (0.002453) [J]	2.69 [J]	**0.163**	3.90J[J]	**115[J]**	ND (0.002914)	ND (0.000891)
040291-A02	M28-2-GR-010-0-S	0.0-1.0	3.20	175[J]	0.475J [J]	ND (0.002453) [J]	10.5 [J]	**0.208**	8.35[J]	**218[J]**	ND (0.002914)	ND (0.000891)
040293-A02	M28-2-GR-012-0-S	0.0-1.0	3.98	172[J]	0.378J [J]	ND (0.002453) [J]	9.12 [J]	**0.215**	7.91[J]	**252[J]**	ND (0.002914)	ND (0.000891)
040397-A02	M28-2-GR-0010A-0.5	0.0-1.0	4.64	227B[J]	0.463J [J]	ND (0.002453) R	8.01 [J]	**0.0671**	9.10[J]	**163[J]**	ND (0.002914)	ND (0.000891)
Canyons Area Background Range[b]	NA	NA	1.6-9.6	39-400	0.2-0.73	0.09-0.99	2.5-20	0.01-0.13	5.3-16	4.7-51	0.01-0.50	0.56-3.1
Background Soil Concentrations—Canyons Area[b]	NA	NA	9.8	246	0.75	0.64[c]	18.7	0.055[c]	16.6	18.9[c]	<0.5[c]	2.7[c]
Quality Control Samples (in mg/L)												
040395-004	M28-2-GR-011-0-DIW (water)	NA	ND (0.00827)	ND (0.001709) [J]	ND (0.001811) [J]	0.00277J	ND (0.003826) [J]	ND (0.000047)	ND (0.012834) [J]	ND (0.000929) [J]	ND (0.002914)	ND (0.000891)

[a]EPA November 1986
[b]UTLs from Zamorski December 1997.
[c]95th percentile provided instead of 95th UTL.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
J = Compound is determined to be present based upon mass spectral data but at a concentration less than the practical quantitation limit of the method.
[J] = Associated value was qualified as estimated during data validation.
mg/kg = Milligram(s) per kilogram.
mg/L = Milligram(s) per liter.
NA = Not applicable.
ND = Nondetect (method detection limit).
R = The data point was nondetect for cadmium, however the percent recovery was outside the acceptance limit in matrix spike and matrix duplicates. Nondetects under these conditions are qualified as unusable.
RCRA = Resource Conservation and Recovery Act.
RFI = RCRA Facility Investigation.
S = Soil sample.
SWMU = Solid Waste Management Unit
TAL = Target analyte list.
UTL = Upper tolerance limit.
[ ] = Qualified during data validation.

Table 2
Summary of SWMU 28-2 RFI Soil Sampling High Explosives Analytical Results, April 1998

Sample Attributes			High Explosives, Methods 8330[a] (µg/kg)			
Sample Number	ER Sample ID	Sample Depth	1,3,5-Trinitrobenzene	Hexahydro-1,3,5-trinitro-1,3,5-triazine	2,4-dinitrotoluene	Nitrobenzene
040282-001	M28-2-GR-001-0-S	0.0-1.0 ft	**140J**	ND (31)	ND (17)	ND (17)
040283-001	M28-2-GR-002-0-S	0.0-1.0 ft	**150J**	ND (31)	ND (17)	ND (17)
040284-001	M28-2-GR-003-0-S	0.0-1.0 ft	**150J**	ND (31)	ND (17)	ND (17)
040285-001	M28-2-GR-004-0-S	0.0-1.0 ft	**150J**	**220J**	ND (17)	ND (17)
040286-001	M28-2-GR-005-0-S	0.0-1.0 ft	**200J**	**220J**	ND (17)	ND (17)
040287-001	M28-2-GR-006-0-S	0.0-1.0 ft	**180J**	**150J**	ND (17)	ND (17)
040288-001	M28-2-GR-007-0-S	0.0-1.0 ft	**180J**	ND (31)	ND (17)	ND (17)
040289-001	M28-2-GR-008-0-S	0.0-1.0 ft	**150J**	**200J**	ND (17)	ND (17)
040290-001	M28-2-GR-009-0-S	0.0-1.0 ft				
040291-001	M28-2-GR-010-0-S	0.0-1.0 ft	**190J**	**160J**	ND (17)	ND (17)
040293-001	M28-2-GR-012-0-S	0.0-1.0 ft	**150J**	ND (31)	ND (17)	ND (17)
040397-001	M28-2-GR-0010A-0.5	0.0-1.0 ft	**190J**	**160J**	ND (17)	ND (17)
Quality Control Samples (in µg/L)						
040292-003	M28-2-GR-011-0-DIW	NA	ND (0.32) [U, J]	ND (0.12) [U,J]	**0.12J [J2]**	**0.16J [U,J]**

[a]EPA November, 1986.
ER = Environmental Restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
[J] = Associated value was qualified as estimated during data validation.
[J2] = Holding time was exceeded for the associated sample analysis. The associated value is an estimated quantity.
J = Compound is determined to be present based upon mass spectral data but at a concentration less than the practical quantitation limit of the method.
NA = Not applicable.
ND = Nondetect.
RFI = RCRA facility investigation.
S = Soil sample.
SWMU = Solid Waste Management Unit.
[U] = The analyte is a common laboratory contaminant. The associated result is less than 10 times the concentration in any blank.
µg/kg = Microgram(s) per kilogram.
µg/L = Microgram(s) per liter.
[ ] = Qualified during data validation.

Table 3
Summary of SWMU 28-2 Surface Soil Sampling, Gamma Spectroscopy Analytical Results—On-Site Laboratory Inorganic Constituents, April 1998

Sample Attributes			Activity[a] (pCi/g)							
			Uranium 238		Thorium 232		Uranium 235		Cesium 137	
Sample Number	ER Sample ID	Sample Depth (ft)	Result[b]	Error	Result[b]	Error	Result[b]	Error	Result[b]	Error
040282-002	M28-2-GR-001-0-S	0.0-1.0	ND (2.56E+00)	--	9.25E-01	4.65E-01	ND (3.18E-01)	--	ND (4.95E-02)	--
040283-002	M28-2-GR-002-0-S	0.0-1.0	7.49E-01	1.33E+00	1.11E+00	5.75E-01	ND (3.04E-01)	--	ND (6.03E-02)	--
040284-002	M28-2-GR-003-0-S	0.0-1.0	ND (2.70E+00)	--	9.72E-01	4.94E-01	ND (3.49E-01)	--	ND (5.66E-02)	--
040285-002	M28-2-GR-004-0-S	0.0-1.0	5.80E-01	8.61E-01	5.47E-01	4.46E-01	ND (2.33E-01)	--	ND (4.47E-02)	--
040286-002	M28-2-GR-005-0-S	0.0-1.0	ND (1.58E+00)	--	6.49-01	5.06E-01	ND (2.44E-01)	--	ND (5.21E-02)	--
040287-002	M28-2-GR-006-0-S	0.0-1.0	ND (1.79E+00)	--	9.09E-01	5.50E-01	ND (2.67E-01)	--	ND (5.35E-02)	--
040288-002	M28-2-GR-007-0-S	0.0-1.0	ND (2.22E+00)	--	1.08E+00	6.18E-01	ND (3.29E-01)	--	ND (7.83E-02)	--
040289-002	M28-2-GR-008-0-S	0.0-1.0	ND (1.98E+00)	--	4.66E-01	3.30E-01	ND (2.71E-01)	--	ND (4.19E-01)	--
040290-002	M28-2-GR-009-0-S	0.0-1.0	ND (1.95E+00)	--	1.13E+00	5.86E-01	ND (3.13E-01)	--	ND (6.09E-02)	--
040291-002	M28-2-GR-010-0-S	0.0-1.0	ND (1.89E+00)	--	4.30E-01	2.43E-01	ND (2.56E-01)	--	ND (3.96E-02)	--
040293-002	M28-2-GR-012-0-S-DU	0.0-1.0	7.12E-01	7.88-01	6.11E-01	4.14E-01	ND (2.32E-01)	--	ND (5.10E-02	--
040297-002	M28-2-GR-010A-0.5	0.5-1.0	ND (2.11E+00)	--	6.54E-01	4.95E-01	ND (3.40E-01)	--	ND (6.99E-02)	--
HRMB Maximum Canyons Background Soil Concentration[c]		NA	2.31	NA	1.03	NA	0.16	NA	1.063	NA
SNL/NM Canyons Soil Background UTL or 95th Percentile		NA	2.31	NA	1.03	NA	<0.391	NA	1.063	NA

[a]U-238 and Th-232 decay chain isotopes with a short half-life are not presented in this table.
[b]Value in parenthesis represents the minimum detection activity.
[c]Zamorski December 1997.

DU = Duplicate.
ER = Environmental Restoration.
ft = Feet (foot).
GR = Grab sample.
ID = Identification.
MDA = Minimum detection activity.
NA = Not applicable.
ND = Nondetect—the analyte was not observed above the MDA, shown in parenthesis ().
pCi/g = Picocuries per gram.
S = Soil sample.
SWMU = Solid Waste Management Unit.
-- = Error not calculated for nondetectable results.

Table 4
Summary of SWMU 28-2, Surface Soil Sampling, Gross Alpha/Gross Beta Results, April 1998

Sample Attributes			Gross Alpha (pCi/g)		Gross Beta (pCi/g)	
Sample Number	ER Sample ID	Sample Depth (ft)	Measured Activity	Error (+/-)	Measured Activity	Error (+/-)
040282-001	M28-2-GR-001-0-S	0.0-1.0	18.3	3.47	52.5	2.69
040283-001	M28-2-GR-002-0-S	0.0-1.0	17.6	3.53	64.4	2.84
040284-001	M28-2-GR-003-0-S	0.0-1.0	14.0	3.37	44.0	2.54
040285-001	M28-2-GR-004-0-S	0.0-1.0	10.5	3.21	29.3	2.30
040286-001	M28-2-GR-005-0-S	0.0-1.0	11.1	3.24	34.3	2.39
040287-001	M28-2-GR-006-0-S	0.0-1.0	13.8	3.37	45.8	2.57
040288-001	M28-2-GR-007-0-S	0.0-1.0	14.9	3.41	50.8	2.65
040289-001	M28-2-GR-008-0-S	0.0-1.0	14.9	3.41	39.1	2.47
040290-001	M28-2-GR-009-0-S	0.0-1.0	17.3	3.51	61.0	2.80
040291-001	M28-2-GR-010-0-S	0.0-1.0	9.18	3.15	35.8	2.41
040293-001	M28-2-GR-012-0-S	0.0-1.0	12.5	3.21	34.3	2.38
040397-001	M28-2-GR-010A-0-S	0.5-1.5	9.69	3.08	30.0	2.31
Quality Control Samples (in pCi/L)						
040396-001	M28-2-GR-011-0-DW	NA	0.800	0.260	ND 0.750)	0.430

DW = Decontamination water.
ER = Environmental restoration.
ft = Foot (feet).
GR = Grab sample.
ID = Identification.
pCi/g = Picocuries per gram.
pCi/L = Picocuries per liter
MDA = Minimum detection activity.
NA = Not applicable.
ND = Nondetect—the analyte was not observed above the MDA shown in parenthesis ().
S = Soil sample.
SWMU = Solid Waste Management Unit.

Annex B

ANNEX B
Voluntary Corrective Action Plan and Waste Management Plan for SWMU 28-2 Mine, Operable Unit 1332, Foothills Test Area, July 2002

Voluntary Corrective Action Plan
July 2002

VOLUNTARY CORRECTIVE ACTION PLAN FOR SWMU 28-2 Mine, OPERABLE UNIT 1332, FOOTHILLS TEST AREA
July 2002

Prepared by
Sandia National Laboratories/New Mexico
Environmental Restoration Project
Albuquerque, New Mexico

Prepared for
The U.S. Department of Energy

VOLUNTARY CORRECTIVE ACTION PLAN
SWMU 28-2, MINE

BACKGROUND

Sandia National Laboratories/New Mexico (SNL/NM) Solid Waste Management Unit (SWMU) 28-2 is one of ten mines identified as the Environmental Restoration (ER) SWMU 28 Mine Shafts in the Hazardous and Solid Waste Amendments Module of SNL/NM's Resource Conservation and Recovery Act (RCRA) Permit. SWMU 28-2 is within the U.S. Forest Service (USFS) Withdrawn Lands near the southeastern portion of Kirtland Air Force Base (KAFB) (Figure 1), and is located approximately 3,000 feet southeast of SWMU 28-1 (Figure 2). There are two horizontal adits at this site: a lower and an upper. The portal of the upper adit is located approximately 60 vertical feet above the lower adit.

New Mexico Environment Department (NMED), KAFB, and SNL/NM personnel have entered and inspected both the lower and upper adits comprising SWMU 28-2. According to site background interviews conducted by SNL/NM ER personnel, SNL/NM staff detonated waste explosives in the lower mine adit at SWMU 28-2. This has been confirmed based upon the presence of the "concrete wall and detonation cord" inside the mine as described below, as well as a follow-up visit to the site. SNL/NM ER personnel conducted a mine entry to characterize and sample the interior of the mine. The results of this entry are discussed below.

Even though there have been no reports of disposal activity at the mine, a small amount of depleted uranium (DU) was found at the entrance to the lower adit during a site visit. The radiation hazard sign previously posted at the portal was replaced with a radiological soil contamination sign due to the recent DU found.

SUMMARY OF EXISTING DATA

Radiation Surveys

A radiation warning sign was present in front of this mine until 1989. Two radiation surveys were conducted in the interior of the mine. The SNL/NM Reactor Applications and Health Physics Divisions conducted the first survey in 1982-1983, and ER project personnel conducted the second survey in 1989. No elevated radiation levels above background were observed in either survey, and the sign was removed based on these surveys. The reason for the warning sign could not be definitively established. However, it was speculated that the sign was installed to keep people out of the mine. No radiation surveys were conducted outside of the mine.

RFI Sampling

The interior of the mine was inspected and sampled during RFI activities in 1998. No characterization sampling was conducted outside of the mine during this investigation. The results of the interior sampling include:

- Significant information was gained by the entry and all observations support the explosives test site history for the mine.
- No evidence was found of buried metal objects in the floor or walls.
- The surveys yielded no evidence of elevated radioactivity.
- The mine is a confined space that easily can develop an atmosphere that is IDLH for oxygen and above action levels for VOCs in the presence of ordinary work equipment.
- Analytical results show no elevated radioactive constituents, slightly elevated metals in dirt/rock consistent with a hard rock mine of this type, and trace amounts of high explosives consistent with the explosive test scenario.
- Sampling was conducted to 18 inches. Deeper soil samples were not collected due to confined space entry requirements. SNL/NM Health and Safety personnel also required supplied air for sampling team members for sampling below 18 inches in depth.

A risk assessment was performed for the interior of the mine based on the above information, and concluded:

- The risk for the designated recreational land use is acceptable.
- The risk assessment is extremely conservative based upon the assumptions of access that will not be possible after the proposed mine closure.
- No unacceptable risk to the environment exists.

1.0 VOLUNTARY CORRECTIVE ACTION

Based upon finding DU immediately beneath the surface outside the entrance to SWMU 28-2, it will be necessary to conduct a Voluntary Corrective Action (VCA) in this area in order to: 1) remove the DU encountered in soil; 2) collect confirmatory soil samples; and 3) restore the site to original grade. The SNL/NM Environmental Restoration Field Office (ERFO) team will conduct the VCA with support from SNL Radiation Protection personnel. SWMU 28-2 is a Radioactive Materials Management Area (RMMA) and all work activities will be performed under a Radiological Work Permit (RWP). Below is a discussion of the planned VCA activities, which will take place in two phases.

Initial Phase:
A SNL Radiological Control Technician (RCT) will survey the access road (including edges) that begins at the entrance to the SWMU and ends at a temporary barrier to the mine (located approximately 12 feet from the mine opening) for radiological hotspots (DU contamination). An E-600 detector with sodium iodide probe will be used to perform the survey. If a hotspot is found, it will then be removed for disposal. Field instrumentation and visual observations will be used to direct the soil removal. Airborne dust may become a concern during removal activities. Water may be used for dust suppression and/or it may be necessary for site workers to wear respirators.

The SNL RCT will screen soil overlying the DU hotspot, and if no contamination is observed, this soil will placed aside and remain on site. The hotspot/DU contamination will then be removed down to undisturbed soil or bedrock, whichever is encountered first. A backhoe and/or hand-held shovels will be used to expose the DU, segregate clean soils, and remove the DU. DU and contaminated soils will be placed in 55-gallon drums and sampled. If hazardous constituents are present, the drummed soil will be handled separately as a mixed waste in accordance with the SWMU 28-2 Waste Plan (Attachment 1).

The loose soil and rock, which have accumulated along the edges of the access road due to erosion, will be removed using a backhoe. Then, these areas will be surveyed for hotspots, and DU contamination removed if found.

After removal of DU-contamination, a confirmatory soil sample will be collected from each hotspot to verify that no additional contamination exists (refer to Section 1.1 for additional discussion regarding confirmatory sampling). All identified hotspots, as well as the entire area surveyed for hotspots, will be surveyed using GPS.

Second Phase:
The second phase of the remediation will involve conducting a radiological survey from the temporary barrier to the opening of the mine. Then, all the hotspots will be identified and DU contamination removed, as discussed above.

Final Survey
A SNL RCT will conduct a final radiological walkover survey over the entire access road to the mine opening to verify that no hotspots are still present at or near the ground surface. An E-600 detector with sodium iodide probe will be used to perform the survey. If any hotspots are identified they will be removed and sampled as discussed above. It is not anticipated that any hotspots will be encountered during the final walkover survey.

The data will support (in conjunction with the walkover survey) removal of SWMU 28-2 from the RMMA site list, as well as providing supporting information for the

NFA proposal. A Field Implementation Plan (FIP) has been prepared to document the specific field sampling procedures and analytical requirements for this project (Attachment 2).

1.1 Waste Characterization and Confirmatory Soil Sampling

The waste drums filled with DU contaminated soil will be staged on pallets adjacent to the access road. Ten percent of the waste drums of soil (minimum of two samples) will be analyzed for TCLP Metals plus Be and Ni, HE, and gamma spectroscopy. These samples will be sent to an off-site laboratory for non-radiological analyses. A portion of the sample will be analyzed at the SNL/NM Radiation Protection Sample Diagnostics (RPSD) laboratory prior to off-site release. The objective of this sampling will be to determine if there are any RCRA hazardous materials in the soil that would require categorizing the soil as a mixed waste. A waste management plan for this project has been reviewed and approved (Attachment 1).

Confirmatory soil samples will be collected from the hotspots where DU was removed. If soil contamination is limited to the area where it was originally detected outside the entrance to the mine, two confirmatory soil samples plus one sample duplicate will be collected. A minimum of one confirmatory sample will be collected from each additional hotspot, and if the hotspot is large, it will be sampled on a 10 ft by 10 ft grid. All sampling will be done in conformance with SNL/ER Field Operation Procedures (FOPs). The attached FIP describes the specific sampling procedures. All confirmatory samples will be analyzed for RCRA metals plus Be and Ni (EPA-6010/7000), HE (EPA-8330), and gamma spectroscopy (RPSD laboratory).

1.2 Site Restoration

After confirmatory soil data has been reviewed and it is determined that clean up objectives have been met, clean soil staged at the site will be used to restore the site to original grade.

1.3 Health and Safety

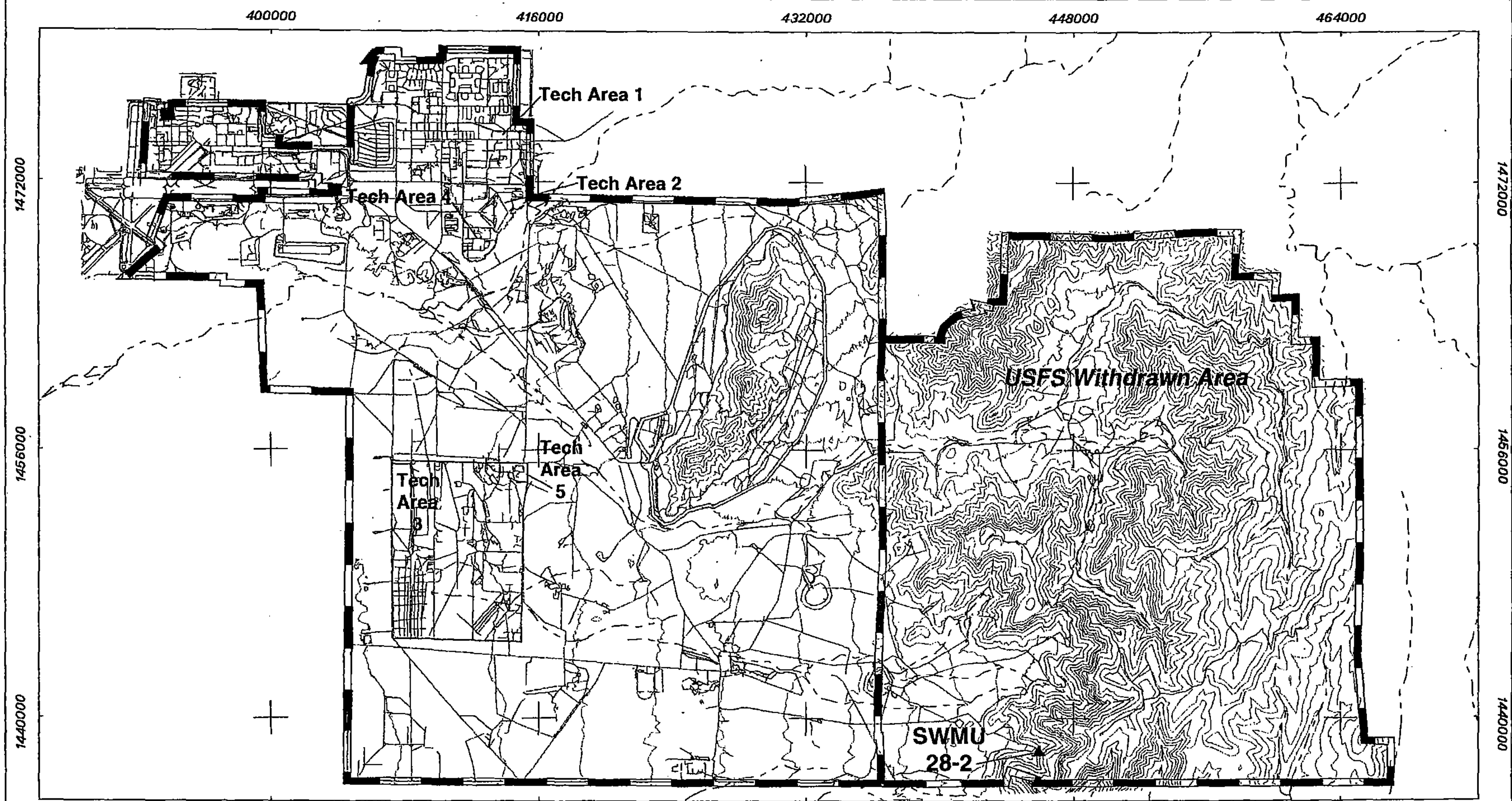
Field activities associated with this project will be performed under the Foothills Test Area, Operable Unit 1332 Health and Safety Project Plan (HASP). Since the primary COC is DU, Sandia Radiation Protection will prepare an RWP that will document personnel protective equipment requirements for the VCA and the associated sampling activities. Emergency phone numbers and route to hospital maps will be posted at the site during project fieldwork. An initial health and safety briefing will be given at the beginning of the project and daily tailgate safety meetings will be performed to assess specific concerns of the daily activities. The loose rock above the mineshaft opening is the main health and safety issue, and this hazard will be discussed daily in the tailgate safety briefing.

1.4 Project Schedule

This VCA has been tentatively scheduled for mid-July 2002 and will require approximately one to two weeks to complete. Site restoration will take place approximately one month after completion of the VCA.

SWMU 28-2 VCA PLAN
FIGURES

MAPID=020513 06/28/02 SNL EGIS ORG. 6135 DHelfrich dh020513.aml



Legend

- ▲ SWMU 28-2
- Road
- Surface Drainage
- 100-foot Contour
- KAFB / USFS Withdrawn Area Boundary
- SNL Technical Area

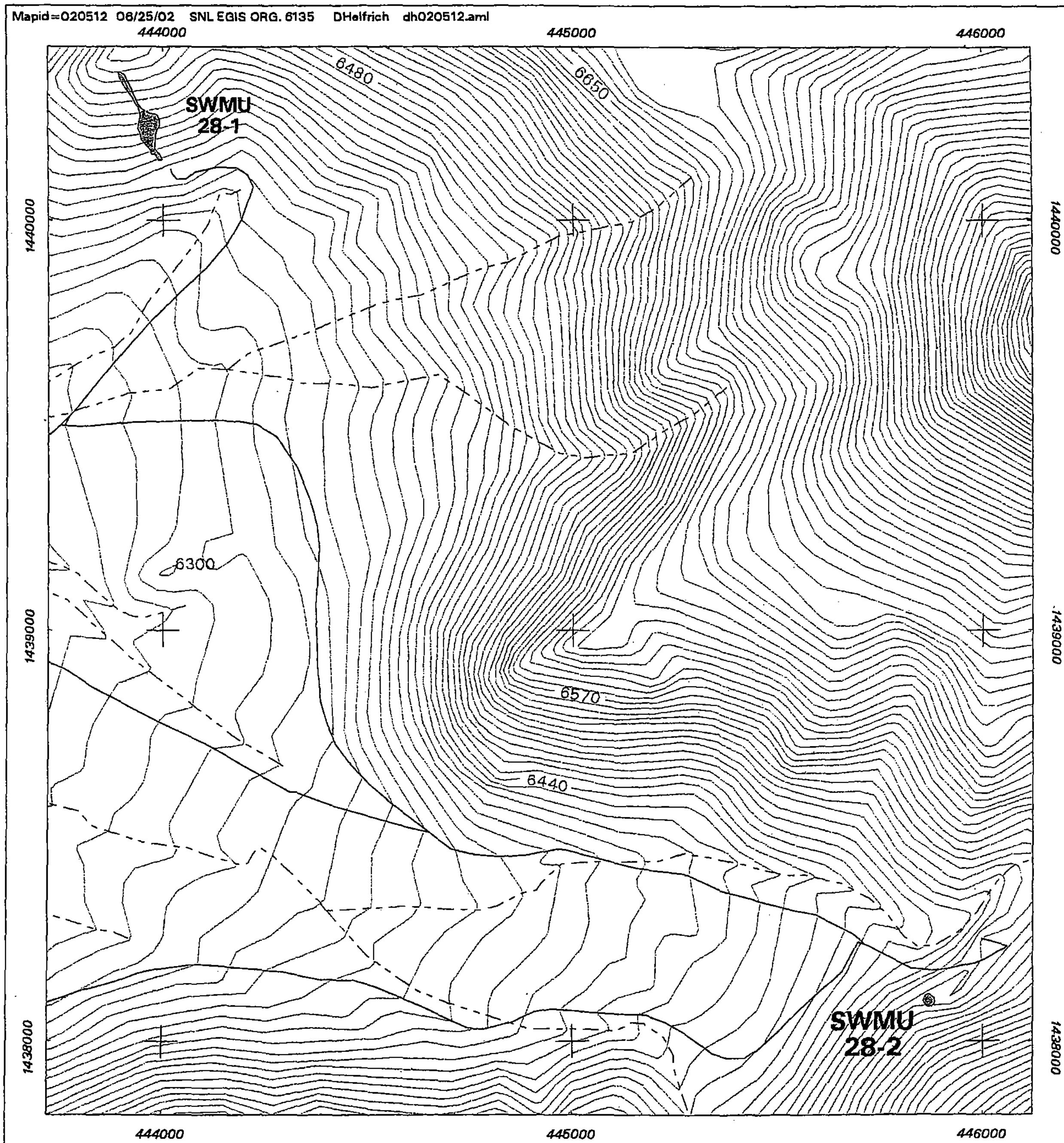
Sandia National Laboratories, New Mexico
Environmental Geographic Information System

Figure 1
General Location Map of SWMU 28-2

0 5000 10000
Scale in Feet

0 1200 2400
Scale in Meters

Mapid=020512 06/25/02 SNL EGIS ORG. 6135 DHelfrich dh020512.aml



Legend

Unpaved Road

Surface Drainage

10-foot Contour

Solid Waste Management Unit

Figure 2
Site Specific Location of Solid Waste Management Unit 28-2

0 200 400
Scale in Feet

0 48 96
Scale in Meters

Sandia National Laboratories, New Mexico
Environmental Geographic Information System

ATTACHMENT 1
SWMU 28-2 VCA Plan
Waste Management Plan

ER Site Specific Waste Management Plan

Site # : SWMU 28-2	**Site Name: Mine**	**ADS # : 1332**
Project Leader: C. Byrd	**Work Organizer Ed Mignardot**	**ADS Name : Foothills Test Area**
Today's Date: 6-18-02	**Start Date: 07-15-02**	**Anticipated Duration: 2 weeks**

Brief Site Description/History: SWMU 28-2 is one of ten mines identified as the SWMU 28 Mine Shafts in the Hazardous and Solid Waste Amendments Module of SNL/NM's Resource Conservation and Recovery Act (RCRA) Permit. SWMU 28-2 is located approximately 3,000 feet southeast of SWMU 28-1 in the U.S. Forest Service Withdrawn Lands near the southeastern portion of KAFB. There are two horizontal adits at this site: a lower and an upper. The portal of the upper adit is located approximately 60 vertical feet above the lower adit. New Mexico Environment Department (NMED), KAFB, and SNL/NM personnel have entered and inspected both the lower and upper adits comprising SWMU 28-2. According to site background interviews conducted by SNL/NM ER personnel, SNL/NM staff detonated waste explosives in the lower mine adit at SWMU 28-2. This has been confirmed based upon the presence of the "concrete wall and detonation cord" inside the mine as described below, as well as a follow-up visit to the site. SNL/NM ER personnel conducted a mine entry to characterize and sample the interior of the mine. Analytical results show no elevated radioactive constituents, slightly elevated metals in dirt/rock consistent with a hard rock mine of this type, and trace amounts of high explosives consistent with the explosive test scenario. Even though there have been no reports of disposal activity at the mine, a small amount of depleted uranium (DU) was found at the entrance to the lower adit during a site visit. The radiation hazard sign previously posted at the portal was replaced due to the recent DU found.

Description of Activity: (Circle any that apply) (NFA) (VCM) (House Keeping) (Characterization)
Based upon finding DU immediately beneath the surface outside the entrance to SWMU 28-2, it will be necessary to conduct a Voluntary Corrective Action (VCA) in this area in order to: 1) remove the DU encountered in soil; 2) collect waste and confirmatory soil samples; and 3) restore the site to original grade. The SNL/NM Environmental Restoration Field Office (ERFO) team, with support from SNL Radiation Protection personnel, will conduct the VCA. SWMU 28-2 is a Radioactive Materials Management Area (RMMA) and all work activities will be performed under a Radiological Work Permit (RWP).

List the Contaminants Of Concern for this event. (Reference any existing sampling plans.)
DU, heavy metals, HE (April 1998 Field Implementation Plan; June 2002 Field Implementation Plan)

(Will a Less-Than-90-Day Waste Accumulation Area be required? Yes No Which <90 Area? ERFO **.) (Is this an RMMA? Yes No) (Will a risk assessment be done at this waste? Yes No) (Will RES RAD be run for this waste? Yes No) (Will rad certified containers be required? Yes No)**

Waste Form [illegible]	Volume (Total) [illegible]	Container Type OHSD [illegible] Drum/WGL/R.Roll[illegible] Pile [illegible]	Waste Classification Haz Rad Mix TSCA [illegible]	Sampling Requirements (San Sewer List: KPN, Physical Metals, AND) Frequency [illegible] Circle Any That Apply [illegible]
Water (Decon, Purge, Development) (Remember Virga)	< 5 Gallons per week	Poly drum	Mixed	Note: waste and soils sampling equipment and shovels will be wet-decontaminated (because less than 5 gallons of decon water will be generated per week, the water will be emptied onto the ground surface within the SWMU), and the backhoe will be dry-decontaminated. (Number of samples: None

Waste (DU) m with contaminated soils mixed	Up to 50 Cu Yd	OHSD		Each waste sample will be analyzed for gamma Spec, TCLP (Metals+Zn+Be+Ni+Sb+Tl) and Expl 8330; and will be field screened prior to release offsite. Q2 each Drum of DU/Soil (Number of samples : 2 Per 55-gallon drum)
High Explosives (HE). Presence of HE is determined by visual inspection. Absence of radiological contamination in the suspect HE is determined by field screening.	0.1 Cu Yd	OHSD	HAZ	HE would not be present in concentration levels large enough to be a RCRA-reactive waste. Therefore, screening or sampling for HE will not be performed. The HE will be disposed of as hazardous waste (mock HE) and/or as ordnance.
PPE	0.25 Cu Yd			All PPE will be 100% field screened; and if not stained and nonRAD, PPE will be disposed of as non-regulated waste. (Number of samples: None
Other				

[illegible]			
Generator Interface	Craig Wood	[illegible]	6/24/02
Rad Data Reviewer	Mike Spoerner or Mark Miller	[illegible]	7/9/02
ERwm Coordinator	Return form to Ernest Vinsant	[illegible]	07/09/02

ATTACHMENT 2
SWMU 28-2 VCA Plan
Field Implementation Plan

Field Implementation Plan (FIP)

SWMU 28-2

SNL/NM Environmental Restoration Project

Plan Authorization and Implementation

Prepared by: Edw R. Miguet, Jr Date: 6-28-02

Technical Review by: C.H. Byrd Date: 7-3-02

Approved by: D. Hill Date: 7/7/02

1. Project Information

Task Description: Perform Voluntary Corrective Action (VCA) and collect waste samples and confirmatory soil samples outside the entrance of SWMU 28-2.

Department No.: 6134 Case No.: 7213.020205

Scheduled Start Date: 7/15/02 Estimated Finish Date: 8/30/02

2. Site Information

Operations: Abandoned mine with explosive test history Technical Area: Foothills

This Field Implementation Plan (FIP) contains the procedures, requirements, and specific instructions for performing fieldwork at Solid Waste Management Unit (SWMU) 28-2. SWMU 28-2 is one of ten mines identified as the SWMU 28 Mine Shafts in the Hazardous and Solid Waste Amendments Module of SNL/NM's Resource Conservation and Recovery Act (RCRA) Permit. SWMU 28-2 is located approximately 3,000 feet southeast of SWMU 28-1 in the U.S. Forest Service (USFS) Withdrawn Lands near the southeastern portion of Kirtland Air Force Base (KAFB) (Figure 1). There are two horizontal adits at this site: a lower and an upper. The portal of the upper adit is located approximately 60 vertical feet above the lower adit.

New Mexico Environment Department (NMED), KAFB, and SNL/NM personnel have entered and inspected both the lower and upper adits comprising SWMU 28-2. According to site background interviews conducted by SNL/NM ER personnel, SNL/NM staff detonated waste explosives in the lower mine adit at SWMU 28-2. This has been confirmed based upon the presence of the "concrete wall and detonation cord" inside the mine as described below, as well as a follow-up visit to the site. SNL/NM ER personnel conducted a mine entry to characterize and sample the interior of the mine. The results of this entry are discussed below.

Even though there have been no reports of disposal activity at the mine, a small amount of depleted uranium (DU) was found at the entrance to the lower adit during a site visit. The radiation hazard sign previously posted at the portal was replaced due to the recent DU found.

Radiation Surveys

A radiation warning sign was present in front of this mine until 1989. Two radiation surveys were conducted in the interior of the mine. The SNL/NM Reactor Applications and Health Physics Divisions conducted the first survey in 1982-1983, and ER project personnel conducted the second survey in 1989. No elevated radiation levels above background were observed in either survey, and the sign was removed based on these surveys. The reason for the warning sign could not be definitively established, however it was speculated that the sign was installed to keep people out of the mine. No radiation surveys were conducted outside of the mine.

RFI Sampling

The interior of the lower adit of Mine 28-2 was inspected and sampled during RFI activities in 1998. No characterization sampling was conducted outside of the mine during this investigation. The results of the interior sampling include:

- Significant information was gained by the entry and all observations support the explosives test site history for the mine.
- No evidence was found of buried metal objects in the floor or walls.
- The surveys yielded no evidence of elevated radioactivity.
- The mine is a confined space that easily can develop an atmosphere that is IDLH for oxygen and above action levels for VOCs in the presence of ordinary work equipment.
- Analytical results show no elevated radioactive constituents, slightly elevated metals in dirt/rock consistent with a hard rock mine of this type, and trace amounts of high explosives consistent with the explosive test scenario.
- Sampling was conducted to 18 inches. Deeper soil samples were not collected due to confined space entry requirements. SNL/NM Health and Safety personnel also required supplied air for sampling team members for sampling below 18 inches in depth.

Objectives

Sampling: Perform VCA and collect waste samples and confirmatory soil samples outside of the Mine 28-2.

Analytical: Obtain data of definitive level to be used in risk based NFA proposal.

4. Data Use

Regulatory Program: Resource Conservation and Recovery Act (RCRA)

SNL Program: Environmental Restoration Project, OU 1332, Foothills Test Area

Work Plan Title: RCRA Facility Investigation Work Plan for Operable Unit 1332, Foothills Test Area

5. Organization

Management:	Department Manager	David Miller	Organization 6134
	Project Task Leader	Caroline Byrd	Organization 6134
	Assistant Task Leader	Ed Mignardot	Organization 6134
Sampling	ERFO Coordinator	Gary Bailey	Organization 6131
	Field Team Leader	Ed Mignardot	Organization 6134
Analytical	Sample Management	Wendy Palencia	Organization 6133
	Analytical Laboratory	Southwest Laboratories	Lab Contact Kert Surface

6. Health and Safety

Health and Safety Plan: OU 1332 Health and Safety Project Plan, Foothills Test Area

Date: June 1995

The VCA and confirmatory sampling outside the lower adit of the 28-2 mine is scheduled to take place on July 15-26, 2002. ERFO technicians will perform remediation and sampling activities. These technicians will: 1) set up the exclusion zone and waste staging area, 2) remove DU contamination, 3) conduct waste and soil sampling and labeling, 4) complete chain-of-custody documentation, and 5) transport samples to SMO for off-site shipment.

7. Sample Collection

Sample Media: __X_ Environmental **_X_ Waste** **Matrix Type: Soil/DU**

Sampling Rationale:

Waste samples will be taken from the 55-gallon drums containing DU and contaminated soils. Confirmatory soil samples will be collected from the areas where DU was removed (hotspots).

Sampling Method:

Samples will be collected by hand trowel. All samples will be collected at the first depth where sufficient material exists to sample (see Table 1 for associated analytes and QA samples).

Sampling Location and Frequency:

Ten percent of the waste drums of soil (minimum of two samples) will be analyzed for TCLP Metals plus Be and Ni, HE, and gamma spectroscopy. These samples will be sent to an off-site laboratory. A portion of the sample will be analyzed at the SNL/NM Radiation Protection Sample Diagnostics laboratory prior to off-site release.

Confirmatory soil samples will be collected from the hotspots where DU was removed. If soil contamination is limited to the area where it was originally detected outside the entrance to the mine, two confirmatory soil samples plus one sample duplicate will be collected. A minimum of one confirmatory sample will be collected from each additional hotspot, and if the hotspot is large, it will be sampled on a 10 ft by 10 ft grid. All confirmatory samples will be analyzed for RCRA Metals plus Be and Ni (EPA-6010/7000), HE (EPA-8330), and gamma spectroscopy.

The size and type of container for each analysis is shown in Table 2.

Radiological equipment shall be calibrated in accordance with SNL/NM ER standard operating procedures, and background measurements for radioactivity outside the mine opening, shall be taken prior to sample collection.

Table 1. Summary of Sample Numbers, QA Samples, and Analytes Required for Waste and Confirmatory Soil Sampling at SWMU 28-2

Site 28-2 Sample Type	SMO Sample No./QA Sample	Environmental Restoration Field Office/COC No.[1]	Analyte
Waste Sample	1 059643	S282-GR-101-0-SS	TCLP Metals plus Zn, Be, Ni, Sb, and Tl, HE, and Gamma Spec[2]
	2 059644	S282-GR-102-0-SS	
	3	S282-GR-103-0-SS	
	4	S282-GR-104-0-SS	
	5	S282-GR-105-0-SS	No samples collected (required)
	6	S282-GR-106-0-SS	
	7	S282-GR-107-0-SS	
	8	S282-GR-108-0-SS	
Confirmatory Soil Sample	9 059653 ~~-005~~ ERM	S282-GR-109-0-SS	RCRA metals plus Be and Ni, HE, and Gamma Spec[2]
	10 059654	S282-GR-110-0-SS	
	11 059655	S282-GR-111-0-SS	
	12 059656	S282-GR-112-0-SS	
	13 059657	S282-GR-113-0-SS	
	14 059658	S282-GR-114-0-SS	
	15 059659	S282-GR-115-0-SS	
	16 059660	S282-GR-116-0-SS	
QA/QC Samples	17 equipment blank rinsate 059661-002	S282-GR-117-0-EB	RCRA metals plus Be and Ni
	18 equipment blank rinsate 0	S282-GR-118-0-EB	RCRA metals plus Be and Ni Not collected
	19 equipment blank rinsate 059661-002	S282-GR-119-0-EB	HE
	20 equipment blank rinsate	S282-GR-120-0-EB	HE Not collected
	21 duplicate of sample No. ~~0~~112 ERM	S282-GR-~~121-0-SD~~ 112-0-DUP ERM	RCRA metals plus Be and Ni, HE, and Gamma Spec[2]

[1]Chain-of Custody/SMO number to be filled out by ERFO personnel while collecting the sample.
[2]Gamma Spec samples will be analyzed on-site, other samples will be analyzed at an off-site laboratory.

Table 2 - Sample Container Type and Quantity

Quantity[a]	Container	Matrix	Parameter	Preservative
9	500 mil wide mouth	soil	RCRA metals plus Be and Ni (up to 8 samples plus one duplicate sample)	None
16	Marinelli	soil	Gamma Spec	None
8	250 mil wide mouth	Soil	HE	None
8	250 mil wide mouth	Waste	TCLP Metals plus Zn, Be, Ni, Sb, and Tl (up to 8 samples)	None
8	250 mil wide mouth	Waste	HE	None
2	500 mil poly	Water	Equipment Rinsate for HE	None
2	500 mil poly	Water	Equipment Rinsate for RCRA metals plus Be and Ni	HNO3

[a]assume up to 2 days fieldwork collecting up to 8 waste and 8 confirmatory samples.

Sampling Procedures:

Applicable FOPs and AOPs are listed in Table 3; however, this site-specific field implementation plan (FIP) should be used as the primary guidance in the field.

Each sample will be homogenized in a stainless steel bowl and then placed in the sample containers. All samples will be immediately labeled and placed in a cooler and stored at 4°C. Samples will then be delivered to the Sample Management Office (SMO) for processing and shipment to the analytical laboratory. A completed COC form will accompany the shipment.

Table 3. Applicable Operating Procedures

Number of Procedure	Title of Procedure
FOP 92-04	Field Operating Procedure for Field Logbook Content and Control
FOP 94-01	Safety Meetings, Inspections, and Pre-Entry Briefings
FOP 94-25	Documentation of Field Activities
FOP 94-26	General Equipment Decontamination
FOP 94-28	Health and Safety Monitoring of Organic Vapors (FID and PID)
FOP 94-38	Drilling Methods and Drill Site Management
FOP 94-52	Spade and Scoop Method for Collection of Soil Samples
FOP 94-34	Field Sample Management and Custody
FOP 94-54	Surface Sediment/Soil Sampling
FOP 94-57	Decontaminating Drilling and Other Field Equipment
FOP 94-68	Field Change Control
FOP 94-69	Personnel Decontamination (Level D, C, and B Protection)
FOP 94-78	Environmental Restoration Project Waste Management and Characterization Procedure
TOP 94-03	Verification and Validation of Chemical and Radiochemical Data
AOP 94-22	Sample Management Office User's Guide
AOP 94-24	System and Performance Audits
AOP 94-25	Deficiency Reporting
AOP 95-16	Administrative Operating Procedure for Sample Management and Custody
RPOP 04-0411	Contamination Survey of Materials, Equipment and Portable Facilities to be Released for Unrestricted Use

Decontamination Activities:

Decontamination water shall be discharged onsite (within the SWMU) as long as discharges are less than 5 gallons per day and up to a maximum of 50 gallons per week.

Waste Disposal:

Based on the results from laboratory analysis, residue/soils will be managed in accordance with the SNL/NM draft internal memorandum titled "ER Project Policy on the Management of Contaminated or Potentially Contaminated Soils within a Solid Waste Management Unit (SWMU)", dated February 12, 1997. Residue/soils will be returned to the outside of the mine. Gamma spec results will be used to release waste and soil samples offsite.

RMMA Requirements

Site 28-2 is situated within an RMMA and all field activities will be conducted under a RAD Worker Permit. Screening of samples and equipment for radioactivity prior to release offsite shall be performed. An RCT shall screen out equipment and PPE from the site. Personnel involved in intrusive activities at the site shall possess RAD Worker II training and shall screen themselves out from the exclusion zone of the site.

cc: C. Byrd (6134)
ER Records Center (ER/1332/28-2/COR)

Annex C

ANNEX C
Final Radiation Survey Map at SWMU 28-2

Survey Number: S59368

RADIOLOGICAL SURVEY FORM

Location: ER Site 28-2 / All	Requester/Org.: Edward Mignardot / 06134	Date: 08/27/2002	Time: 08:00
Purpose: Post-Job Survey	Request #: N/A	RWP#: RWP1688	

Instrument and Probe Type and Serial Number		Surveyor(s) Printed Name(s)	Surveyor(s) Signature/Date
Eberline E600 / SPA-3 NaI	1523 / 2050	George H. Hoskison	[signature] 8/27/02
N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A

#	Item Description/Location	BETA-GAMMA ACTIVITY Counting Data Attached: ☐ YES ☒NO % Eff.: (c) N/A Radionuclide: N/A				ALPHA ACTIVITY Counting Data Attached: ☐ YES ☒NO % Eff.: (c) N/A Radionuclide: N/A				RADIATION SURVEY Background: N/A mrem/hr Radiation Type: N/A	
		cpm	Bkg. cpm	dpm(a, b) / 100cm2	T/R/F(e)	cpm	Bkg. cpm	dpm(a, b) / 100cm2	T/R/F(e)	mrem/hr	Distance from Source(d)
	See maps for survey locations and results										
	N/A										

(a) ND = No detectable activity above background (b) If other than 100 cm², indicate area or record as 'dpm/probe' or 'dpm/LAW' (large area wipe). (c) T/R/F = Total/Removable/Fixed (d) OC or CT = On Contact (e) %Eff-Removable/Direct

Remarks: Performed post-job survey with the E600 and SPA-3 NaI detector after remediation of ER – Site 28-2. See attached Background Determination Log for action level.

Reviewed by: [signature] Date: 8-28-02

Reference RPO-04-401, Issue 04
rsf.dot

Effective: 5/29/01

BACKGROUND DETERMINATION LOG

Project Location: Mine 28-2 RCT Signature:

Project Description: Remediation of Area (RWP1688)

Inst. Type: E600 / SPA-3 NaI	Inst. Type:	Inst. Type:
Inst. S/N: 1523 / 2050	Inst. S/N:	Inst. S/N:
Time: 08:00	Time:	Time:
Date: 8 / 27 / 02	Date:	Date:
Background Readings	Background Readings	Background Readings
1) 12890	1)	1)
2) 14720	2)	2)
3) 13670	3)	3)
4) 14520	4)	4)
Mean Background	Mean Background	Mean Background
$\bar{x}$ = 13950	$\bar{x}$ =	$\bar{x}$ =
Standard Deviation	Standard Deviation	Standard Deviation
σ = 841	σ =	σ =
Action Level	Action Level	Action Level
AL = 20925	AL =	AL =
Comments	Comments	Comments

Standard Deviation: $\sigma = \sqrt{\dfrac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

$AL = \bar{x} + 2\sigma$ Sample Screening

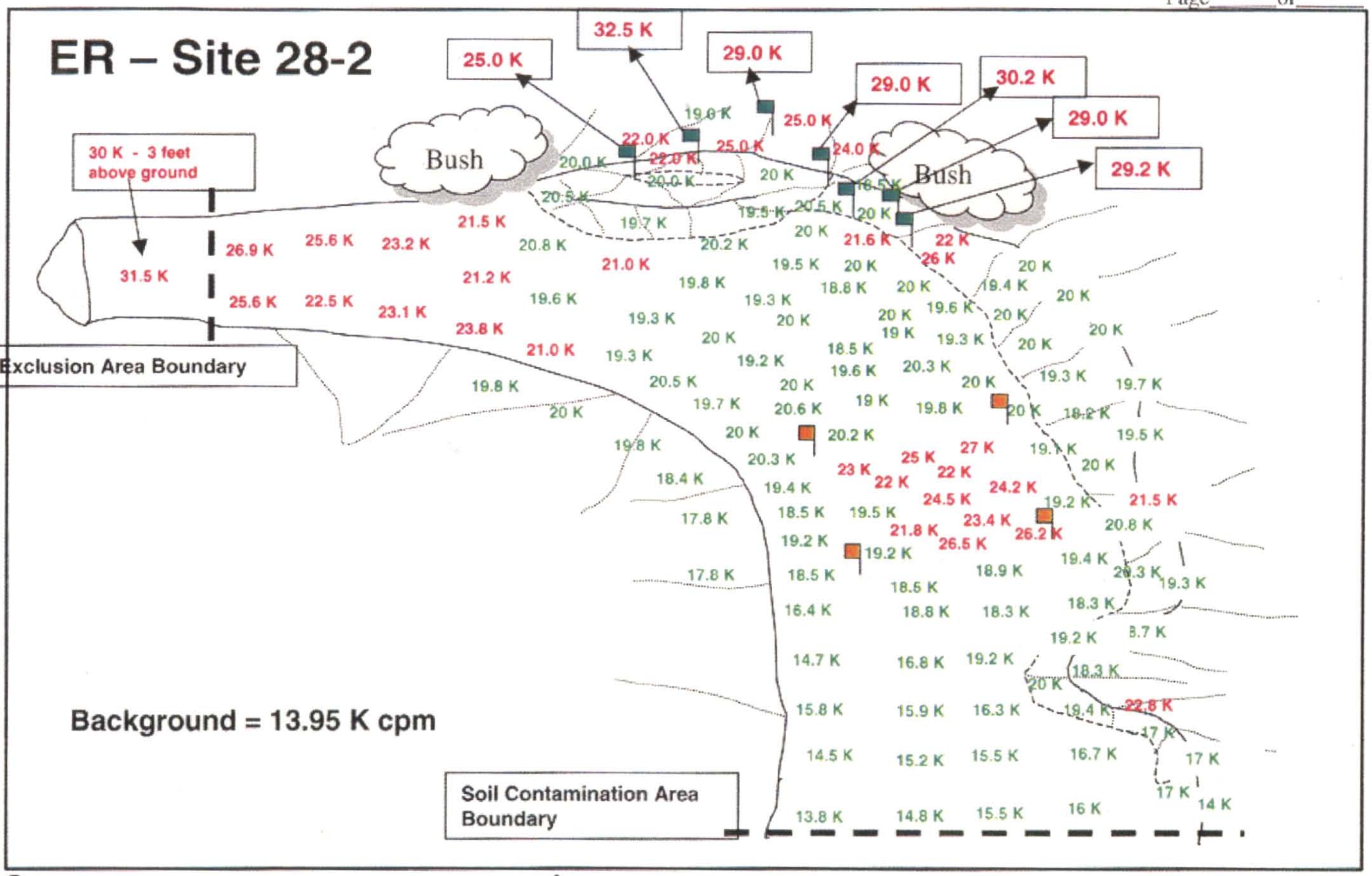
$AL = 1.5\bar{x}$ Area Surveys

where:

$\bar{x}$ = Mean Background
x_i = Individual Background Measurement
n = Number of Measurements

Survey Number: S-59368

RADIOLOGICAL SURVEY MAP



○ indicates smear location * indicates contact radiation reading △ indicates LAW location All radiation readings are gamma in mrem/h unless noted otherwise.

SOP indicates Step Off Pad location AS# indicates Air Sample location and number □ Static Count

Reference RPO-04-401, Issue 04

rsm.dot

Effective: 5/29/01

Annex D

ANNEX D
Gamma Spectroscopy Results

Confirmatory Soil Sampling Gamma Spectroscopy Results
August 2003

ON-SITE LABORATORY (RPSD)

ANALYSIS REQUEST AND CHAIN OF CUSTODY

CSBYRD

Confirmatory Samples

559482

Internal Lab Batch No. 201227

SAR/WR No.

AR/COC **605644**

Dept. No./Mail Stop: 6134/1088
Project/Task Manager: Caroline Byrd
Project Name: 28-2 Mine Site VCA
Record Center Code:
Logbook Ref. No.:
Service Order No.: CF031-02

Date Samples Shipped: 9-4-02 SMO USE
Carrier/Waybill No. HC
Lab Contact: S. Shanks
Lab Destination: RSPD
SMO Contact/Phone: D. Perry/ 845-0867

Logged By:
Project/Task No.: 7213.02.02.05
SMO Authorization:

☐ Characterization Only
☐ Waste Characterization
-RCRA Date =
-Send preliminary/copy report to:

☐ Release to ERCL On-Site Lab
☑ Release to Off-Site Lab
-This COC Number Releases
COC No(s) 605645

Sample No.-Fraction (ID) / RPSD No.-Fraction	ER Sample ID or Sample Location Detail (SD) / RPSD Remarks/Aliquot Amounts	Beginning Depth (ft) / Screen CPM	ER Site No. / Sample Mass	Date/Time(hr) Collected / Sample Quantity	Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Analysis Request
059645-004	S282-GR-109-0-SS	0	28-2	082902/0920	S	M	500ml	None	G	SA	Gamma Spec
01			812.3g								60 cpm
059646-004	S282-GR-110-0-SS	0	28-2	082902/0857	S	M	500ml	None	G	SA	Gamma Spec
02			665.0g								200 cpm
059647-004	S282-GR-111-0-SS	0	28-2	082902/0915	S	M	500ml	None	G	SA	Gamma Spec
03			694.8g								400-300 cpm
059648-004	S282-GR-112-0-SS	0	28-2	082902/0845	S	M	500ml	None	G	SA	Gamma Spec
04			703.4g								45 cpm

RMMA ☑ Yes ☐ No Ref. No.
Sample Disposal ☐ Return to Client ☑ Disposal by Lab
Turnaround Time ☑ Normal ☐ Rush
Required Report Date

Sample Tracking — Smo Use
Date Entered(mm/dd/yy) 09/17/02
Entered by: RK
QC inits. JAC

Special Instructions/QC Requirements
EDD ☑ Yes ☐ No
Raw Data Package ☑ Yes ☐ No
*Please send report to:
Ed Mignardot : Mailstop 1088/284-3733

Sample Team Members

Name	Signature	Init	Company/Organization/Phone
W. Gibson	William Gibson	WG	MDM/6135/284-5232
D. Grandi	D. Grandi	DAG	Shaw/6135/263-6467

		Org.	Date	Time			Org.	Date	Time
1.Relinquished by	[signature]	6135	9 4 02	0810	4.Relinquished by	[signature]	3123	9-5-02	10:05
1. Received by	[signature] SMO	6132	9/4/02	0810	4. Received by	[signature]	6133	09-05-02	1005
2.Relinquished by	[signature] SMO	6132	9-4-02	0855	5.Relinquished by				
2. Received by	[signature]	3123	9-4-02	0855	5. Received by				
3.Relinquished by		3123	9-4-02	0920	6.Relinquished by				
3. Received by	[signature] 9/5/02				6. Received by				

ON-SITE LABORATORY

Analysis Request And Chain Of Custody (Continuation)

AR/COC- 605644

Project Name: 28-2 Mine Site VCA | Project/Task Manger: Caroline Byrd | Case No: 7213.02.02.05

Sample No.-Fraction / RPSD No.-Fraction	ER Sample ID or Sample Location Detail / RPSD Remarks/Aliquot Amounts	Beginning Depth (ft) / Screen CPM	ER Site No. / Sample Mass	Date/Time (hr) Collected / Sample Quantity	Sample Matrix	Container Type	Container Volume	Preservative	Collection Method	Sample Type	Analysis Request
059649-004	S282-GR-113-0-SS	0	28-2	082902/0904	S	M	500ml	None	G	SA	Gamma Spec
05			772.5g								40 cpm
059650-004	S282-GR-114-0-SS	0	28-2	082902/0851	S	M	500ml	None	G	SA	Gamma Spec 30cpm
06			678.5g								
059651-004	S282-GR-115-0-SS	0	28-2	082902/0841	S	M	500ml	None	G	SA	Gamma Spec 450cpm
07			857.9g								
059652-004	S282-GR-116-0-SS	0	28-2	082902/0910	S	M	500ml	None	G	SA	Gamma Spec 30cpm
08			708.3g								
LCS γ											
09											

Abnormal Conditions on Receipt

LAB USE

Recipient Initials________

```
*****************************************************************************
*                      Sandia National Laboratories                         *
*    Radiation Protection Sample Diagnostics Program                        *
*                        9/04/02 12:14:30 PM                                *
*****************************************************************************
*                                                                           *
* Analyzed by:                              Reviewed by:      9/5/02        *
*****************************************************************************
Customer                      : BYRD, C (6134)
Customer Sample ID            : 059645-004
Lab Sample ID                 : 20122701

Sample Description            : S282-GR-109-0-SS
Sample Quantity               :    812.300  gram
Sample Date/Time              :   8/29/02   9:20:00 AM
Acquire Start Date/Time       :   9/04/02  10:52:11 AM
Detector Name                 : LAB02
Elapsed Live/Real Time        :    6000 /   6004 seconds

Comments:
U-235/Ra-226 peaks not resolved. Either isotope may be overestimated.
*****************************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	7.65E-001
RA-226	1.80E+000	5.41E-001	7.25E-001
PB-214	7.17E-001	1.07E-001	6.38E-002
BI-214	5.89E-001	9.63E-002	5.52E-002
PB-210	Not Detected	---------	2.81E+001
TH-232	1.08E+000	4.98E-001	2.18E-001
RA-228	1.31E+000	2.11E-001	1.21E-001
AC-228	1.16E+000	2.01E-001	1.01E-001
TH-228	9.27E-001	4.42E-001	6.50E-001
RA-224	1.49E+000	3.01E-001	7.78E-002
PB-212	1.19E+000	1.69E-001	3.84E-002
BI-212	1.21E+000	3.36E-001	4.05E-001
TL-208	1.10E+000	1.64E-001	7.67E-002
U-235	Not Detected	---------	2.28E-001
TH-231	Not Detected	---------	1.14E+001
PA-231	Not Detected	---------	1.34E+000
TH-227	Not Detected	---------	3.79E-001
RA-223	Not Detected	---------	2.61E-001
RN-219	Not Detected	---------	3.30E-001
PB-211	Not Detected	---------	7.66E-001
TL-207	Not Detected	---------	1.24E+001
AM-241	Not Detected	---------	4.32E-001
PU-239	Not Detected	---------	4.32E+002
NP-237	Not Detected	---------	2.25E+000
PA-233	Not Detected	---------	5.39E-002
TH-229	Not Detected	---------	2.35E-001

[Summary Report] - Sample ID: : 20122701

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	3.52E-002
AG-110m	Not Detected	---------	2.93E-002
BA-133	Not Detected	---------	4.53E-002
BE-7	Not Detected	---------	2.45E-001
CD-115	Not Detected	---------	4.40E-001
CE-139	Not Detected	---------	2.84E-002
CE-141	Not Detected	---------	5.64E-002
CE-144	Not Detected	---------	2.33E-001
CM-243	Not Detected	---------	1.68E-001
CO-56	Not Detected	---------	3.04E-002
CO-57	Not Detected	---------	3.02E-002
CO-58	Not Detected	---------	3.18E-002
CO-60	Not Detected	---------	3.42E-002
CR-51	Not Detected	---------	2.52E-001
CS-134	Not Detected	---------	3.59E-002
CS-137	1.44E-002	1.66E-002	2.66E-002
EU-152	Not Detected	---------	8.91E-002
EU-154	Not Detected	---------	1.62E-001
EU-155	Not Detected	---------	1.33E-001
FE-59	Not Detected	---------	6.99E-002
GD-153	Not Detected	---------	9.76E-002
HG-203	Not Detected	---------	3.27E-002
I-131	Not Detected	---------	4.33E-002
IR-192	Not Detected	---------	2.71E-002
K-40	2.51E+001	3.33E+000	2.79E-001
MN-52	Not Detected	---------	5.82E-002
MN-54	Not Detected	---------	3.12E-002
MO-99	Not Detected	---------	9.95E-001
NA-22	Not Detected	---------	3.93E-002
NA-24	Not Detected	---------	2.52E+001
ND-147	Not Detected	---------	2.65E-001
NI-57	Not Detected	---------	7.57E-001
RU-103	Not Detected	---------	2.77E-002
RU-106	Not Detected	---------	2.60E-001
SB-122	Not Detected	---------	1.73E-001
SB-124	Not Detected	---------	2.69E-002
SB-125	Not Detected	---------	7.63E-002
SN-113	Not Detected	---------	3.53E-002
SR-85	Not Detected	---------	3.62E-002
TA-182	Not Detected	---------	1.43E-001
TA-183	Not Detected	---------	8.46E-001
TL-201	Not Detected	---------	6.29E-001
Y-88	Not Detected	---------	2.49E-002
ZN-65	Not Detected	---------	9.29E-002
ZR-95	Not Detected	---------	5.32E-002

```
************************************************************************
*                    Sandia National Laboratories                      *
*     Radiation Protection Sample Diagnostics Program                  *
*                      9/04/02  1:56:51 PM                             *
************************************************************************
*                                                                      *
* Analyzed by:                 9/5/02   Reviewed by:        9/5/02     *
************************************************************************
```

Customer : BYRD, C (6134)
Customer Sample ID : 059646-004
Lab Sample ID : 20122702

Sample Description : S282-GR-110-0-SS
Sample Quantity : 665.000 gram
Sample Date/Time : 8/29/02 8:57:00 AM
Acquire Start Date/Time : 9/04/02 12:16:14 PM
Detector Name : LAB02
Elapsed Live/Real Time : 6000 / 6021 seconds

Comments:

****

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)	
U-238	4.51E+002	6.17E+001	2.83E+000	
RA-226	1.44E+001	1.90E+001	2.67E+000	
PB-214	9.62E-001	1.78E-001	1.87E-001	
BI-214	8.71E-001	1.59E-001	1.42E-001	
PB-210	Not Detected	---------	1.23E+002	
TH-232	1.49E+000	7.57E-001	5.98E-001	
RA-228	1.75E+000	2.84E-001	2.22E-001	
AC-228	1.67E+000	2.97E-001	1.94E-001	
TH-228	1.19E+000	1.32E+000	2.11E+000	
RA-224	1.86E+000	3.73E-001	7.90E-002	
PB-212	1.68E+000	2.41E-001	1.19E-001	
BI-212	2.43E+000	7.68E-001	1.04E+000	
TL-208	1.38E+000	2.41E-001	2.16E-001	
U-235	7.12E+000	1.15E+000	9.10E-001	
TH-231	Not Detected	---------	6.63E+001	
PA-231	Not Detected	---------	4.37E+000	
TH-227	Not Detected	---------	7.87E-001	
RA-223	~~4.22E+000~~	~~7.89E-001~~	1.25E+000	NOT DETECTED 9-5-02
RN-219	Not Detected	---------	9.89E-001	
PB-211	Not Detected	---------	2.23E+000	
TL-207	~~1.63E+001~~	~~1.28E+001~~	1.79E+001	NOT DETECTED 9-5-02
AM-241	Not Detected	---------	2.05E+000	
PU-239	Not Detected	---------	1.68E+003	
NP-237	Not Detected	---------	1.12E+001	
PA-233	Not Detected	---------	1.72E-001	
TH-229	Not Detected	---------	1.62E+000	

[Summary Report] - Sample ID: : 20122702

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	----------	8.07E-002
AG-110m	Not Detected	----------	7.39E-002
BA-133	Not Detected	----------	1.10E-001
BE-7	Not Detected	----------	6.90E-001
CD-115	Not Detected	----------	1.03E+000
CE-139	Not Detected	----------	1.17E-001
CE-141	Not Detected	----------	2.48E-001
CE-144	Not Detected	----------	9.51E-001
CM-243	Not Detected	----------	5.12E-001
CO-56	Not Detected	----------	6.98E-002
CO-57	Not Detected	----------	1.28E-001
CO-58	Not Detected	----------	7.58E-002
CO-60	Not Detected	----------	5.02E-002
CR-51	Not Detected	----------	7.85E-001
CS-134	Not Detected	----------	7.76E-002
CS-137	Not Detected	----------	7.73E-002
EU-152	Not Detected	----------	3.80E-001
EU-154	Not Detected	----------	3.71E-001
EU-155	Not Detected	----------	6.47E-001
FE-59	Not Detected	----------	1.07E-001
GD-153	Not Detected	----------	7.30E-001
HG-203	Not Detected	----------	1.01E-001
I-131	Not Detected	----------	1.40E-001
IR-192	Not Detected	----------	8.52E-002
K-40	2.91E+001	3.87E+000	4.17E-001
MN-52	~~8.00E-002~~	~~5.53E-002~~	8.41E-002 NOT DETECTED [illegible] 9-5-02
MN-54	Not Detected	----------	7.18E-002
MO-99	Not Detected	----------	3.64E+000
NA-22	Not Detected	----------	5.73E-002
NA-24	Not Detected	----------	4.12E+001
ND-147	Not Detected	----------	7.60E-001
NI-57	Not Detected	----------	1.15E+000
RU-103	Not Detected	----------	8.18E-002
RU-106	Not Detected	----------	6.88E-001
SB-122	Not Detected	----------	4.87E-001
SB-124	Not Detected	----------	7.44E-002
SB-125	Not Detected	----------	2.27E-001
SN-113	Not Detected	----------	1.04E-001
SR-85	Not Detected	----------	7.97E-002
TA-182	Not Detected	----------	2.00E-001
TA-183	Not Detected	----------	4.05E+000
TL-201	Not Detected	----------	3.29E+000
Y-88	Not Detected	----------	5.66E-002
ZN-65	Not Detected	----------	1.31E-001
ZR-95	Not Detected	----------	1.36E-001

Sandia National Laboratories
Radiation Protection Sample Diagnostics Program
9/04/02 3:39:01 PM

Analyzed by: [signature] 9/5/02 Reviewed by: [signature] 9/5/02

Customer : BYRD, C (6134)
Customer Sample ID : 059647-004
Lab Sample ID : 20122703

Sample Description : S282-GR-111-0-SS
Sample Quantity : 694.800 gram
Sample Date/Time : 8/29/02 9:15:00 AM
Acquire Start Date/Time : 9/04/02 1:58:36 PM
Detector Name : LAB02
Elapsed Live/Real Time : 6000 / 6007 seconds

Comments:

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)	
U-238	8.98E+001	1.19E+001	1.31E+000	
RA-226	4.18E+000	4.04E+000	1.26E+000	
PB-214	9.31E-001	1.40E-001	9.29E-002	
BI-214	7.36E-001	1.23E-001	8.23E-002	
PB-210	Not Detected	---------	5.90E+001	
TH-232	1.42E+000	6.57E-001	3.01E-001	
RA-228	1.36E+000	2.27E-001	1.70E-001	
AC-228	1.38E+000	2.44E-001	1.47E-001	
TH-228	1.36E+000	6.85E-001	1.02E+000	
RA-224	1.54E+000	3.17E-001	9.75E-002	
PB-212	1.49E+000	2.12E-001	5.92E-002	
BI-212	1.45E+000	4.51E-001	5.84E-001	
TL-208	1.33E+000	2.03E-001	1.16E-001	
U-235	1.51E+000	3.55E-001	4.28E-001	
TH-231	Not Detected	---------	2.97E+001	
PA-231	Not Detected	---------	2.15E+000	
TH-227	Not Detected	---------	5.03E-001	
RA-223	~~6.85E-001~~	~~4.92E-001~~	7.70E-001	NOT DETECTED [initials] 9-5-02
RN-219	Not Detected	---------	5.08E-001	
PB-211	Not Detected	---------	1.16E+000	
TL-207	Not Detected	---------	1.59E+001	
AM-241	Not Detected	---------	1.01E+000	
PU-239	Not Detected	---------	7.92E+002	
NP-237	Not Detected	---------	5.00E+000	
PA-233	Not Detected	---------	8.53E-002	
TH-229	Not Detected	---------	6.54E-001	

[Summary Report] - Sample ID: : 20122703

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)	
AG-108m	Not Detected	---------	4.83E-002	
AG-110m	Not Detected	---------	4.74E-002	
BA-133	Not Detected	---------	6.35E-002	
BE-7	Not Detected	---------	3.75E-001	
CD-115	Not Detected	---------	6.26E-001	
CE-139	Not Detected	---------	5.43E-002	
CE-141	Not Detected	---------	1.15E-001	
CE-144	Not Detected	---------	4.38E-001	
CM-243	Not Detected	---------	2.63E-001	
CO-56	Not Detected	---------	4.19E-002	
CO-57	Not Detected	---------	5.89E-002	
CO-58	Not Detected	---------	4.54E-002	
CO-60	Not Detected	---------	4.28E-002	
CR-51	Not Detected	---------	3.85E-001	
CS-134	Not Detected	---------	5.00E-002	
CS-137	1.18E-001	3.26E-002	4.10E-002	
EU-152	Not Detected	---------	1.74E-001	
EU-154	Not Detected	---------	2.22E-001	
EU-155	Not Detected	---------	2.90E-001	
FE-59	Not Detected	---------	8.78E-002	
GD-153	Not Detected	---------	2.92E-001	
HG-203	Not Detected	---------	5.17E-002	
I-131	Not Detected	---------	6.88E-002	
IR-192	Not Detected	---------	4.16E-002	
K-40	3.21E+001	4.24E+000	3.39E-001	
MN-52	~~4.75E-002~~	~~6.09E-002~~	7.61E-002	NOT DETECTED KA 9-5-02
MN-54	Not Detected	---------	2.64E-002	
MO-99	Not Detected	---------	1.84E+000	
NA-22	Not Detected	---------	4.75E-002	
NA-24	Not Detected	---------	3.54E+001	
ND-147	Not Detected	---------	3.96E-001	
NI-57	Not Detected	---------	1.02E+000	
RU-103	Not Detected	---------	4.31E-002	
RU-106	Not Detected	---------	3.74E-001	
SB-122	Not Detected	---------	2.68E-001	
SB-124	Not Detected	---------	4.10E-002	
SB-125	Not Detected	---------	1.18E-001	
SN-113	Not Detected	---------	5.35E-002	
SR-85	Not Detected	---------	4.84E-002	
TA-182	Not Detected	---------	1.73E-001	
TA-183	Not Detected	---------	2.01E+000	
TL-201	Not Detected	---------	1.54E+000	
Y-88	Not Detected	---------	3.29E-002	
ZN-65	Not Detected	---------	1.15E-001	
ZR-95	Not Detected	---------	8.07E-002	

```
*****************************************************************************
*                      Sandia National Laboratories                          *
*       Radiation Protection Sample Diagnostics Program                      *
*                        9/04/02  5:21:06 PM                                 *
*****************************************************************************
*                                                                            *
* Analyzed by:                      9/5/02  Reviewed by:      9/5/02         *
*****************************************************************************
Customer                       : BYRD, C (6134)
Customer Sample ID             : 059648-004
Lab Sample ID                  : 20122704

Sample Description             : S282-GR-112-0-SS
Sample Quantity                :    703.400  gram
Sample Date/Time               :   8/29/02   8:45:00 AM
Acquire Start Date/Time        :   9/04/02   3:40:46 PM
Detector Name                  : LAB02
Elapsed Live/Real Time         :     6000 /   6004 seconds

Comments:
U-235/Ra-226 peaks not resolved. Either isotope may be overestimated.
*****************************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	4.45E+000	8.54E-001	6.87E-001
RA-226	3.51E+000	7.53E-001	8.44E-001
PB-214	9.55E-001	1.38E-001	7.40E-002
BI-214	7.60E-001	1.23E-001	6.89E-002
PB-210	Not Detected	---------	3.49E+001
TH-232	1.47E+000	6.68E-001	2.61E-001
RA-228	1.67E+000	2.64E-001	1.49E-001
AC-228	1.61E+000	2.74E-001	1.40E-001
TH-228	1.32E+000	5.62E-001	8.10E-001
RA-224	1.68E+000	3.40E-001	9.05E-002
PB-212	1.67E+000	2.35E-001	4.54E-002
BI-212	1.67E+000	4.36E-001	5.13E-001
TL-208	1.46E+000	2.15E-001	9.53E-002
U-235	2.44E-001	2.25E-001	2.85E-001
TH-231	Not Detected	---------	1.44E+001
PA-231	Not Detected	---------	1.64E+000
TH-227	Not Detected	---------	4.69E-001
RA-223	Not Detected	---------	3.36E-001
RN-219	Not Detected	---------	4.23E-001
PB-211	Not Detected	---------	9.37E-001
TL-207	Not Detected	---------	1.52E+001
AM-241	Not Detected	---------	5.42E-001
PU-239	Not Detected	---------	5.21E+002
NP-237	Not Detected	---------	2.76E+000
PA-233	Not Detected	---------	6.46E-002
TH-229	Not Detected	---------	3.02E-001

[Summary Report] - Sample ID: : 20122704

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.34E-002
AG-110m	Not Detected	---------	3.34E-002
BA-133	Not Detected	---------	5.65E-002
BE-7	Not Detected	---------	2.99E-001
CD-115	Not Detected	---------	5.75E-001
CE-139	Not Detected	---------	3.47E-002
CE-141	Not Detected	---------	7.02E-002
CE-144	Not Detected	---------	2.80E-001
CM-243	Not Detected	---------	2.03E-001
CO-56	Not Detected	---------	3.66E-002
CO-57	Not Detected	---------	3.63E-002
CO-58	Not Detected	---------	3.64E-002
CO-60	Not Detected	---------	3.86E-002
CR-51	Not Detected	---------	3.03E-001
CS-134	Not Detected	---------	4.36E-002
CS-137	Not Detected	---------	3.80E-002
EU-152	Not Detected	---------	1.07E-001
EU-154	Not Detected	---------	2.00E-001
EU-155	Not Detected	---------	1.64E-001
FE-59	Not Detected	---------	8.39E-002
GD-153	Not Detected	---------	1.25E-001
HG-203	Not Detected	---------	4.05E-002
I-131	Not Detected	---------	5.54E-002
IR-192	Not Detected	---------	3.25E-002
K-40	2.93E+001	3.89E+000	3.09E-001
MN-52	Not Detected	---------	7.22E-002
MN-54	Not Detected	---------	2.04E-002
MO-99	Not Detected	---------	1.24E+000
NA-22	Not Detected	---------	4.62E-002
NA-24	Not Detected	---------	4.01E+001
ND-147	Not Detected	---------	3.22E-001
NI-57	Not Detected	---------	9.90E-001
RU-103	Not Detected	---------	3.48E-002
RU-106	Not Detected	---------	3.18E-001
SB-122	Not Detected	---------	2.23E-001
SB-124	Not Detected	---------	3.38E-002
SB-125	Not Detected	---------	9.14E-002
SN-113	Not Detected	---------	4.27E-002
SR-85	Not Detected	---------	4.43E-002
TA-182	Not Detected	---------	1.73E-001
TA-183	Not Detected	---------	1.10E+000
TL-201	Not Detected	---------	8.23E-001
Y-88	Not Detected	---------	2.90E-002
ZN-65	Not Detected	---------	1.12E-001
ZR-95	Not Detected	---------	6.62E-002

```
*************************************************************************
*                    Sandia National Laboratories                       *
*     Radiation Protection Sample Diagnostics Program                   *
*                         9/04/02  7:03:31 PM                           *
*************************************************************************
*                                                                       *
* Analyzed by:              9/5/02     Reviewed by:        9/5/02       *
*************************************************************************
Customer                    : BYRD, C (6134)
Customer Sample ID          : 059649-004
Lab Sample ID               : 20122705

Sample Description          : S282-GR-113-0-SS
Sample Quantity             :   772.500  gram
Sample Date/Time            :  8/29/02   9:04:00 AM
Acquire Start Date/Time     :  9/04/02   5:22:52 PM
Detector Name               : LAB02
Elapsed Live/Real Time      :   6000 /   6025 seconds

Comments:
*************************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	1.42E+002	3.18E+001	2.55E+000
RA-226	−1.79E+001	1.31E+001	2.71E+000
PB-214	9.99E-001	1.91E-001	2.10E-001
BI-214	7.98E-001	1.47E-001	1.35E-001
PB-210	Not Detected	---------	9.78E+001
TH-232	1.63E+000	8.25E-001	6.51E-001
RA-228	1.41E+000	2.38E-001	2.29E-001
AC-228	1.35E+000	2.49E-001	1.87E-001
TH-228	Not Detected	---------	2.24E+000
RA-224	1.47E+000	3.00E-001	8.20E-002
PB-212	1.48E+000	2.15E-001	1.29E-001
BI-212	1.05E+000	5.49E-001	8.27E-001
TL-208	1.11E+000	2.16E-001	2.26E-001
U-235	3.52E+000	7.42E-001	8.54E-001
TH-231	Not Detected	---------	5.21E+001
PA-231	Not Detected	---------	4.76E+000
TH-227	Not Detected	---------	8.10E-001
RA-223	Not Detected	---------	1.21E+000
RN-219	Not Detected	---------	1.11E+000
PB-211	Not Detected	---------	2.47E+000
TL-207	Not Detected	---------	2.53E+001
AM-241	Not Detected	---------	1.52E+000
PU-239	Not Detected	---------	1.50E+003
NP-237	Not Detected	---------	1.05E+001
PA-233	Not Detected	---------	1.91E-001
TH-229	Not Detected	---------	1.61E+000

[Summary Report] - Sample ID: : 20122705

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)	
AG-108m	Not Detected	----------	7.88E-002	
AG-110m	Not Detected	----------	7.53E-002	
BA-133	Not Detected	----------	1.23E-001	
BE-7	Not Detected	----------	7.38E-001	
CD-115	Not Detected	----------	1.20E+000	
CE-139	Not Detected	----------	1.11E-001	
CE-141	Not Detected	----------	2.21E-001	
CE-144	Not Detected	----------	8.56E-001	
CM-243	Not Detected	----------	5.54E-001	
CO-56	Not Detected	----------	7.09E-002	
CO-57	Not Detected	----------	1.13E-001	
CO-58	Not Detected	----------	7.79E-002	
CO-60	Not Detected	----------	4.80E-002	
CR-51	Not Detected	----------	8.74E-001	
CS-134	Not Detected	----------	7.87E-002	
CS-137	Not Detected	----------	7.83E-002	
EU-152	Not Detected	----------	3.36E-001	
EU-154	Not Detected	----------	3.63E-001	
EU-155	Not Detected	----------	5.98E-001	
FE-59	Not Detected	----------	1.01E-001	
GD-153	Not Detected	----------	7.24E-001	
HG-203	Not Detected	----------	1.10E-001	
I-131	Not Detected	----------	1.56E-001	
IR-192	Not Detected	----------	9.40E-002	
K-40	3.23E+001	4.26E+000	3.75E-001	
MN-52	~~1.88E-001~~	~~6.48E-002~~	8.46E-002	NOT DETECTED [illegible] 9-5-02
MN-54	Not Detected	----------	6.87E-002	
MO-99	Not Detected	----------	3.90E+000	
NA-22	Not Detected	----------	5.48E-002	
NA-24	Not Detected	----------	5.12E+001	
ND-147	Not Detected	----------	8.16E-001	
NI-57	Not Detected	----------	1.21E+000	
RU-103	Not Detected	----------	8.86E-002	
RU-106	Not Detected	----------	7.21E-001	
SB-122	Not Detected	----------	5.45E-001	
SB-124	Not Detected	----------	7.84E-002	
SB-125	Not Detected	----------	2.46E-001	
SN-113	Not Detected	----------	1.15E-001	
SR-85	Not Detected	----------	8.22E-002	
TA-182	Not Detected	----------	1.98E-001	
TA-183	Not Detected	----------	3.09E+000	
TL-201	Not Detected	----------	2.59E+000	
Y-88	Not Detected	----------	5.60E-002	
ZN-65	Not Detected	----------	1.23E-001	
ZR-95	Not Detected	----------	1.40E-001	

****** ***
*   Sandia National Laboratories   *
*   Radiation Protection Sample Diagnostics Program   *
*   9/04/02 8:45:33 PM   *
****
*
* Analyzed by: 9/5/02 Reviewed by: 9/5/02 *
****

Customer : BYRD, C (6134)
Customer Sample ID : 059650-004
Lab Sample ID : 20122706

Sample Description : S282-GR-114-0-SS
Sample Quantity : 678.500 gram
Sample Date/Time : 8/29/02 8:51:00 AM
Acquire Start Date/Time : 9/04/02 7:05:16 PM
Detector Name : LAB02
Elapsed Live/Real Time : 6000 / 6004 seconds

Comments:
U-235/Ra-226 peaks not resolved. Either isotope may be overestimated.
****

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.40E+000	6.07E-001	7.25E-001
RA-226	2.96E+000	7.36E-001	9.11E-001
PB-214	9.88E-001	1.44E-001	8.15E-002
BI-214	9.07E-001	1.42E-001	6.64E-002
PB-210	Not Detected	---------	3.48E+001
TH-232	1.77E+000	7.98E-001	2.60E-001
RA-228	1.74E+000	2.74E-001	1.48E-001
AC-228	1.68E+000	2.85E-001	1.40E-001
TH-228	1.53E+000	5.97E-001	8.44E-001
RA-224	1.83E+000	3.69E-001	9.77E-002
PB-212	1.76E+000	2.48E-001	4.82E-002
BI-212	1.88E+000	4.55E-001	5.04E-001
TL-208	1.53E+000	2.24E-001	9.56E-002
U-235	Not Detected	---------	2.86E-001
TH-231	Not Detected	---------	1.45E+001
PA-231	Not Detected	---------	1.68E+000
TH-227	Not Detected	---------	4.89E-001
RA-223	Not Detected	---------	3.44E-001
RN-219	Not Detected	---------	4.34E-001
PB-211	Not Detected	---------	9.67E-001
TL-207	Not Detected	---------	1.48E+001
AM-241	Not Detected	---------	5.48E-001
PU-239	Not Detected	---------	5.38E+002
NP-237	Not Detected	---------	2.83E+000
PA-233	Not Detected	---------	6.86E-002
TH-229	Not Detected	---------	3.03E-001

[Summary Report] - Sample ID: : 20122706

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.40E-002
AG-110m	Not Detected	---------	3.74E-002
BA-133	Not Detected	---------	5.83E-002
BE-7	Not Detected	---------	3.15E-001
CD-115	Not Detected	---------	6.37E-001
CE-139	Not Detected	---------	3.57E-002
CE-141	Not Detected	---------	7.14E-002
CE-144	Not Detected	---------	2.91E-001
CM-243	Not Detected	---------	2.08E-001
CO-56	Not Detected	---------	3.88E-002
CO-57	Not Detected	---------	3.82E-002
CO-58	Not Detected	---------	3.64E-002
CO-60	Not Detected	---------	3.89E-002
CR-51	Not Detected	---------	3.11E-001
CS-134	Not Detected	---------	4.71E-002
CS-137	2.73E-002	2.00E-002	3.08E-002
EU-152	Not Detected	---------	1.13E-001
EU-154	Not Detected	---------	2.02E-001
EU-155	Not Detected	---------	1.69E-001
FE-59	Not Detected	---------	8.54E-002
GD-153	Not Detected	---------	1.26E-001
HG-203	Not Detected	---------	4.18E-002
I-131	Not Detected	---------	5.74E-002
IR-192	Not Detected	---------	3.33E-002
K-40	2.74E+001	3.65E+000	3.68E-001
MN-52	Not Detected	---------	7.10E-002
MN-54	Not Detected	---------	4.00E-002
MO-99	Not Detected	---------	1.32E+000
NA-22	Not Detected	---------	4.62E-002
NA-24	Not Detected	---------	4.61E+001
ND-147	Not Detected	---------	3.35E-001
NI-57	Not Detected	---------	1.14E+000
RU-103	Not Detected	---------	3.46E-002
RU-106	Not Detected	---------	3.18E-001
SB-122	Not Detected	---------	2.35E-001
SB-124	Not Detected	---------	3.58E-002
SB-125	Not Detected	---------	9.65E-002
SN-113	Not Detected	---------	4.53E-002
SR-85	Not Detected	---------	4.61E-002
TA-182	Not Detected	---------	1.76E-001
TA-183	Not Detected	---------	1.13E+000
TL-201	Not Detected	---------	8.77E-001
Y-88	Not Detected	---------	2.91E-002
ZN-65	Not Detected	---------	1.13E-001
ZR-95	Not Detected	---------	6.62E-002

```
***********************************************************************
*                    Sandia National Laboratories                     *
*     Radiation Protection Sample Diagnostics Program                 *
*                      9/04/02 10:27:40 PM                            *
***********************************************************************
*                                                                     *
* Analyzed by:                9/5/02    Reviewed by:        9/5/02    *
***********************************************************************
Customer                    : BYRD, C (6134)
Customer Sample ID          : 059651-004
Lab Sample ID               : 20122707

Sample Description          : S282-GR-115-0-SS
Sample Quantity             :   857.900  gram
Sample Date/Time            :  8/29/02   8:41:00 AM
Acquire Start Date/Time     :  9/04/02   8:47:17 PM
Detector Name               : LAB02
Elapsed Live/Real Time      :   6000 /   6008 seconds

Comments:
***********************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)	
U-238	8.99E+001	1.22E+001	1.19E+000	
RA-226	3.82E+000	3.80E+000	1.18E+000	
PB-214	9.59E-001	1.41E-001	8.94E-002	
BI-214	8.38E-001	1.32E-001	7.25E-002	
PB-210	Not Detected	---------	5.35E+001	
TH-232	1.28E+000	5.99E-001	3.11E-001	
RA-228	1.49E+000	2.34E-001	1.47E-001	
AC-228	1.50E+000	2.53E-001	1.30E-001	
TH-228	1.46E+000	6.48E-001	9.52E-001	
RA-224	1.70E+000	3.37E-001	8.46E-002	
PB-212	1.54E+000	2.17E-001	5.68E-002	
BI-212	1.41E+000	4.33E-001	5.67E-001	
TL-208	1.35E+000	2.02E-001	1.06E-001	
U-235	1.54E+000	3.43E-001	4.01E-001	
TH-231	Not Detected	---------	2.75E+001	
PA-231	Not Detected	---------	1.97E+000	
TH-227	Not Detected	---------	4.66E-001	
RA-223	~~1.07E+000~~	~~2.60E-001~~	4.99E-001	NOT DETECTED KAT 9-5-02
RN-219	Not Detected	---------	4.95E-001	
PB-211	Not Detected	---------	1.10E+000	
TL-207	Not Detected	---------	1.46E+001	
AM-241	Not Detected	---------	9.06E-001	
PU-239	Not Detected	---------	7.45E+002	
NP-237	Not Detected	---------	4.58E+000	
PA-233	Not Detected	---------	8.14E-002	
TH-229	Not Detected	---------	5.97E-001	

[Summary Report] - Sample ID: : 20122707

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.49E-002
AG-110m	Not Detected	---------	4.11E-002
BA-133	Not Detected	---------	6.10E-002
BE-7	Not Detected	---------	3.48E-001
CD-115	Not Detected	---------	6.38E-001
CE-139	Not Detected	---------	5.07E-002
CE-141	Not Detected	---------	1.09E-001
CE-144	Not Detected	---------	4.20E-001
CM-243	Not Detected	---------	2.43E-001
CO-56	Not Detected	---------	3.78E-002
CO-57	Not Detected	---------	5.55E-002
CO-58	Not Detected	---------	4.13E-002
CO-60	Not Detected	---------	3.65E-002
CR-51	Not Detected	---------	3.77E-001
CS-134	Not Detected	---------	4.63E-002
CS-137	4.33E-002	2.45E-002	3.71E-002
EU-152	Not Detected	---------	1.65E-001
EU-154	Not Detected	---------	2.06E-001
EU-155	Not Detected	---------	2.69E-001
FE-59	Not Detected	---------	7.98E-002
GD-153	Not Detected	---------	2.69E-001
HG-203	Not Detected	---------	4.81E-002
I-131	Not Detected	---------	6.82E-002
IR-192	Not Detected	---------	4.01E-002
K-40	2.90E+001	3.83E+000	2.68E-001
MN-52	Not Detected	---------	6.82E-002
MN-54	Not Detected	---------	2.38E-002
MO-99	Not Detected	---------	1.80E+000
NA-22	Not Detected	---------	4.24E-002
NA-24	Not Detected	---------	4.64E+001
ND-147	Not Detected	---------	3.71E-001
NI-57	Not Detected	---------	1.06E+000
RU-103	Not Detected	---------	4.07E-002
RU-106	Not Detected	---------	3.56E-001
SB-122	~~9.63E-002~~	~~6.03E-002~~	1.50E-001 NOT DETECTED [illegible] 9-5-02
SB-124	Not Detected	---------	3.89E-002
SB-125	Not Detected	---------	1.09E-001
SN-113	Not Detected	---------	5.13E-002
SR-85	Not Detected	---------	4.53E-002
TA-182	Not Detected	---------	1.54E-001
TA-183	Not Detected	---------	1.89E+000
TL-201	Not Detected	---------	1.53E+000
Y-88	Not Detected	---------	3.24E-002
ZN-65	Not Detected	---------	1.03E-001
ZR-95	Not Detected	---------	7.40E-002

```
*******************************************************************************
*                     Sandia National Laboratories                            *
*      Radiation Protection Sample Diagnostics Program                        *
*                       9/05/02 12:09:50 AM                                   *
*******************************************************************************
*                                                                             *
* Analyzed by:              9/5/02    Reviewed by:       9/5/02               *
*******************************************************************************
```

Customer : BYRD, C (6134)
Customer Sample ID : 059652-004
Lab Sample ID : 20122708

Sample Description : S282-GR-116-0-SS
Sample Quantity : 708.300 gram
Sample Date/Time : 8/29/02 9:10:00 AM
Acquire Start Date/Time : 9/04/02 10:29:25 PM
Detector Name : LAB02
Elapsed Live/Real Time : 6000 / 6004 seconds

Comments:
U-235/Ra-226 peaks not resolved. Either isotope may be overestimated.

****

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	9.12E-001
RA-226	2.33E+000	6.70E-001	8.86E-001
PB-214	9.74E-001	1.41E-001	7.59E-002
BI-214	8.51E-001	1.45E-001	1.08E-001
PB-210	Not Detected	---------	3.48E+001
TH-232	1.57E+000	7.13E-001	2.66E-001
RA-228	1.65E+000	2.62E-001	1.50E-001
AC-228	1.58E+000	2.68E-001	1.33E-001
TH-228	1.70E+000	5.63E-001	7.56E-001
RA-224	1.88E+000	3.74E-001	7.95E-002
PB-212	1.63E+000	2.30E-001	4.75E-002
BI-212	2.07E+000	4.49E-001	4.43E-001
TL-208	1.48E+000	2.18E-001	9.35E-002
U-235	1.91E-001	2.23E-001	2.82E-001
TH-231	Not Detected	---------	1.36E+001
PA-231	Not Detected	---------	1.62E+000
TH-227	Not Detected	---------	4.65E-001
RA-223	Not Detected	---------	3.20E-001
RN-219	Not Detected	---------	4.27E-001
PB-211	Not Detected	---------	9.35E-001
TL-207	Not Detected	---------	1.52E+001
AM-241	Not Detected	---------	5.03E-001
PU-239	Not Detected	---------	5.11E+002
NP-237	Not Detected	---------	2.71E+000
PA-233	Not Detected	---------	6.83E-002
TH-229	Not Detected	---------	2.89E-001

[Summary Report] - Sample ID: : 20122708

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	----------	4.55E-002
AG-110m	Not Detected	----------	3.59E-002
BA-133	Not Detected	----------	5.73E-002
BE-7	Not Detected	----------	3.08E-001
CD-115	Not Detected	----------	6.40E-001
CE-139	Not Detected	----------	3.49E-002
CE-141	Not Detected	----------	6.97E-002
CE-144	Not Detected	----------	2.82E-001
CM-243	Not Detected	----------	2.10E-001
CO-56	Not Detected	----------	3.87E-002
CO-57	Not Detected	----------	3.66E-002
CO-58	Not Detected	----------	3.72E-002
CO-60	Not Detected	----------	4.03E-002
CR-51	Not Detected	----------	3.10E-001
CS-134	Not Detected	----------	4.48E-002
CS-137	Not Detected	----------	3.64E-002
EU-152	Not Detected	----------	1.08E-001
EU-154	Not Detected	----------	2.10E-001
EU-155	Not Detected	----------	1.64E-001
FE-59	Not Detected	----------	8.88E-002
GD-153	Not Detected	----------	1.21E-001
HG-203	Not Detected	----------	4.09E-002
I-131	Not Detected	----------	5.58E-002
IR-192	Not Detected	----------	3.32E-002
K-40	3.43E+001	4.53E+000	3.13E-001
MN-52	Not Detected	----------	6.80E-002
MN-54	Not Detected	----------	2.58E-002
MO-99	Not Detected	----------	1.37E+000
NA-22	Not Detected	----------	4.99E-002
NA-24	Not Detected	----------	5.49E+001
ND-147	Not Detected	----------	3.31E-001
NI-57	Not Detected	----------	1.15E+000
RU-103	Not Detected	----------	3.61E-002
RU-106	Not Detected	----------	3.11E-001
SB-122	~~9.50E-002~~	~~8.99E-002~~	1.42E-001 NOT DETECTED [illegible] 9-5-02
SB-124	Not Detected	----------	3.39E-002
SB-125	Not Detected	----------	9.72E-002
SN-113	Not Detected	----------	4.47E-002
SR-85	Not Detected	----------	4.44E-002
TA-182	Not Detected	----------	1.74E-001
TA-183	Not Detected	----------	1.05E+000
TL-201	Not Detected	----------	8.27E-001
Y-88	Not Detected	----------	3.31E-002
ZN-65	Not Detected	----------	1.14E-001
ZR-95	Not Detected	----------	6.72E-002

```
* **************************************************************************
*                  Sandia National Laboratories                            *
*    Radiation Protection Sample Diagnostics Program                       *
*                      9/05/02  6:59:39 AM                                 *
****************************************************************************
*                                                                          *
* Analyzed by:           9/5/02          Reviewed by:      9/5/02          *
****************************************************************************
Customer                   : BYRD, C (6134)
Customer Sample ID         : LAB_CONTROL_SAMPLE_USING_CG-134
Lab Sample ID              : 20122709

Sample Description         : MIXED_GAMMA_STANDARD_CG-134
Sample Quantity            :      1.000  Each
Sample Date/Time           : 11/01/90  12:00:00 PM
Acquire Start Date/Time    :  9/05/02   6:49:18 AM
Detector Name              : LAB02
Elapsed Live/Real Time     :     600 /     604 seconds

Comments:
****************************************************************************
```

Nuclide Name	Activity (pCi/Each)	2-sigma Error	MDA (pCi/Each)
U-238	Not Detected	---------	3.77E+003
RA-226	Not Detected	---------	5.52E+003
PB-214	Not Detected	---------	5.79E+002
BI-214	Not Detected	---------	4.86E+002
PB-210	Not Detected	---------	2.65E+005
TH-232	Not Detected	---------	1.78E+003
RA-228	Not Detected	---------	1.73E+003
AC-228	Not Detected	---------	9.89E+002
TH-228	Not Detected	---------	4.22E+005
RA-224	Not Detected	---------	2.03E+004
PB-212	Not Detected	---------	3.24E+004
BI-212	Not Detected	---------	2.05E+005
TL-208	Not Detected	---------	5.29E+004
U-235	Not Detected	---------	1.49E+003
TH-231	Not Detected	---------	6.87E+004
PA-231	Not Detected	---------	1.24E+004
TH-227	Not Detected	---------	2.52E+003
RA-223	Not Detected	---------	1.00E+026
RN-219	Not Detected	---------	5.50E+003
PB-211	Not Detected	---------	1.24E+004
TL-207	Not Detected	---------	1.70E+005
AM-241	8.11E+004	1.20E+004	3.89E+003
PU-239	Not Detected	---------	2.74E+006
NP-237	Not Detected	---------	1.42E+004
PA-233	Not Detected	---------	5.11E+002
TH-229	Not Detected	---------	1.52E+003

[Summary Report] - Sample ID: : 20122709

Nuclide Name	Activity (pCi/Each)	2-sigma Error	MDA (pCi/Each)
AG-108m	Not Detected	---------	2.21E+002
AG-110m	Not Detected	---------	2.12E+008
BA-133	Not Detected	---------	7.85E+002
BE-7	Not Detected	---------	1.00E+026
CD-115	Not Detected	---------	1.00E+026
CE-139	Not Detected	---------	5.53E+011
CE-141	Not Detected	---------	1.00E+026
CE-144	Not Detected	---------	5.78E+007
CM-243	Not Detected	---------	1.83E+003
CO-56	Not Detected	---------	1.97E+019
CO-57	Not Detected	---------	1.22E+007
CO-58	Not Detected	---------	5.29E+020
CO-60	8.13E+004	1.06E+004	5.14E+002
CR-51	Not Detected	---------	1.00E+026
CS-134	Not Detected	---------	1.18E+004
CS-137	7.09E+004	8.96E+003	3.14E+002
EU-152	Not Detected	---------	1.10E+003
EU-154	Not Detected	---------	2.47E+003
EU-155	Not Detected	---------	4.98E+003
FE-59	Not Detected	---------	1.00E+026
GD-153	Not Detected	---------	1.53E+008
HG-203	Not Detected	---------	1.00E+026
I-131	Not Detected	---------	1.00E+026
IR-192	Not Detected	---------	1.04E+020
K-40	Not Detected	---------	1.15E+003
MN-52	Not Detected	---------	1.00E+026
MN-54	Not Detected	---------	3.66E+006
MO-99	Not Detected	---------	1.00E+026
NA-22	Not Detected	---------	3.57E+003
NA-24	Not Detected	---------	1.00E+026
ND-147	Not Detected	---------	1.00E+026
NI-57	Not Detected	---------	1.00E+026
RU-103	Not Detected	---------	1.00E+026
RU-106	Not Detected	---------	7.67E+006
SB-122	Not Detected	---------	1.00E+026
SB-124	Not Detected	---------	1.00E+026
SB-125	Not Detected	---------	1.94E+004
SN-113	Not Detected	---------	7.69E+013
SR-85	Not Detected	---------	1.00E+026
TA-182	Not Detected	---------	1.67E+014
TA-183	Not Detected	---------	1.00E+026
TL-201	Not Detected	---------	1.00E+026
Y-88	Not Detected	---------	1.97E+014
ZN-65	Not Detected	---------	1.27E+008
ZR-95	Not Detected	---------	1.00E+026

****

Sandia National Laboratories
Radiation Protection Sample Diagnostics Program
Quality Assurance Report

****

Report Date	: 9/05/02 6:59:45 AM
QA File	: C:\GENIE2K\CAMFILES\LCS2.QAF
Analyst	: RPREESE
Sample ID	: 20122709
Sample Quantity	: 1.00 Each
Sample Date	: 11/01/90 12:00:00 PM
Measurement Date	: 9/05/02 6:49:18 AM
Elapsed Live Time	: 600 seconds
Elapsed Real Time	: 604 seconds

Parameter	Mean	1S Error	New Value	LU	SD	UD	BS
AM-241 Activity	8.246E-002	3.731E-003	8.105E-002				
CS-137 Activity	7.188E-002	3.328E-003	7.089E-002				
CO-60 Activity	8.007E-002	4.770E-003	7.915E-002				

Flags Key:
- LU = Boundary Test (Ab = Above , Be = Below)
- SD = Sample Driven N-Sigma Test (In = Investigate, Ac = Action)
- UD = User Driven N-Sigma Test (In = Investigate, Ac = Action)
- BS = Measurement Bias Test (In = Investigate, Ac = Action)

Reviewed by: [illegible] 9/5/02

In Situ Gamma Spectroscopy Results
August 2002

****
* Sandia National Laboratories *
* Radiation Protection Sample Diagnostics Program *
* 09/10/02 8:25:21 AM *
****
*
* Analyzed by: JPK 9-10-02 Reviewed by: 9/10/02 *
****

Customer : MIGNARDOT E (6134)
Customer Sample ID : LOCATION #1
Lab Sample ID : 29002601

Sample Description : ENTRANCE TO MINE
Sample Quantity : 1000.000 gram
Sample Date/Time : 08/29/02 10:34:22 AM
Acquire Start Date/Time : 08/29/02 10:34:22 AM
Detector Name : PGE08
Elapsed Live/Real Time : 3600 / 3644 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.
****

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.40E+001	5.68E+000	5.11E+000
RA-226	9.49E+000	2.55E+000	3.27E+000
PB-214	Not Detected	---------	1.70E-001
BI-214	Not Detected	---------	1.35E-001
PB-210	Not Detected	---------	1.07E+001
TH-232	Not Detected	---------	5.28E-001
RA-228	Not Detected	---------	3.26E-001
AC-228	Not Detected	---------	2.07E-001
TH-228	Not Detected	---------	1.79E+000
RA-224	Not Detected	---------	1.41E-001
PB-212	Not Detected	---------	1.85E-001
BI-212	Not Detected	---------	7.15E-001
TL-208	Not Detected	---------	1.95E-001
U-235	7.47E-001	8.34E-001	9.34E-001
TH-231	Not Detected	---------	4.10E+001
PA-231	Not Detected	---------	3.91E+000
TH-227	Not Detected	---------	7.06E-001
RA-223	Not Detected	---------	6.52E-001
PB-211	Not Detected	---------	1.81E+000
TL-207	Not Detected	---------	1.71E+001
AM-241	Not Detected	---------	6.30E-001
PU-239	Not Detected	---------	1.73E+003
NP-237	Not Detected	---------	1.07E+001
PA-233	Not Detected	---------	1.51E-001
TH-229	Not Detected	---------	1.06E+000

[Summary Report] - Sample ID: : 29002601

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	----------	5.23E-002
AG-110m	Not Detected	----------	4.81E-002
BA-133	Not Detected	----------	9.87E-002
BE-7	Not Detected	----------	4.61E-001
CD-115	Not Detected	----------	1.31E-001
CE-139	Not Detected	----------	1.06E-001
CE-141	Not Detected	----------	2.00E-001
CE-144	Not Detected	----------	9.61E-001
CM-243	Not Detected	----------	4.60E-001
CO-56	Not Detected	----------	4.05E-002
CO-57	Not Detected	----------	1.31E-001
CO-58	Not Detected	----------	4.17E-002
CO-60	Not Detected	----------	3.11E-002
CR-51	Not Detected	----------	5.84E-001
CS-134	Not Detected	----------	6.14E-002
CS-137	Not Detected	----------	5.14E-002
EU-152	Not Detected	----------	3.97E-001
EU-154	Not Detected	----------	2.41E-001
EU-155	Not Detected	----------	6.28E-001
FE-59	Not Detected	----------	7.71E-002
GD-153	Not Detected	----------	4.35E-001
HG-203	Not Detected	----------	8.28E-002
I-131	Not Detected	----------	6.48E-002
IR-192	Not Detected	----------	7.00E-002
K-40	2.04E+001	3.03E+000	1.14E+000
MN-52	Not Detected	----------	2.57E-002
MN-54	Not Detected	----------	4.28E-002
MO-99	Not Detected	----------	3.52E-001
NA-22	Not Detected	----------	3.96E-002
NA-24	Not Detected	----------	2.89E-002
ND-147	Not Detected	----------	3.53E-001
NI-57	Not Detected	----------	3.98E-002
RU-103	Not Detected	----------	5.31E-002
RU-106	Not Detected	----------	4.61E-001
SB-122	Not Detected	----------	6.42E-002
SB-124	Not Detected	----------	4.84E-002
SB-125	Not Detected	----------	1.71E-001
SN-113	Not Detected	----------	8.16E-002
SR-85	Not Detected	----------	5.42E-002
TA-182	Not Detected	----------	1.43E-001
TA-183	Not Detected	----------	5.33E-001
TL-201	Not Detected	----------	3.97E-001
Y-88	Not Detected	----------	1.57E-002
ZN-65	Not Detected	----------	9.83E-002
ZR-95	Not Detected	----------	7.90E-002

```
****************************************************************************
*                    Sandia National Laboratories                          *
*    Radiation Protection Sample Diagnostics Program                       *
*                      09/10/02  8:26:51 AM                                *
****************************************************************************
*                                                                          *
* Analyzed by:   JPK 9-10-02 Reviewed by:         9/10/02                  *
****************************************************************************
Customer                   : MIGNARDOT E (6134)
Customer Sample ID         : LOCATION #2
Lab Sample ID              : 29002602

Sample Description         : LOCATION #2
Sample Quantity            :  1000.000  gram
Sample Date/Time           : 08/29/02  11:41:52 AM
Acquire Start Date/Time    : 08/29/02  11:41:52 AM
Detector Name              : PGE08
Elapsed Live/Real Time     :   3600 /   3636 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.
****************************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	2.47E+000
RA-226	3.34E+000	1.66E+000	2.50E+000
PB-214	Not Detected	---------	1.45E-001
BI-214	Not Detected	---------	1.10E-001
PB-210	Not Detected	---------	1.06E+001
TH-232	Not Detected	---------	4.44E-001
RA-228	Not Detected	---------	2.59E-001
AC-228	Not Detected	---------	1.82E-001
TH-228	Not Detected	---------	1.48E+000
RA-224	Not Detected	---------	1.48E-001
PB-212	Not Detected	---------	1.64E-001
BI-212	Not Detected	---------	5.57E-001
TL-208	Not Detected	---------	1.74E-001
U-235	4.10E-001	7.28E-001	8.23E-001
TH-231	Not Detected	---------	3.74E+001
PA-231	Not Detected	---------	3.17E+000
TH-227	Not Detected	---------	6.20E-001
RA-223	Not Detected	---------	5.96E-001
PB-211	Not Detected	---------	1.41E+000
TL-207	Not Detected	---------	1.22E+001
AM-241	Not Detected	---------	6.17E-001
PU-239	Not Detected	---------	1.54E+003
NP-237	Not Detected	---------	9.33E+000
PA-233	Not Detected	---------	1.24E-001
TH-229	Not Detected	---------	9.76E-001

[Summary Report] - Sample ID: : 29002602

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	----------	3.57E-002
AG-110m	Not Detected	----------	3.49E-002
BA-133	Not Detected	----------	7.53E-002
BE-7	Not Detected	----------	3.65E-001
CD-115	Not Detected	----------	1.09E-001
CE-139	Not Detected	----------	9.52E-002
CE-141	Not Detected	----------	1.76E-001
CE-144	Not Detected	----------	8.51E-001
CM-243	Not Detected	----------	3.74E-001
CO-56	Not Detected	----------	2.92E-002
CO-57	Not Detected	----------	1.17E-001
CO-58	Not Detected	----------	2.97E-002
CO-60	Not Detected	----------	2.10E-002
CR-51	Not Detected	----------	4.72E-001
CS-134	Not Detected	----------	3.64E-002
CS-137	Not Detected	----------	3.81E-002
EU-152	Not Detected	----------	3.54E-001
EU-154	Not Detected	----------	1.68E-001
EU-155	Not Detected	----------	5.56E-001
FE-59	Not Detected	----------	5.12E-002
GD-153	Not Detected	----------	3.96E-001
HG-203	Not Detected	----------	6.72E-002
I-131	Not Detected	----------	5.27E-002
IR-192	Not Detected	----------	5.69E-002
K-40	7.68E+000	1.35E+000	1.14E+000
MN-52	Not Detected	----------	1.83E-002
MN-54	Not Detected	----------	3.14E-002
MO-99	Not Detected	----------	2.47E-001
NA-22	Not Detected	----------	2.61E-002
NA-24	Not Detected	----------	1.91E-002
ND-147	Not Detected	----------	2.71E-001
NI-57	Not Detected	----------	2.87E-002
RU-103	Not Detected	----------	4.10E-002
RU-106	Not Detected	----------	3.37E-001
SB-122	Not Detected	----------	5.17E-002
SB-124	Not Detected	----------	3.47E-002
SB-125	Not Detected	----------	1.35E-001
SN-113	Not Detected	----------	6.44E-002
SR-85	Not Detected	----------	4.24E-002
TA-182	Not Detected	----------	1.09E-001
TA-183	Not Detected	----------	5.20E-001
TL-201	Not Detected	----------	3.85E-001
Y-88	Not Detected	----------	1.11E-002
ZN-65	Not Detected	----------	5.87E-002
ZR-95	Not Detected	----------	5.75E-002

```
***********************************************************************
*                   Sandia National Laboratories                      *
*    Radiation Protection Sample Diagnostics Program                  *
*                   09/10/02  8:33:28 AM                              *
***********************************************************************
*                                                                     *
* Analyzed by:  JPK 9-10-02    Reviewed by:            9/10/02        *
***********************************************************************
Customer                     : MIGNARDOT E (6134)
Customer Sample ID           : LOCATION #3
Lab Sample ID                : 29002603

Sample Description           : LOCATION #3
Sample Quantity              :  1000.000  gram
Sample Date/Time             : 08/29/02   1:22:20 PM
Acquire Start Date/Time      : 08/29/02   1:22:20 PM
Detector Name                : PGE08
Elapsed Live/Real Time       :    3600 /   3632 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.
***********************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	2.27E+000
RA-226	2.67E+000	1.56E+000	2.40E+000
PB-214	Not Detected	---------	1.46E-001
BI-214	Not Detected	---------	1.15E-001
PB-210	Not Detected	---------	9.21E+000
TH-232	Not Detected	---------	4.57E-001
RA-228	Not Detected	---------	2.88E-001
AC-228	Not Detected	---------	1.85E-001
TH-228	Not Detected	---------	1.54E+000
RA-224	Not Detected	---------	1.39E-001
PB-212	Not Detected	---------	1.61E-001
BI-212	Not Detected	---------	6.20E-001
TL-208	Not Detected	---------	1.76E-001
U-235	5.21E-001	6.96E-001	7.84E-001
TH-231	Not Detected	---------	3.43E+001
PA-231	Not Detected	---------	3.33E+000
TH-227	Not Detected	---------	6.14E-001
RA-223	Not Detected	---------	5.46E-001
PB-211	Not Detected	---------	1.55E+000
TL-207	Not Detected	---------	1.46E+001
AM-241	Not Detected	---------	5.37E-001
PU-239	Not Detected	---------	1.47E+003
NP-237	Not Detected	---------	8.94E+000
PA-233	Not Detected	---------	1.29E-001
TH-229	Not Detected	---------	8.86E-001

[Summary Report] - Sample ID: : 29002603

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.51E-002
AG-110m	Not Detected	---------	4.21E-002
BA-133	Not Detected	---------	8.40E-002
BE-7	Not Detected	---------	3.91E-001
CD-115	Not Detected	---------	1.12E-001
CE-139	Not Detected	---------	9.02E-002
CE-141	Not Detected	---------	1.68E-001
CE-144	Not Detected	---------	8.13E-001
CM-243	Not Detected	---------	3.93E-001
CO-56	Not Detected	---------	3.34E-002
CO-57	Not Detected	---------	1.11E-001
CO-58	Not Detected	---------	3.51E-002
CO-60	Not Detected	---------	2.71E-002
CR-51	Not Detected	---------	4.95E-001
CS-134	Not Detected	---------	5.31E-002
CS-137	3.45E-002	2.39E-002	3.73E-002
EU-152	Not Detected	---------	3.36E-001
EU-154	Not Detected	---------	2.09E-001
EU-155	Not Detected	---------	5.32E-001
FE-59	Not Detected	---------	6.22E-002
GD-153	Not Detected	---------	3.62E-001
HG-203	Not Detected	---------	7.09E-002
I-131	Not Detected	---------	5.46E-002
IR-192	Not Detected	---------	5.90E-002
K-40	1.90E+000	7.74E-001	1.14E+000
MN-52	Not Detected	---------	2.28E-002
MN-54	Not Detected	---------	3.65E-002
MO-99	Not Detected	---------	2.87E-001
NA-22	Not Detected	---------	3.30E-002
NA-24	Not Detected	---------	2.42E-002
ND-147	Not Detected	---------	2.95E-001
NI-57	Not Detected	---------	3.33E-002
RU-103	Not Detected	---------	4.44E-002
RU-106	Not Detected	---------	3.86E-001
SB-122	Not Detected	---------	5.52E-002
SB-124	Not Detected	---------	4.24E-002
SB-125	Not Detected	---------	1.46E-001
SN-113	Not Detected	---------	7.03E-002
SR-85	Not Detected	---------	4.71E-002
TA-182	Not Detected	---------	1.23E-001
TA-183	Not Detected	---------	4.55E-001
TL-201	Not Detected	---------	3.33E-001
Y-88	Not Detected	---------	1.43E-002
ZN-65	Not Detected	---------	8.31E-002
ZR-95	Not Detected	---------	6.67E-002

```
**********************************************************************
*                    Sandia National Laboratories                    *
*    Radiation Protection Sample Diagnostics Program                 *
*                     09/10/02  8:35:25 AM                           *
**********************************************************************
*                                                                    *
* Analyzed by:  JPK 9-10-02   Reviewed by:  [signature] 9/10/02      *
**********************************************************************
Customer                     : MIGNARDOT E (6134)
Customer Sample ID           : LOCATION #4
Lab Sample ID                : 29002604

Sample Description           : LOCATION #4
Sample Quantity              :  1000.000  gram
Sample Date/Time             : 08/29/02   2:32:40 PM
Acquire Start Date/Time      : 08/29/02   2:32:40 PM
Detector Name                : PGE08
Elapsed Live/Real Time       :   3600 /   3633 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.
**********************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	2.32E+000
RA-226	3.50E+000	1.38E+000	2.00E+000
PB-214	Not Detected	---------	1.48E-001
BI-214	Not Detected	---------	1.17E-001
PB-210	Not Detected	---------	9.31E+000
TH-232	Not Detected	---------	4.65E-001
RA-228	Not Detected	---------	2.97E-001
AC-228	Not Detected	---------	1.91E-001
TH-228	Not Detected	---------	1.60E+000
RA-224	Not Detected	---------	1.42E-001
PB-212	Not Detected	---------	1.64E-001
BI-212	Not Detected	---------	6.26E-001
TL-208	Not Detected	---------	1.80E-001
U-235	7.20E-001	7.19E-001	8.04E-001
TH-231	Not Detected	---------	3.51E+001
PA-231	Not Detected	---------	3.34E+000
TH-227	Not Detected	---------	6.11E-001
RA-223	Not Detected	---------	5.58E-001
PB-211	Not Detected	---------	1.54E+000
TL-207	Not Detected	---------	1.45E+001
AM-241	Not Detected	---------	5.43E-001
PU-239	Not Detected	---------	1.51E+003
NP-237	Not Detected	---------	9.16E+000
PA-233	Not Detected	---------	1.30E-001
TH-229	Not Detected	---------	9.03E-001

[Summary Report] - Sample ID: : 29002604

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	----------	4.55E-002
AG-110m	Not Detected	----------	4.21E-002
BA-133	Not Detected	----------	8.96E-002
BE-7	Not Detected	----------	3.99E-001
CD-115	Not Detected	----------	1.14E-001
CE-139	Not Detected	----------	9.25E-002
CE-141	Not Detected	----------	1.72E-001
CE-144	Not Detected	----------	8.34E-001
CM-243	Not Detected	----------	3.95E-001
CO-56	Not Detected	----------	3.38E-002
CO-57	Not Detected	----------	1.14E-001
CO-58	Not Detected	----------	3.45E-002
CO-60	Not Detected	----------	2.74E-002
CR-51	Not Detected	----------	5.04E-001
CS-134	Not Detected	----------	5.09E-002
CS-137	3.73E-002	1.84E-002	2.74E-002
EU-152	Not Detected	----------	3.43E-001
EU-154	Not Detected	----------	2.12E-001
EU-155	Not Detected	----------	5.43E-001
FE-59	Not Detected	----------	6.43E-002
GD-153	Not Detected	----------	3.69E-001
HG-203	Not Detected	----------	7.15E-002
I-131	Not Detected	----------	5.50E-002
IR-192	Not Detected	----------	6.01E-002
K-40	2.02E+000	7.78E-001	1.13E+000
MN-52	Not Detected	----------	2.28E-002
MN-54	Not Detected	----------	3.68E-002
MO-99	Not Detected	----------	2.92E-001
NA-22	Not Detected	----------	3.41E-002
NA-24	Not Detected	----------	2.48E-002
ND-147	Not Detected	----------	2.97E-001
NI-57	Not Detected	----------	3.32E-002
RU-103	Not Detected	----------	4.53E-002
RU-106	Not Detected	----------	3.93E-001
SB-122	Not Detected	----------	5.64E-002
SB-124	Not Detected	----------	4.09E-002
SB-125	Not Detected	----------	1.47E-001
SN-113	Not Detected	----------	7.03E-002
SR-85	Not Detected	----------	4.85E-002
TA-182	Not Detected	----------	1.22E-001
TA-183	Not Detected	----------	4.60E-001
TL-201	Not Detected	----------	3.38E-001
Y-88	Not Detected	----------	1.50E-002
ZN-65	Not Detected	----------	8.33E-002
ZR-95	Not Detected	----------	6.60E-002

```
******************************************************************************
*                    Sandia National Laboratories                            *
*    Radiation Protection Sample Diagnostics Program                         *
*                       09/10/02  8:36:48 AM                                 *
******************************************************************************
*                                                                            *
* Analyzed by:    JPK 9-10-02 Reviewed by:   9/10/02                         *
******************************************************************************
Customer                     : MIGNARDOT E (6134)
Customer Sample ID           : LOCATION #5
Lab Sample ID                : 29002605

Sample Description           : ELEVATED PAD (LOCATION #5)
Sample Quantity              :  1000.000  gram
Sample Date/Time             : 08/30/02   9:30:19 AM
Acquire Start Date/Time      : 08/30/02   9:30:19 AM
Detector Name                : PGE08
Elapsed Live/Real Time       :   3600 /   3634 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.
******************************************************************************
```

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	2.51E+001	5.75E+000	4.60E+000
RA-226	1.01E+001	2.54E+000	3.13E+000
PB-214	Not Detected	---------	1.50E-001
BI-214	Not Detected	---------	1.19E-001
PB-210	Not Detected	---------	9.71E+000
TH-232	Not Detected	---------	4.63E-001
RA-228	Not Detected	---------	2.88E-001
AC-228	Not Detected	---------	1.84E-001
TH-228	Not Detected	---------	1.59E+000
RA-224	Not Detected	---------	1.40E-001
PB-212	Not Detected	---------	1.64E-001
BI-212	Not Detected	---------	6.25E-001
TL-208	Not Detected	---------	1.77E-001
U-235	4.27E-001	7.20E-001	8.13E-001
TH-231	Not Detected	---------	3.72E+001
PA-231	Not Detected	---------	3.39E+000
TH-227	Not Detected	---------	6.17E-001
RA-223	Not Detected	---------	5.92E-001
PB-211	Not Detected	---------	1.58E+000
TL-207	Not Detected	---------	1.47E+001
AM-241	Not Detected	---------	5.87E-001
PU-239	Not Detected	---------	1.51E+003
NP-237	Not Detected	---------	9.40E+000
PA-233	Not Detected	---------	1.31E-001
TH-229	Not Detected	---------	9.41E-001

[Summary Report] - Sample ID: : 29002605

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.55E-002
AG-110m	Not Detected	---------	4.34E-002
BA-133	Not Detected	---------	8.58E-002
BE-7	Not Detected	---------	4.02E-001
CD-115	Not Detected	---------	1.13E-001
CE-139	Not Detected	---------	9.34E-002
CE-141	Not Detected	---------	1.74E-001
CE-144	Not Detected	---------	8.42E-001
CM-243	Not Detected	---------	4.00E-001
CO-56	Not Detected	---------	3.41E-002
CO-57	Not Detected	---------	1.15E-001
CO-58	Not Detected	---------	3.55E-002
CO-60	Not Detected	---------	2.75E-002
CR-51	~~2.32E-001~~	~~2.77E-001~~	4.45E-001 NOT DETECTED JPK 9-10-02
CS-134	Not Detected	---------	5.29E-002
CS-137	8.66E-002	3.95E-002	5.91E-002
EU-152	Not Detected	---------	3.48E-001
EU-154	Not Detected	---------	2.11E-001
EU-155	Not Detected	---------	5.55E-001
FE-59	Not Detected	---------	6.31E-002
GD-153	Not Detected	---------	3.90E-001
HG-203	Not Detected	---------	7.22E-002
I-131	Not Detected	---------	5.56E-002
IR-192	Not Detected	---------	6.07E-002
K-40	1.05E+000	7.26E-001	1.14E+000
MN-52	Not Detected	---------	2.21E-002
MN-54	Not Detected	---------	3.62E-002
MO-99	Not Detected	---------	3.10E-001
NA-22	Not Detected	---------	3.34E-002
NA-24	Not Detected	---------	2.50E-002
ND-147	Not Detected	---------	3.04E-001
NI-57	Not Detected	---------	3.41E-002
RU-103	Not Detected	---------	4.58E-002
RU-106	Not Detected	---------	3.98E-001
SB-122	Not Detected	---------	5.61E-002
SB-124	Not Detected	---------	4.14E-002
SB-125	Not Detected	---------	1.51E-001
SN-113	Not Detected	---------	7.11E-002
SR-85	Not Detected	---------	4.79E-002
TA-182	Not Detected	---------	1.21E-001
TA-183	Not Detected	---------	4.93E-001
TL-201	Not Detected	---------	3.61E-001
Y-88	Not Detected	---------	1.50E-002
ZN-65	Not Detected	---------	8.24E-002
ZR-95	Not Detected	---------	6.83E-002

```
************************************************************************
*                    Sandia National Laboratories                      *
*     Radiation Protection Sample Diagnostics Program                  *
*                      09/10/02  8:21:16 AM                            *
************************************************************************
*                                                                      *
* Analyzed by:  JPK 9-10-02  Reviewed by:  9/10/02                     *
************************************************************************
```

Customer : MIGNARDOT E (6134)
Customer Sample ID : BACKGROUND
Lab Sample ID : B8920830

Sample Description : BACKGROUND
Sample Quantity : 1000.000 gram
Sample Date/Time : 08/30/02 11:25:14 AM
Acquire Start Date/Time : 08/30/02 11:25:14 AM
Detector Name : PGE08
Elapsed Live/Real Time : 3600 / 3635 seconds

Comments:
UNCALIBRATED GEOMETRY. ALL VALUES ESTIMATED.

****

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
U-238	Not Detected	---------	2.38E+000
RA-226	Not Detected	---------	2.19E+000
PB-214	1.05E+000	1.84E-001	1.65E-001
BI-214	1.09E+000	1.85E-001	1.34E-001
PB-210	Not Detected	---------	9.70E+000
TH-232	2.37E+000	1.10E+000	5.34E-001
RA-228	2.19E+000	3.17E-001	1.57E-001
AC-228	2.07E+000	3.40E-001	1.38E-001
TH-228	1.51E+000	5.13E-001	1.28E+000
RA-224	1.99E+000	6.55E-001	2.44E-002
PB-212	2.41E+000	4.02E-001	2.16E-001
BI-212	2.27E+000	5.72E-001	7.00E-001
TL-208	2.00E+000	2.97E-001	1.31E-001
U-235	Not Detected	---------	8.35E-001
TH-231	Not Detected	---------	3.62E+001
PA-231	Not Detected	---------	3.50E+000
TH-227	Not Detected	---------	6.68E-001
RA-223	Not Detected	---------	5.76E-001
PB-211	Not Detected	---------	1.61E+000
TL-207	Not Detected	---------	1.48E+001
AM-241	Not Detected	---------	5.65E-001
PU-239	Not Detected	---------	1.57E+003
NP-237	Not Detected	---------	9.50E+000
PA-233	Not Detected	---------	1.36E-001
TH-229	Not Detected	---------	9.38E-001

[Summary Report] - Sample ID: : B8920830

Nuclide Name	Activity (pCi/gram)	2-sigma Error	MDA (pCi/gram)
AG-108m	Not Detected	---------	4.76E-002
AG-110m	Not Detected	---------	4.32E-002
BA-133	Not Detected	---------	8.84E-002
BE-7	Not Detected	---------	4.09E-001
CD-115	Not Detected	---------	1.20E-001
CE-139	Not Detected	---------	9.58E-002
CE-141	Not Detected	---------	1.79E-001
CE-144	Not Detected	---------	8.68E-001
CM-243	Not Detected	---------	4.13E-001
CO-56	Not Detected	---------	3.37E-002
CO-57	Not Detected	---------	1.19E-001
CO-58	Not Detected	---------	3.60E-002
CO-60	Not Detected	---------	2.76E-002
CR-51	Not Detected	---------	5.22E-001
CS-134	Not Detected	---------	5.39E-002
CS-137	Not Detected	---------	4.54E-002
EU-152	Not Detected	---------	3.58E-001
EU-154	Not Detected	---------	2.21E-001
EU-155	Not Detected	---------	5.65E-001
FE-59	Not Detected	---------	6.30E-002
GD-153	Not Detected	---------	3.82E-001
HG-203	Not Detected	---------	7.44E-002
I-131	Not Detected	---------	5.75E-002
IR-192	Not Detected	---------	6.23E-002
K-40	3.28E+001	4.72E+000	2.51E-001
MN-52	Not Detected	---------	2.30E-002
MN-54	Not Detected	---------	2.11E-002
MO-99	Not Detected	---------	2.99E-001
NA-22	Not Detected	---------	3.39E-002
NA-24	Not Detected	---------	2.53E-002
ND-147	Not Detected	---------	3.05E-001
NI-57	Not Detected	---------	2.90E-002
RU-103	Not Detected	---------	4.59E-002
RU-106	Not Detected	---------	4.00E-001
SB-122	~~2.54E-002~~	~~2.57E-002~~	4.10E-002 NOT DETECTED JPL 4-10-02
SB-124	Not Detected	---------	4.20E-002
SB-125	Not Detected	---------	1.52E-001
SN-113	Not Detected	---------	7.37E-002
SR-85	Not Detected	---------	5.03E-002
TA-182	Not Detected	---------	1.24E-001
TA-183	Not Detected	---------	4.78E-001
TL-201	Not Detected	---------	3.52E-001
Y-88	Not Detected	---------	1.57E-002
ZN-65	Not Detected	---------	8.42E-002
ZR-95	Not Detected	---------	6.86E-002

Annex E

ANNEX E
Risk Assessment

TABLE OF CONTENTS

This page intentionally left blank.

LIST OF TABLES

Table **Page**

LIST OF TABLES (Concluded)

Table **Page**

LIST OF FIGURES

Figure **Page**

SWMU 28-2: RISK ASSESSMENT REPORT

I. Site Description and History

Solid Waste Management Unit (SWMU) 28-2, situated approximately 3,000 feet to the southeast of SWMU 28-1 in the U.S. Forest Service (USFS) Withdrawn Area near the southeast corner of Kirtland Air Force Base, consists of two horizontal adits: a lower and an upper. The portal of the upper adit is located approximately 60 feet above the lower adit. The exterior of the lower adit, determined by the New Mexico Environment Department (NMED) to require remediation, is addressed in this report. Refer to Sandia National Laboratories/New Mexico (SNL/NM) August 1995 (Proposal for No Further Action [NFA] Environmental Restoration [ER] Project Site 28, Mineshafts, Operable Unit 1332, August 1995) and SNL/NM May 1999 (ER Project Supplemental Information and Summary of Requested Actions at SWMU 28) for a complete discussion of the physical features and materials present at SWMU 28-2.

SWMU 28-2 is an abandoned mine where mining activities took place in the early to mid-1900s. This mine is classified as a SWMU because of interviews which indicate that SNL/NM personnel used it for experimental tests and possible disposal activities. In addition, buried depleted uranium was found outside the mine by SNL/NM personnel during gate installation activities.

II. Data Quality Objectives

The Data Quality Objectives (DQOs) presented in the SWMU 28-2 Voluntary Corrective Action (VCA) plan (SNL/NM July 2002) identified the confirmatory sample locations, sample depths, sampling procedures, and analytical requirements. For the risk assessment calculations, all available analytical data including analyses from samples collected from the interior of the mine (Annex A of the SWMU 28-2 VCA Summary Report), were used. The remainder of this section discusses the DQO requirements for the confirmatory samples.

The DQOs outlined the quality assurance (QA)/quality control (QC) requirements necessary for producing defensible analytical data suitable for risk assessment purposes. The confirmatory sampling conducted outside the mine at SWMU 28-2 was designed to:

- Confirm that a remediation action had been conducted during the VCA.
- Characterize the nature and extent of residual constituents of concern (COCs).
- Provide analytical data of sufficient quality to support risk assessments.

Table 1 provides the rationale for designing the sampling pattern. The source of potential COCs at SWMU 28-2 was the material generated from explosives tests inside the mine and site operations activities outside the mine. The VCA activities removed approximately five cubic yards of soil contaminated with depleted uranium.

Table 1
Summary of Sampling Performed at SWMU 28-2 to Meet DQOs

SWMU 28-2 Sampling Areas	Potential COC Source	Number of Sampling Locations	Sample Density (samples/acre)	Sampling Location Rationale
Exterior of Mine	Site operations activities	8	NA	Confirm that no significant levels of COCs remain where DU hot spots were removed.

COC = Constituent of concern.
DQO = Data Quality Objective.
DU = Depleted uranium.
NA = Not applicable.
SWMU = Solid Waste Management Unit.

Following the conclusion of the VCA remediation activities (excavation, depleted uranium–contaminated soil removal, and radiation surveying), a series of confirmatory soil samples were collected (Table 2) at eight locations; these samples were identified as S282-GR-109-0-SS through S282-GR-116-0-SS. All of the samples were surface-soil samples, which were collected from depths of 0 to 0.5 foot below ground surface (bgs) using a hand trowel.

Table 2
Number of Confirmatory Soil Samples Collected During the SWMU 28-2 VCA

Sample Type	Number of Samples	Gamma Spectroscopy	RCRA Metals + Be and Ni	HE
Confirmatory	8	8	8	8
Duplicate	1	1	1	1
Equipment Blank	1	0	1	0
Total Samples	10	9	10	9
Analytical Laboratory	–	RPSD Laboratory	GEL	GEL

Notes: Sample numbers: S282-GR-109-0-SS through S282-GR-116-0-SS.
Sampling date: 9/4/02.
AR/COC forms: 605644, 605645.
AR/COC = Analysis request/chain-of-custody.
GEL = General Engineering Laboratories, Inc.
HE = High explosive(s).
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics.
SWMU = Solid Waste Management Unit.
VCA = Voluntary Corrective Action.
– = Not applicable.

The soil samples were collected according to the sampling procedures detailed in the SWMU 28-2 VCA plan (SNL/NM July 2002).

The SWMU 28-2 confirmatory soil samples were analyzed for all COCs including depleted uranium-related radionuclides (U-235, U-238), Resource Conservation and Recovery Act (RCRA) metals, and high explosive (HE) compounds. The samples were analyzed by General Engineering Laboratories, Inc. (GEL) and the on-site SNL/NM Radiation Protection Sample Diagnostics (RPSD) Laboratory. Table 3 summarizes the analytical methods and data quality requirements from the SWMU 28-2 VCA plan (SNL/NM July 2002).

Table 3
Summary of SWMU 28-2 Data Quality Requirements

Analytical Method[a]	Data Quality Level	GEL	RPSD Laboratory
Gamma Spectroscopy EPA Method 901.1	Defensible	Not analyzed	8 samples[b]
RCRA metals EPA Method 6010/7470/7471	Defensible	8 samples[b]	Not analyzed
HE compounds EPA Method 8330	Defensible	8 samples[b]	Not analyzed

[a]EPA November 1986.
[b]The number of samples does not include QA/QC samples such as duplicates and equipment blanks.
EPA = U.S. Environmental Protection Agency.
GEL = General Engineering Laboratories, Inc.
HE = High explosive(s).
QA = Quality assurance.
QC = Quality control.
RCRA = Resource Conservation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics.
SWMU = Solid Waste Management Unit.

Two QA/QC samples were collected during the confirmatory sampling effort according to the ER Project Quality Assurance Project Plan. The QA/QC samples consisted of one duplicate and one equipment blank. No significant QA/QC problems were identified in the QA/QC samples.

All of the confirmatory soil sample results were verified/validated by SNL/NM. The off-site laboratory results from GEL were reviewed according to SNL/NM ER Project Data Validation Procedure for Chemical and Radiochemical Data, AOP [Analytical Operating Procedure] 00-03, Rev. 0 (SNL/NM January 2000). The data validation reports are presented in the associated SWMU 28-2 VCA summary report. The gamma spectroscopy data from the RPSD Laboratory were reviewed according to “Laboratory Data Review Guidelines,” Procedure No. RPSD-02-11, Issue No. 02. The gamma spectroscopy results are presented in Annex D of the SWMU 28-2 VCA Summary Report. The reviews confirmed that the analytical data are defensible and therefore acceptable for use in the VCA summary report. Therefore, the DQOs have been fulfilled.

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

III.1 Introduction

The determination of the nature, migration rate, and extent of contamination at SWMU 28-2 was based upon an initial conceptual model validated with confirmatory sampling at the site. The initial conceptual model was developed from archival research, soil sampling, aerial photographs, and radiological surveys. The DQOs contained in the SWMU 28-2 VCA plan (SNL/NM July 2002) identified the sample locations, sample density, sample depth, and analytical requirements. The sample data were subsequently used to develop the final conceptual model for SWMU 28-2, which is presented in Section 2.5 of the VCA summary report. The quality of the data used to specifically determine the nature, migration rate, and extent of contamination are described in the following sections.

III.2 Nature of Contamination

The nature of contamination at SWMU 28-2 was evaluated using laboratory analyses of the soil samples (Section IV). The analytical requirements included analyses for depleted uranium-related radionuclides, RCRA metals plus beryllium and nickel, and HE compounds. The analyses characterized potential contaminants remaining after the debris removal operation. The analytes and methods listed in Tables 2 and 3 are appropriate for characterizing the COCs and potential degradation products at SWMU 28-2.

III.3 Rate of Contaminant Migration

SWMU 28-2 is an inactive site that was recently remediated; therefore, all primary sources of COCs have been eliminated. As a result, only secondary sources of COCs potentially remain in the soil in the form of adsorbed COCs (depleted uranium, RCRA metals plus beryllium and nickel, and HE compounds). The rate of COC migration from surficial soil is, therefore, predominantly dependent upon precipitation and occasional surface-water flow as described in Section V. Data available from the nearby Sandia North Groundwater Investigation; numerous SNL/NM monitoring programs for air, water, and radionuclides; various biological surveys; and meteorological monitoring are adequate for characterizing the rate of COC migration at SWMU 28-2.

III.4 Extent of Contamination

Surface confirmatory soil samples were collected from the remediated area using the sampling density presented in Table 1 to assess the effectiveness of the VCA remediation after the following VCA excavation objectives were met:

- No visible depleted uranium pieces or anomalies remained.
- Verification radiological surveys with field instruments indicated that no depleted uranium pieces or soil contaminated with depleted uranium were present at or near the surface.

The confirmatory soil samples were collected from the ground surface. Sampling at a more extensive depth was not a concern at SWMU 28-2 because the two VCA excavation objectives were satisfied. Furthermore, the vertical rate of contamination migration was expected to be extremely low for SWMU 28-2 because of the low precipitation, high evapotranspiration, impermeable vadose zone soil, and relatively low solubility of depleted uranium and metals. Therefore, the confirmatory soil samples are considered to be representative of the soil potentially contaminated with the COCs and sufficient to determine the vertical extent, if any, of COCs.

In summary, the design of the confirmatory sampling was appropriate and adequate to determine the nature and extent of residual COCs in surface soil at SWMU 28-2.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The SWMU 28-2 proposal for NFA (SNL/NM August 1995) and the supplemental information report (SNL/NM May 1999) describe the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across the site. Generally, COCs that were evaluated in this risk assessment included all detected organic and all inorganic and radiological COCs for which samples were analyzed. When the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetected organic compounds not included in this assessment were determined to have detection limits low enough to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997, Garcia November 1998) was selected to provide the background screen listed in Tables 4 and 5.

Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. The nonradiological COCs included in this risk assessment consist of both inorganic and organic compounds.

Table 4 lists the nonradiological COCs and Table 5 lists the radiological COCs for the human health and ecological risk assessments for SWMU 28-2. Both tables show the associated SNL/NM maximum background values (Dinwiddie September 1997, Garcia November 1998). Section VI.4 discusses the results presented in Tables 4 and 5.

V. Fate and Transport

The primary releases of COCs at SWMU 28-2 occurred at the surface and possibly in the shallow subsurface soil as a result of testing and disposal activities. The primary release sources have been removed from outside the mine as part of the VCA remediation. Therefore, only secondary sources (residual COCs in the soil) remain at the site. Wind, water, and biota are natural mechanisms of COC transport from the release points. Because the site is situated within the woodland habitat of the Manzanita Mountains, it is largely protected from strong winds. Therefore, wind is not considered a significant transport mechanism for COCs at this site.

Table 4
Nonradiological COCs for Human Health and Ecological Risk Assessments at SWMU 28-2 with Comparison to the Associated SNL/NM Background Screening Value, BCF, Log K_{ow}, and Subpart S Screening Value

COC	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}	Is COC a Bioaccumulator[b] (BCF>40, Log K_{ow}>4)
Inorganic						
Arsenic	20.5	9.8	**No**	44[c]	NA	**Yes**
Barium	1880	246	**No**	170[d]	NA	**Yes**
Beryllium	1.23	0.75	**No**	19[c]	NA	No
Cadmium	0.477 J	0.64	Yes	64[c]	NA	**Yes**
Chromium, total	22.2	18.8	**No**	16[c]	NA	No
Lead	484	18.9	**No**	49[c]	NA	**Yes**
Mercury	1.02	0.055	**No**	5,500[c]	NA	**Yes**
Nickel	14.2	16.6	Yes	47[c]	NA	**Yes**
Selenium	0.685 B	2.7	Yes	800[e]	NA	**Yes**
Silver	1.78	<0.5	**No**	0.5[c]	NA	No
Organic						
1,3,5-Trinitrobenzene	0.200 JZ	NA	**NA**	23[f]	1.1[f]	No
RDX	0.220 J	NA	**NA**	9[g]	0.87[f]	No

Note: **Bold** indicates COC concentrations that exceed background screening values and/or are bioaccumulators.
[a]Garcia November 1998, Lower Canyons Area.
[b]NMED March 1998.
[c]BCF and/or Log K_{ow} from Yanicak (March 1997).
[d]BCF from Neumann (1976).
[e]BCF from Callahan et al. (1979).
[f]BCF and/or Log K_{ow} from Micromedex (1998)
[g]BCF from Talmage et al. (1996)

B = Analyte present in associated method blank
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.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SNL/NM = Sandia National Laboratories/ New Mexico.
SWMU = Solid Waste Management Unit.
Z = Matrix spike/matrix spike duplicate relative percent differences out of compliance criteria.

Table 5
Radiological COCs for Human Health and Ecological Risk Assessments at SWMU 28-2 with Comparison to the Associated SNL/NM Background Screening Value and BCF

COC	Maximum Activity (pCi/g)	SNL/NM Background Activity (pCi/g)[a]	Is Maximum COC Activity Less Than or Equal to the Applicable SNL/NM Background Screening Value?	BCF (maximum aquatic)	Is COC a Bioaccumulator?[b] (BCF >40)
Th-232	**1.77**	1.03	**No**	900[c]	Yes
U-235	**7.12**	0.16	**No**	3,000[c]	Yes
U-238	**452**	2.31	**No**	3,000[c]	Yes

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.
[a]Garcia November 1998, Lower Canyons Area.
[b]NMED March 1998.
[c]Baker and Soldat 1992.
BCF = Bioconcentration factor.
COC = Constituent of concern.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
SWMU = Solid Waste Management Unit.

Water at SWMU 28-2 is received as precipitation (rain or occasionally snow) that will either evaporate at or near the point of contact, infiltrate into the soil, or form runoff. Infiltration at the site is enhanced by the coarse nature of the soil; however, surface runoff may be produced during intense rainfall events and during extended rainfall periods. The sloping surfaces of the site increase the potential for surface runoff from the site and for erosion of soil by this runoff. The distance of transport will depend upon the size of the particle and the velocity of the water.

The COCs may be leached deeper into the subsurface soil via water that infiltrates the soil surface and percolates through the soil. The depth of percolation of water at this site is expected to be limited by the low annual precipitation (approximately 8 to 10 inches) and high evapotranspiration rates (accounting for approximately 95 percent of the precipitation) (NOAA 1990). In addition, the COCs at the site generally are not prone to rapid movement by leaching. The depth to groundwater at this site is unknown, but is greater than 100 feet bgs based upon depth to groundwater in the Canyon Area. Thus, infiltration and percolation are not expected to be significant mechanisms for migration, and COCs are not expected to reach groundwater at this site.

The COCs in the soil may be taken up by plant roots and transported to the aboveground tissues, which may be consumed by herbivores or returned to the surface soil as litter. Aboveground litter is capable of transport by wind until consumed by decomposer organisms in the soil. COCs in the primary consumers may be transferred to secondary consumers (predators) through ingestion of the primary consumer. COCs in the tissues of the primary and secondary consumers may be transported from the site by the movements of these animals. The potential for transport of the constituents within the food chain is dependent upon both the mobility of the species that comprise the food chain and the potential for the constituent to accumulate in tissues and be transferred across the links in the food chain. Although the habitat at SWMU 28-2 is highly disturbed, natural vegetation occurs on the site. Potential herbivores at the site include rodents (such as mice and ground squirrels) and rabbits. Therefore, food chain uptake is a potential, though minor, transport mechanism at this site.

The COCs identified at SWMU 28-2 include both organic and inorganic analytes, with the latter including radionuclides. Because the inorganic constituents are elemental in form, these are generally not considered to be degradable. Radiological COCs, however, undergo decay to stable isotopes or radioactive daughter elements. Other transformations of inorganic constituents may include changes in valence (oxidation/reduction reactions). The rates of such processes are expected to be slow due to the long half-lives of the radionuclides and the aridity of the environment at this site.

The organic COCs may be degraded through photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water and may occur in the soil solution. Biotransformation (i.e., transformation caused by plants, animals, and microorganisms) may occur; however, biological activity may be limited by the arid environment at this site. Only two organic COCs (1,3,5-trinitrobenzene and hexahydra-1,3,5-trinitro-1,3,5-triazine [RDX]) were identified at this site. Degradation and/or biotransformation of the organic COCs are considered to be insignificant mechanisms of loss.

Table 6 summarizes the fate and transport processes that may occur at SWMU 28-2. Because the site is located in woodland habitat, the soil is sheltered from significant transport by wind. Soil particles from the site may, however, be carried by surface-water runoff. The potential for COCs to leach into the subsurface soil is low due to limited precipitation and high evapotranspiration rates. COCs are not expected to reach groundwater. Some vegetation and small animals inhabit the site; therefore, uptake into the food chain is possible, but is unlikely to be a significant transport mechanism. The potential for significant loss by degradation and/or transformation of the COCs at this site is also low.

Table 6
Summary of Fate and Transport at SWMU 28-2

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

SWMU = Solid Waste Management Unit.

VI. Human Health Risk Assessment

VI.1 Introduction

The human health risk 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 is a screening procedure that 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 carried forward in the risk assessment process.
Step 4.	Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening procedure.
Step 5.	Potential toxicity effects (specified as a hazard index [HI]) and estimated 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 applies only when a radiological COC occurs as contamination and exists as a natural background radionuclide.

Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA), NMED, and the U.S. Department of Energy (DOE) to determine whether further evaluation and potential site cleanup are required. Nonradiological COC risk values also are compared to background risk so that an incremental risk can be calculated.
Step 7.	Uncertainties of the above steps are addressed.

VI.2 Step 1. Site Data

Section I of this risk assessment provides the description and history for SWMU 28-2. Section II presents a comparison of results to DQOs. Section III discusses the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

SWMU 28-2 has been designated with a future land-use scenario of recreational (DOE et al. October 1995) (see Appendix 1 for default exposure pathways and parameters). However, the residential land-use scenario is also considered in the pathway analysis. Because of the location and characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well. The dermal pathway is included for the nonradiological COCs because of the potential for the receptor to be exposed to contaminated soil. No water pathways to the groundwater are considered. Depth to groundwater at SWMU 28-2 is unknown but likely to be greater than 100 feet bgs. No intake routes through plant, meat, or milk ingestion are considered appropriate for either the recreational or residential land-use scenarios. Figure 1 shows the conceptual model flow diagram for SWMU 28-2.

Pathway Identification

Nonradiological Constituents	Radiological Constituents
Soil ingestion	Soil ingestion
Inhalation (dust and volatiles)	Inhalation (dust)
Dermal contact	Direct gamma

VI.4 Step 3. Background Screening Procedure

This section discusses Step 3, the background screening procedure, which compares the maximum COC concentration to the background screening level. The methodology and results are described in the following sections.

VI.4.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM maximum screening levels for this area. The SNL/NM maximum background concentration

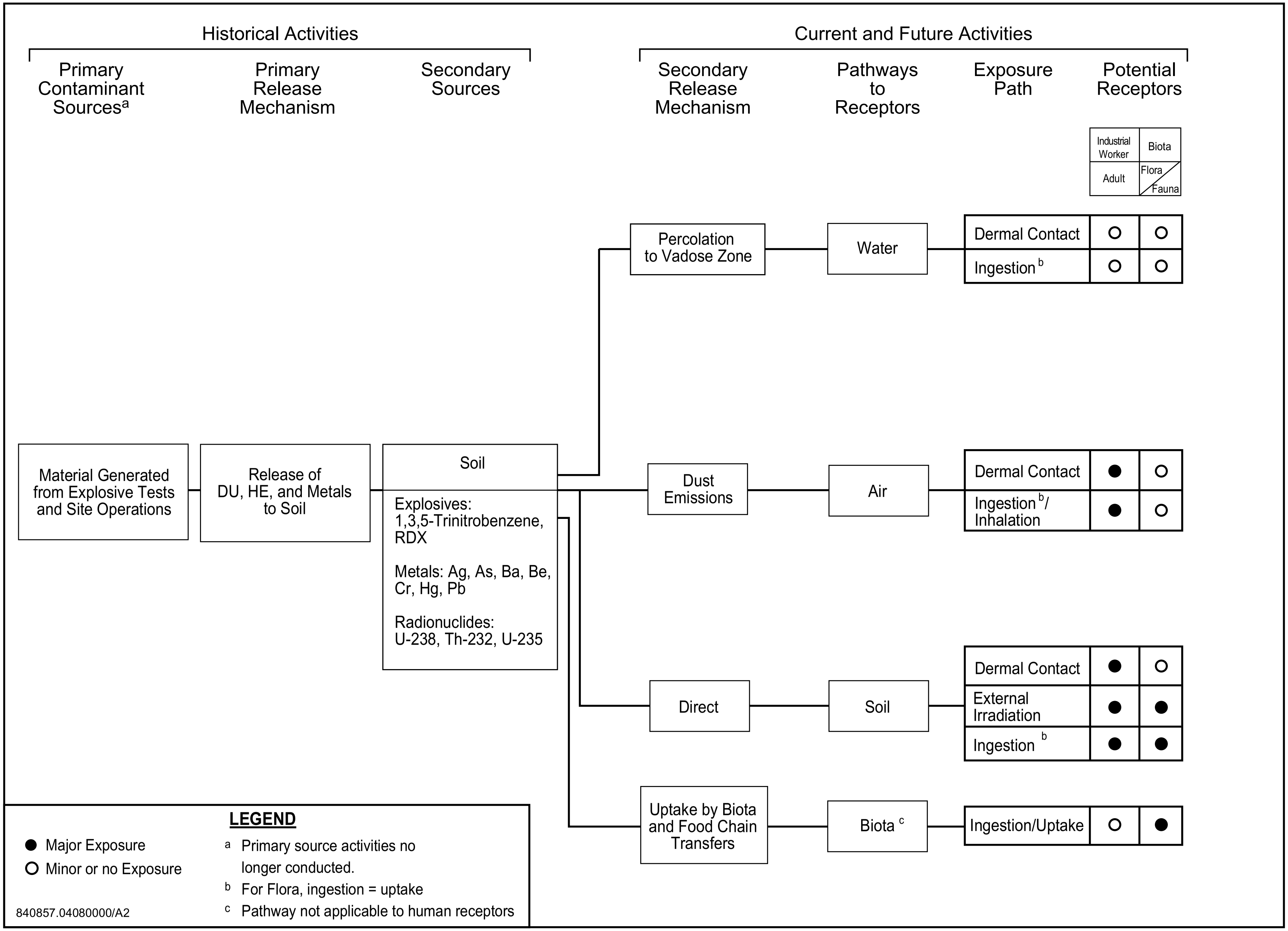


Figure 1

Conceptual Site Model Flow Diagram for SWMU 28-2

was selected to provide the background screen in Table 4 and was used to calculate risk attributable to background in Section VI.6.2. Only the COCs that either were detected above the corresponding SNL/NM maximum background screening levels or did not have either a quantifiable or calculated 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, “Radiation Protection of the Public and the Environment” (DOE 1993). Radiological COCs that do 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.4.2 Results

Tables 4 and 5 present the maximum COC concentrations for SWMU 28-2 that were compared to the SNL/NM maximum background values (Dinwiddie September 1997, Garcia November 1998) for the human health risk assessment. For the nonradiological COCs, seven constituent concentrations exceeded the corresponding background screening levels. Two constituents were organic compounds that do not have background screening values.

The maximum concentration value for lead is 484 milligrams (mg)/kilogram (kg). The EPA intentionally does not provide human health toxicological data on lead; therefore, no risk parameter values could be calculated. However, the NMED guidance for lead screening concentrations for construction and industrial land-use scenarios are 750 and 1,500 mg/kg, respectively (Olson and Moats March 2000). The EPA screening guidance value for a residential land-use scenario is 400 mg/kg (Laws July 1994). The maximum lead concentration is greater than the residential screening value. However, because the site has been adequately characterized, the 95% upper confidence limit (UCL) of the mean is more representative of actual site conditions. For this site, the 95% UCL of the mean lead concentration, which is 259.6 mg/kg (Appendix 2), is lower than all the screening values; therefore, lead is eliminated from further consideration in the human health risk assessment.

For the radiological COCs, three constituents (Th-232, U-235 and U-238) exhibited detectable activities greater than the corresponding background levels. These values were noted in individual samples found after the site was remediated. However, for the sake of conservatism in this assessment, these values were modeled as if the entire site were contaminated at this level.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 7 and 8 list the nonradiological and radiological COCs retained in the risk assessment as well as the available toxicological information. The toxicological parameters used in Table 7 were obtained from the Integrated Risk Information System (IRIS) (EPA 2003), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), and the EPA

Table 7
Toxicological Parameter Values for SWMU 28-2 Nonradiological COCs

COC	RfD_o (mg/kg-d)	Confidence[a]	RfD_{inh} (mg/kg-d)	Confidence[a]	SF_o $(mg/kg\text{-}d)^{-1}$	SF_{inh} $(mg/kg\text{-}d)^{-1}$	Cancer Class[b]	ABS
Inorganic								
Arsenic	3E-4[c]	M	–	–	1.5E+0[c]	1.5E+1[c]	A	0.03[d]
Barium	7E-2[c]	M	1.4E-4[e]	–	–	–	D	0.01[d]
Beryllium	2E-3[c]	L to M	5.7E-6[c]	M	–	8.4E+0[c]	B1	0.01[d]
Chromium III	1.5E+0[c]	L	–	–	–	–	D	0.01[d]
Chromium VI	3E-3[c]	L	2.3E-6[c]	L	–	4.2E+1[c]	A	0.01[d]
Mercury	3E-4[e]	–	8.6E-5[c]	M	–	–	D	0.01[d]
Silver	5E-3[c]	L	–	–	–	–	D	0.01[d]
Organic								
1,3,5-Trinitrobenzene	3E-2[c]	M	3E-2[f]	–	–	–	–	0.01[g]
RDX	3E-3[c]	H	3E-3[f]	–	1.1E-1[c]	1.1E-1[f]	C	0.1[d]

[a]Confidence associated with IRIS (EPA 2003) database values. Confidence: L = low, M = medium, H = high.
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 2003):

- A = Human carcinogen.
- B1 = Probable human carcinogen. Limited human data are available.
- C = Possible human carcinogen.
- D = Not classifiable as to human carcinogenicity.

[c]Toxicological parameter values from IRIS electronic database (EPA 2003).
[d]Toxicological parameter values from NMED December 2000.
[e]Toxicological parameter values from HEAST (EPA 1997a).
[f]Toxicological parameter values from EPA Region 6 (EPA 2002a).
[g]Toxicological parameter values from Risk Assessment Information System (ORNL 2003).

ABS = Gastrointestinal absorption coefficient.
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.
$(mg/kg\text{-}d)^{-1}$ = Per milligram per kilogram day.
ORNL = Oak Ridge National Laboratory.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
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 8
Radiological Toxicological Parameter Values for SWMU 28-2 COCs Obtained from RESRAD Risk Coefficients[a]

COC	SF_o (1/pCi)	SF_{inh} (1/pCi)	SF_{ev} (g/pCi-yr)	Cancer Class[b]
Th-232	3.3E-11	1.9E-08	2.0E-11	A
U-235	4.70E-11	1.30E-08	2.70E-07	A
U-238	6.20E-11	1.2E-08	6.6E-08	A

[a]Yu et al. 1993a.
[b]EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = Human carcinogen for high dose and high dose rate (i.e., greater than 50 rem per year). For low-level environmental exposures, the carcinogenic effect has not been observed and documented.
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.

Region 6 (EPA 2002a) and the Risk Assessment Information System (ORNL 2003) electronic databases. Dose conversion factors (DCFs) used in determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

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

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

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

VI.6 Step 5. Exposure Assessment and Risk Characterization

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

VI.6.1 Exposure Assessment

Appendix 1 provides the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both recreational and residential land-use scenarios. The equations for nonradiological COCs are based upon the Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), as well as other EPA and NMED guidance documents, and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989).

Although the designated land-use scenario is recreational for this site, risk and TEDE values for a residential land-use scenario are also presented.

VI.6.2 Risk Characterization

Table 9 shows an HI of 0.03 for the SWMU 28-2 nonradiological COCs and an estimated excess cancer risk of 1E-6 for the designated recreational land-use scenario. The numbers presented include exposure from soil ingestion, dermal contact, and dust and volatile inhalation for nonradiological COCs. For nonradiological background constituents, Table 10 shows an HI of 0.01 and an estimated excess cancer risk of 6E-7 for the designated recreational land-use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the recreational land-use scenario, a TEDE was calculated that resulted in an incremental TEDE of 1.8 millirem (mrem)/year (yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land-use scenario (recreational in this case); the calculated dose value for SWMU 28-2 for the recreational land use is well below this guideline. The estimated excess cancer risk is 2.3E-5.

For the residential land-use scenario nonradiological COCs, the HI is 1.46 with an estimated excess cancer risk of 5E-5 (Table 9). The numbers in the table include exposure from soil ingestion, dermal contact, and dust and volatile inhalation. Although the EPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 10 shows that for the SWMU 28-2 associated background constituents, the HI is 0.50 and the estimated excess cancer risk is 3E-5.

For the radiological COCs, the incremental TEDE for the residential land-use scenario is 3.2E+1 mrem/yr. The guideline being used is a 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 28-2 for the residential land-use scenario is well below this guideline. Consequently, SWMU 28-2 is eligible for unrestricted radiological release as the residential land-use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is 2.2E-4. The excess cancer risk from the

Table 9
Risk Assessment Values for SWMU 28-2 Nonradiological COCs

COC	Maximum Concentration (mg/kg)	Recreational Land-Use Scenario[a]		Residential Land-Use Scenario[a]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Inorganic					
Arsenic	20.5	0.02	1E-6	0.95	5E-5
Barium	1880	0.01	–	0.36	–
Beryllium	1.23	0.00	4E-11	0.01	1E-9
Chromium, total[b]	22.2	0.00	4E-9	0.10	1E-7
Mercury	1.02	0.00	–	0.04	–
Silver	1.78	0.00	–	0.00	–
Organic					
1,3,5-Trinitrobenzene	0.2 Z	0.00	–	0.00	–
RDX	0.22 J	0.00	1E-9	0.00	5E-8
Total		**0.03**	**1E-6**	**1.46**	**5E-5**

[a]EPA 1989.
[b]Chromium, total is considered to be chromium VI in risk calculations (most conservative).

COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
J = Concentration is an estimate.
mg/kg = Milligram(s) per kilogram.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.
Z = Matrix spike/matrix spike duplicate relative percent differences out of compliance criteria.
– = Information not available.

Table 10
Risk Assessment Values for SWMU 28-2 Nonradiological Background Constituents

COC	Background Concentration[a] (mg/kg)	Recreational Land-Use Scenario[b]		Residential Land-Use Scenario[b]	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Inorganic					
Arsenic	9.8	0.01	6E-7	0.45	3E-5
Barium	246	0.00	–	0.05	–
Beryllium	0.75	0.00	3E-11	0.00	7E-10
Chromium, total[c]	18.8	0.00	–	0.00	–
Mercury	0.055	0.00	–	0.00	–
Silver	<0.5	–	–	–	–
Total		**0.01**	**6E-7**	**0.50**	**3E-5**

[a]Garcia November 1998, Lower Canyons Area.
[b]EPA 1989.
[c]Chromium, total is considered to be chromium III in risk calculations (most conservative)
COC = Constituent of concern.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
SWMU = Solid Waste Management Unit.
– = Information not available.

nonradiological and radiological COCs should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants, as noted in OSWER Directive No. 9200.4-18 "Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination," (EPA 1997b). This summation is tabulated in Section VI.9, Summary.

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 the recreational land-use scenario (the designated land-use scenario for this site) and the residential land-use scenario.

For the nonradiological COCs under the recreational land-use scenario, the HI is 0.03 (less than the numerical guideline of 1 suggested in the RAGS [EPA 1989]). The estimated excess cancer risk is 1E-6. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is below the suggested acceptable risk value. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the recreational and the residential land-use scenarios. Assuming the recreational land-use scenario, for nonradiological COCs the HI is 0.01 and the estimated excess cancer risk is 6E-7. The 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, the background constituents that do not have quantifiable background screening values are assumed to have a hazard quotient (HQ) of 0.00. The incremental HI is 0.02 and the incremental estimated excess cancer risk is 4.05E-7 for the recreational land-use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering a recreational land-use scenario.

For the radiological COCs under the recreational land-use scenario, the incremental TEDE is 1.8 mrem/yr, which is significantly less than EPA's numerical guideline of 15 mrem/yr. The incremental estimated excess cancer risk is 2.3E-5.

The calculated HI for the residential land-use scenario nonradiological COCs is 1.46, which is above the numerical guidance. The estimated excess cancer risk is 5E-5. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is above the suggested acceptable risk value. For background concentrations of the nonradiological COCs, the HI is 0.50 and the estimated excess cancer risk is 3E-5. The incremental HI is 0.96 and the incremental estimated cancer risk is 2.02E-5 for the residential land-use scenario. The incremental estimated excess cancer risk to human health from nonradiological COCs is above NMED guidelines considering a residential land-use scenario.

The incremental TEDE for a residential land-use scenario from the radiological components is 3.2E-1 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 2.2E-4.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at SWMU 28-2 was based upon an initial conceptual model that was validated with confirmatory sampling conducted across the site. The confirmatory sampling was implemented in accordance with the SWMU 28-2 VCA plan (SNL/NM July 2002). The DQOs contained in the VCA plan and the Field Implementation Plan (Annex B) are appropriate for use in risk assessments. The data collected, based upon sample location, density, and depth, are representative of the site. The analytical requirements and results satisfy the DQOs. Data quality was verified/validated in accordance with SNL/NM procedures (SNL/NM January 2000, SNL/NM July 1996). Therefore, there is limited uncertainty associated with the data quality used to perform the risk assessment at SWMU 28-2.

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

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

Table 7 shows the uncertainties (confidence level) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 2003), HEAST (EPA 1997a), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), and the EPA Region 6 (EPA 2002a) and the Risk Assessment Information System (ORNL 2003) electronic databases. Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 2003), Technical Background Document for Development of Soil Screening Levels (NMED December 2000), the Risk Assessment Information System (ORNL 2003) or the EPA regions (EPA 2002a, 2002b, 2002c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

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

Although both the HI and estimated excess cancer risk are above the NMED guideline for the residential land-use scenario, maximum concentrations were used in the risk calculation. Because the site has been adequately characterized, average concentrations are more representative of actual site conditions. Using the 95% UCL of the mean concentration for arsenic, the main contributor to excess cancer risk (10.3 mg/kg) (Appendix 2), the incremental HI and excess cancer risk are reduced to 0.49 and 1.50E-7, respectively. Thus, using realistic concentrations in the risk calculations that more accurately depict actual site conditions reduces the incremental HI and estimated excess cancer risks to values below NMED guidelines.

The summation of the nonradiological and radiological carcinogenic risks are tabulated in Table 11.

Table 11
Summation of the Radiological and Nonradiological Risks from Site Carcinogens

Scenario	Nonradiological Risk	Radiological Risk	Total Risk
Recreational	4.05E-7	2.3E-5	2.3E-5
Residential	1.50E-7	2.2E-4	2.2E-4

Uncertainties associated with the calculations are considered small relative to the conservatism of the risk assessment analysis. Therefore, it is concluded that this site poses insignificant risk to human health under both the recreational and residential land-use scenarios.

VII. Ecological Risk Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPECs) in the soil at SWMU 28-2. A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological assessment that corresponds with that presented in EPA's Ecological RAGS (EPA 1997c). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed risk assessment. Initial components of NMED's decision tree (a discussion of DQOs, data assessment, and evaluations of bioaccumulation as well as fate and transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a risk assessment whereby a more quantitative estimation of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment also are used as recommended by the EPA (1998) 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 constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk-management decision (Section VII.2.4) involves summarizing the scoping results and determining whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 4 and 5), inorganic constituents in soil within the 0- to 5-foot depth interval that exceeded background concentrations were as follows:

- Arsenic
- Barium
- Beryllium
- Chromium (total)
- Lead
- Mercury
- Silver
- Th-232
- U-235
- U-238

Organic analytes detected in the soil were as follows:

- 1,3,5-Trinitrobenzene
- RDX

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 4 and 5):

- Arsenic
- Barium
- Lead
- Mercury
- Selenium
- Th-232
- U-235
- U-238

It should be noted, however, that as directed by the NMED (March 1998), bioaccumulation for inorganic constituents is assessed exclusively based upon maximum reported bioconcentration factors (BCFs) 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 migrate from the source of contamination to other media or biota is discussed in Section V. As noted in Table 6 (Section V), wind is expected to be of low significance as a transport mechanism for COPECs at this site, and surface-water runoff is potentially of moderate significance. Migration to groundwater is not anticipated. Food chain uptake is expected to be of low significance. Degradation (decay) and transformation of the COPECs are also expected to be of low significance.

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 exist at the site. As a consequence, a risk assessment was deemed necessary to predict the potential level of ecological risk associated with the site.

VII.3 Risk Assessment

As concluded in Section VII.2.4, both complete ecological pathways and COPECs are associated with SWMU 28-2. The risk assessment performed for the site involves a quantitative estimation of current ecological risks using exposure models in association with exposure parameters and toxicity information obtained from the literature. The estimation of potential ecological risks is conservative to ensure that ecological risks are not underpredicted.

Components within the risk assessment include the following:

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure Estimation—provides a quantitative estimate of potential exposure.
- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk Interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Risk Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the ecological risk assessment.

VII.3.1 Problem Formulation

Problem formulation is the initial stage of the ecological risk 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 risk assessment) are presented in the "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico" (IT July 1998) and are not duplicated here.

VII.3.1.1 Ecological Pathways and Setting

SWMU 28-2 is less than 1 acre in size. The site is located in an area dominated by pinon-juniper woodland habitat. Although the mining activities at the site disturbed much of the original habitat, and the VCA remediation caused further disturbance, ruderal and early successional vegetation occurs at the site and it is open to use by wildlife. No threatened or endangered species are known to occur at SWMU 28-2 (IT February 1995) and no surface-water bodies, seeps, or springs are associated with the site.

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

VII.3.1.2 COPECs

Testing and disposal activities were the primary sources of COPECs at SWMU 28-2. Inorganic and organic COPECs identified for this site are listed in Section VII.2.1. The inorganic COPECs include both radiological and nonradiological analytes. The inorganic analytes were screened against background concentrations and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997, Garcia November 1998) for the area were considered to be COPECs. Nonradiological inorganic constituents 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). All organic analytes detected within the upper 5 feet of soil were considered to be COPECs for the site. In order to provide conservatism, this ecological risk assessment was based upon the maximum soil concentrations of the COPECs measured in the upper 5 feet of soil at this site. Tables 4 and 5 present the maximum concentrations for the COPECs.

VII.3.1.3 Ecological Receptors

A nonspecific perennial plant was selected as the receptor to represent plant species at the site (IT July 1998). Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with the site. The deer mouse (*Peromyscus maniculatus*) and the burrowing owl (*Speotyto cunicularia*) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was used to represent a top predator at this site. The burrowing owl is present at SNL/NM; however, based upon habitat conditions, other small owls, such as the western screech owl (*Otus kennicottii*), may be more likely to occur at this site. The burrowing owl 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 from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 12 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

Although home range is also included in this table, exposures for this risk assessment were modeled using an area use factor of 1.0, implying that all food and ingested soil come from the site. The maximum COPEC concentrations measured in surface soil samples were used to conservatively estimate potential exposures and risks to plants and wildlife at this site.

For the radiological dose-rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Receptors are exposed to radiation both internally and externally from Th-232, U-235, and U-238. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from DOE (1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (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-

Table 12
Exposure Factors for Ecological Receptors at SWMU 28-2

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

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

emitting radionuclides transfer only a fraction of their energy to the tissues because gamma rays interact less with matter than do beta or alpha emitters. The external and internal dose-rate results are summed to calculate a total dose rate from exposure to Th-232, U-235, and U-238 in soil.

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

VII.3.3 Ecological Effects Evaluation

Table 15 shows benchmark toxicity values for the plant and wildlife receptors. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Sufficient toxicity information was not available to estimate the LOAELs or NOAELs for some COPECs.

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 protect other groups within the terrestrial habitat of SWMU 28-2.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 16 presents the results of these comparisons. The HQs are used to quantify the comparison with benchmarks for plant and wildlife exposure.

For plants, the HQs for arsenic, barium, total chromium, lead, and mercury exceeded unity. For the deer mouse, HQs exceeded unity for all three dietary regimes for arsenic, barium, and mercury, when the mercury was assumed to be entirely in organic form. For the burrowing owl, the only HQ that exceeded unity was for mercury when it was assumed to be entirely in organic form. Because of a lack of sufficient toxicity information, an HQ for plants could not be determined for 1,3,5-trinitrobenzene. Similarly for the burrowing owl, HQs could not be determined for beryllium, silver, and both of the organic COPECs. 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). All receptors had total HIs greater than unity, with a maximum HI of 56 for the insectivorous deer mouse.

Tables 17 and 18 summarize the internal and external dose-rate model results for Th-232, U-235, and U-238 for the deer mouse and burrowing owl, respectively. The total radiation dose rate to the deer mouse was predicted to be 7.4E-2 rad/day and that for the burrowing owl was 7.1E-2 rad/day. The dose rates for the deer mouse and the burrowing owl are less than the benchmark of 0.1 rad/day.

Table 13
Transfer Factors Used in Exposure Models for COPECs at SWMU 28-2

COPEC	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Inorganic			
Arsenic	4.0E-2[a]	1.0E+0[b]	2.0E-3[a]
Barium	1.5E-1[a]	1.0E+0[b]	2.0E-4[c]
Beryllium	1.0E-2[a]	1.0E+0[b]	1.0E-3[a]
Chromium (total)	4.0E-2[c]	1.3E-1[d]	3.0E-2[c]
Lead	9.0E-2[c]	4.0E-2[e]	8.0E-4[c]
Mercury	1.0E+0[c]	1.0E+0[b]	2.5E-1[a]
Silver	1.0E+0[c]	2.5E-1[e]	5.0E-3[c]
Organic[f]			
1,3,5-Trinitrobenzene	9.0E+0	1.5E+1	2.5E-7
RDX	1.2E+1	1.5E+1	1.5E-7

[a]Baes et al. 1984.
[b]Default value.
[c]NCRP January 1989.
[d]Ma 1982.
[e]Stafford et al. 1991.
[f]Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988). Soil-to-invertebrate transfer factors from equations developed in Connell and Markwell (1990). All three equations based upon relationship of the transfer factor to the Log K_{ow} value of compound.

COPEC = Constituent of potential ecological concern.
K_{ow} = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council on Radiation Protection and Measurements.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.

Table 14
Media Concentrations[a] for COPECs at SWMU 28-2

COPEC	Soil (maximum)[a]	Plant Foliage[b]	Soil Invertebrate[b]	Deer Mouse Tissues[c]
Inorganic				
Arsenic	2.1E+1	8.2E-1	2.1E+1	6.9E-2
Barium	1.9E+3	2.8E+2	1.9E+3	7.0E-1
Beryllium	1.2E+0	1.2E-2	1.2E+0	2.0E-3
Chromium (total)	2.2E+1	8.9E-1	2.9E+0	2.2E-1
Lead	4.8E+2	4.4E+1	1.9E+1	1.0E-1
Mercury	1.0E+0	1.0E+0	1.0E+0	8.1E-1
Silver	1.8E+0	1.8E+0	4.5E-1	1.8E-2
Organic				
1,3,5-Trinitrobenzene	2.0E-1	1.8E+0	3.0E+0	1.9E-6
RDX	2.2E-1[d]	2.7E+0	3.2E+0	1.3E-6

[a]In milligrams per kilogram. All biotic media are based upon dry weight of the media. Soil concentration measurements are assumed to have been based upon dry weight. Values have been rounded to two significant digits after calculation.
[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 ingested in food and soil times the food-to-muscle transfer factor times a wet weight-dry weight conversion factor of 3.125 (EPA 1993).
[d]Estimated value.
COPEC = Constituent of potential ecological concern.
EPA = U.S. Environmental Protection Agency.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.

Table 15
Toxicity Benchmarks for Ecological Receptors at SWMU 28-2

COPEC	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]
Inorganic							
Arsenic	10	mouse	0.126	0.133	mallard	5.14	5.14
Barium	500	rat[h]	5.1	10.5	chicken	20.8	20.8
Beryllium	10	rat	0.66	1.29	–	–	–
Chromium (total)	1	rat	2,737	5,354	black duck	1.0	1.0
Lead	50	rat	8.0	15.7	American kestrel	3.85	3.85
Mercury (organic)	0.3	rat	0.03	0.06	mallard	0.0064	0.0064
Mercury (inorganic)	0.3	mouse	13.2	14.0	Japanese quail	0.45	0.45
Silver	2	rat	17.8[i]	34.8	–	–	–
Organic							
1,3,5-Trinitrobenzene	–	white-footed mouse	6.74	6.32	–	–	–
RDX	100	mouse[j]	7	7.76	–	–	–

[a]In milligrams per kilogram soil dry weight.
[b]Efroymson et al. 1997.
[c]Body weights (in kilograms) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350; white-footed mouse, 0.0185 (except where noted).
[d]Sample et al. 1996, except where noted.
[e]In milligrams 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: 0.435 kilogram.
[i]Based upon a rat LOAEL of 89 mg/kg/d (EPA 2003) and an uncertainty factor of 0.2.
[j]Body weight: 0.36 kilogram.

COPEC = Constituent of potential ecological concern.
LOAEL = Lowest-observed-adverse-effect level.
mg/kg/d = Milligram(s) per kilogram per day.
NOAEL = No-observed-adverse-effect level.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data.

Table 16
HQs for Ecological Receptors at SWMU 28-2

COPEC	Plant HQ[a]	Deer Mouse HQ (Herbivorous)[a]	Deer Mouse HQ (Omnivorous)[a]	Deer Mouse HQ (Insectivorous)[a]	Burrowing Owl HQ[a]
Inorganic					
Arsenic	**2.1E+0**	**1.4E+0**	**1.3E+1**	**2.4E+1**	1.0E-2
Barium	**3.8E+0**	**4.7E+0**	**1.7E+1**	**2.8E+1**	2.1E-1
Beryllium	1.2E-1	4.4E-3	7.8E-2	1.5E-1	–
Chromium (total)	**2.2E+1**	3.9E-5	6.8E-5	9.7E-5	7.4E-2
Lead	**9.7E+0**	5.3E-1	4.1E-1	2.9E-1	2.8E-1
Mercury (organic)	**3.4E+0**	**2.6E+0**	**2.6E+0**	**2.6E+0**	**1.5E+1**
Mercury (inorganic)	**3.4E+0**	1.2E-2	1.2E-2	1.2E-2	2.1E-1
Silver	8.9E-1	8.1E-3	5.1E-3	2.1E-3	–
Organic					
1,3,5-Trinitrobenzene	–	4.4E-2	5.9E-2	7.4E-2	–
RDX	2.2E-3	5.4E-2	5.9E-2	6.4E-2	–
HI[b]	**4.3E+1**	**9.5E+0**	**3.3E+1**	**5.6E+1**	**1.5E+1**

[a]**Bold** text indicates the HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs.
COPEC = Constituent of potential ecological concern.
HI = Hazard index.
HQ = Hazard quotient.
RDX = Hexahydra-1,3,5-trinitro-1,3,5-triazine.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data available for risk estimation purposes.

Table 17
Total Dose Rates for Deer Mice
Exposed to Radionuclides at SWMU 28-2

Radionuclide	Maximum Concentration (pCi/g)	Total Dose (rad/day)
Th-232	1.77	3.4E-4
U-235	7.12	1.9E-4
U-238	452	7.3E-2
Total Dose		7.4E-2

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

Table 18
Total Dose Rates for Burrowing Owls
Exposed to Radionuclides at SWMU 28-2

Radionuclide	Maximum Concentration (pCi/g)	Total Dose (rad/day)
Th-232	1.77	3.4E-4
U-235	7.12	1.5E-4
U-238	452	7.1E-2
Total Dose		7.1E-2

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

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at SWMU 28-2. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate true risk presented at the site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than to underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of maximum analyte concentrations measured in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, and the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HQ values for the deer mouse. Each of these uncertainties, which are consistent among each of the SWMU-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Program (IT July 1998).

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

The assumption of an area use factor of 1.0 is a source of uncertainty for the burrowing owl at this site. Because SWMU 28-2 is less than 1 acre in size and the home range of the burrowing owl is 35 acres, an area use factor of 0.03 would be justified for this receptor. The use of this factor reduces the burrowing owl HQ for organic mercury from 15 to 0.45. Therefore, the application of a more realistic area use factor results in no HQs exceeding unity for this receptor.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Conservatisms in the modeling of exposure and risk can result in the prediction of risk to ecological receptors when exposed at background concentrations. As shown in Table 19, HQs associated with exposures to background are greater than 1 for arsenic, barium, and total chromium. The background concentrations of arsenic and barium resulted in HQs greater than 1 for both the omnivorous and insectivorous deer mice, and the background concentration of total chromium resulted in an HQ greater than unity for plants. These results indicate that, at least for these HQs for these COPEC/receptor pairs, the predicted risk significantly overestimates actual risk at this site.

For total chromium, background may account for 85 percent of the maximum HQ for the site. It should be noted that the plant toxicity benchmark for this metal is based upon chromium VI (Efroymson et al. 1997), which may be more toxic to plants than the more common chromium III. The majority of the total chromium measured at SWMU 28-2 is expected to be chromium III. For this reason, it is uncertain whether the calculated HQ for total chromium accurately predicts the potential risk to plants. Further, this benchmark is conservatively based upon laboratory tests using soil amendments with a highly available form of chromium ($K_2Cr_2O_7$) (Efroymson et al. 1997). It is likely that only a small fraction of the chromium in the soil at SWMU 28-2 is in a form that is highly available for plant uptake; therefore, the plant toxicity benchmark for this metal probably overestimates risk to plants to a significant degree.

Table 19
HQs for Ecological Receptors Exposed to Background Concentrations at SWMU 28-2

COPEC	Plant HQ[a]	Deer Mouse HQ (Herbivorous)[a]	Deer Mouse HQ (Omnivorous)[a]	Deer Mouse HQ (Insectivorous)[a]	Burrowing Owl HQ[a]
Inorganic					
Arsenic	9.8E-1	6.9E-1	**6.2E+0**	**1.2E+1**	5.0E-3
Barium	4.9E-1	6.2E-1	**2.2E+0**	**3.7E+0**	2.7E-2
Beryllium	7.5E-2	2.7E-3	4.7E-2	9.2E-2	–
Chromium (total)	**1.9E+1**	3.3E-5	5.7E-5	8.2E-5	6.3E-2
Lead	3.8E-1	2.1E-2	1.6E-2	1.1E-2	1.1E-2
Mercury (organic)	1.8E-1	1.4E-1	1.4E-1	1.4E-1	7.8E-1
Silver	1.3E-1	1.1E-3	7.2E-4	3.0E-4	–
HI[b]	**2.1E+1**	**1.5E+0**	**8.5E+0**	**1.6E+1**	8.9E-1

[a]**Bold** text indicates the HQ or HI exceeds unity.
[b]The HI is the sum of individual HQs.
COPEC = Constituent of potential ecological concern.
HI = Hazard index.
HQ = Hazard quotient.
SWMU = Solid Waste Management Unit.
– = Insufficient toxicity data available for risk estimation purposes.

A further source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations to evaluate exposure and risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions. For example, the 95% UCL of the mean soil concentrations for total chromium is 14.0 mg/kg, which is less than the background screening value for this constituent (18.8 mg/kg). Therefore, risk from total chromium is expected to be within the range of background risk. Similarly, the 95% UCL for arsenic (10.3 mg/kg) is only slightly higher than the background screening value for this element (9.8 mg/kg). The HQs based upon the 95% UCL for arsenic are less than or essentially equal to 1 for plants and the herbivorous deer mouse. The HQs for the omnivorous and insectivorous deer mice (based upon the 95% UCL) are 6.5 and 12, respectively, which are very close to the background levels shown in Table 19.

The 95% UCLs for barium, lead, and mercury (692, 260, and 0.40 mg/kg, respectively) also result in lower HQs when used as the exposure point concentration. In the case of mercury, the HQs based upon organic mercury are reduced to 1.0 for all three deer mice, and the plant HQ is reduced to 1.3. For lead, the HQ for plants is reduced to 5.2. For barium, the HQs for the herbivorous, omnivorous, and insectivorous deer mice are reduced to 1.7, 6.1, and 10, respectively, and the HQ for plants is reduced to 1.4. The low magnitude of these HQs (less than or equal to 10) indicates a low potential for ecological risk associated with this site. This is especially true when the small size of the site and the disturbed nature of the habitat at the site are considered.

Based upon this uncertainty analysis, the potential for ecological risks at SWMU 28-2 is expected to be low. HQs as high as 28 were initially predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to conservative toxicity benchmarks, the use of maximum concentrations, maximum bioavailability, and maximum area use factors to estimate exposure, and the contribution of background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with SWMU 28-2 were estimated through a risk assessment that incorporated available site-specific information. Initial predictions of potential risk to plants, deer mice, and the burrowing owl from exposure to arsenic, barium, total chromium, lead, and mercury were based upon highly conservative exposure assumptions and toxicity benchmarks. Actual risks to these receptors are expected to be within the range of background risk for arsenic and total chromium. Potential risks from exposures to barium, lead, and mercury are expected to be low when conservative assumptions, such as 100-percent area use factor (for the burrowing owl), 100-percent bioavailability, and the use of maximum detected values to estimate exposure are taken into account when evaluating the HQs. Further, the small size of SWMU 28-2 and the disturbed nature of the habitat at this site limit the potential for exposure for ecological receptors. Finally, it should be noted that the relatively high levels of these metals (arsenic, barium, chromium, lead, and mercury) are associated with the ore and other rock material taken from the mine. As such, their bioavailability in the soil is expected to be low.

VII.3.7 Risk Assessment Scientific/Management Decision Point

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

VIII. References

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

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

Bearzi, J.P. (New Mexico Environment Department), January 2001. Memorandum to RCRA-Regulated Facilities, “Risk-Based Screening Levels for RCRA Corrective Action Sites in New Mexico,” Hazardous Waste Bureau, New Mexico Environment Department, Santa Fe, New Mexico. January 23, 2001.

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

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

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

DOE, see U.S. Department of Energy.

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

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

EPA, see U.S. Environmental Protection Agency.

Garcia, B.J. (New Mexico Environment Department). Letter to M. Zamorski (U.S. Department of Energy, Kirtland Air Force Base) and J.B. Woodard (Sandia National Laboratories/New Mexico) regarding SNL/NM background study approval. November 25, 1998.

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

IAEA, see International Atomic Energy Agency.

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

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

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

IT, see IT Corporation.

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

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

Ma, W.C., 1982. "The Influence of Soil Properties and Worm-Related Factors on the Concentration of Heavy Metals in Earthworms," *Pedobiologia*, Vol. 24, pp. 109-119.

Micromedex, Inc., 1998. "Registry of Toxic Effects of Chemical Substances (RTECS)," Hazardous Substances Databank.

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

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

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

National Oceanic and Atmospheric Administration (NOAA), 1990. Local Climatological Data, Annual Summary with Comparative Data, Albuquerque, New Mexico.

NCRP, see National Council on Radiation Protection and Measurements.

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

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

New Mexico Environment Department (NMED), December 2000. Technical Background Document for Development of Soil Screening Levels,” Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, New Mexico Environment Department, Santa Fe, New Mexico.

NMED, see New Mexico Environment Department.

NOAA, see National Oceanographic and Atmospheric Administration.

Oak Ridge National Laboratories, 2003. “Risk Assessment Information System,” electronic database maintained by Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Olson, K., and W. Moats (New Mexico Environment Department), March 2000. Memorandum to File, “Proposed ER Site 8 Cleanup Levels,” Hazardous and Radioactive Materials Bureau, New Mexico Environment Department, Santa Fe, New Mexico.

ORNL, see Oak Ridge National Laboratory.

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

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

Sandia National Laboratories/New Mexico (SNL/NM), August 1995. “Proposal for No Further Action Environmental Restoration Project Site 28, Mineshafts, Operable Unit 1332, August 1995,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

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

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

Sandia National Laboratories/New Mexico (SNL/NM), May 1999. “Sandia National Laboratories May 1999 Environmental Restoration Project Supplemental Information and Summary of Requested Actions at SWMU 28,” Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), January 2000. "Data Validation Procedure for Chemical and Radiochemical Data, Sandia National Laboratories/New Mexico Environmental Restoration Project, AOP 00-03," Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories/New Mexico (SNL/NM), July 2002. "Voluntary Corrective Action Plan for SWMU 28-2 Mine, Operable Unit 1332, Foothills Test Area, July 2002," Environmental Restoration Project, Sandia National Laboratories, Albuquerque, New Mexico.

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

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

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

Talmage et al 1996 (Table 4) to be provided

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

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

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

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

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

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

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

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

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

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

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

U.S. Environmental Protection Agency (EPA), 1997b. “Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination,” OSWER Directive No. 9200.4-18, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, Washington, D.C.

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

U.S. Environmental Protection Agency (EPA), 1998. “Guidelines for Ecological Risk Assessment,” EPA/630/R-95/002F, U.S. Environmental Protection Agency, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 2002a. “Region 6 Preliminary Remediation Goals (PRGs) 2002,” electronic database maintained by Region 6, U.S. Environmental Protection Agency, Dallas, Texas.

U.S. Environmental Protection Agency (EPA), 2002b. “Region 9 Preliminary Remediation Goals (PRGs) 1996,” electronic database maintained by Region 9, U.S. Environmental Protection Agency, San Francisco, California.

U.S. Environmental Protection Agency (EPA), 2002c. “Risk-Based Concentration Table,” electronic database maintained by Region 3, U.S. Environmental Protection Agency, Philadelphia, Pennsylvania.

U.S. Environmental Protection Agency (EPA), 2003. Integrated Risk Information System (IRIS) electronic database, maintained by the U.S. Environmental Protection Agency, Washington D.C.

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

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

Yanicak, S. (Oversight Bureau, Department of Energy, New Mexico Environment Department), March 1997. Letter to M. Johansen (DOE/AIP/POC Los Alamos National Laboratory), "(Tentative) list of constituents of potential ecological concern (COPECs) which are considered to be bioconcentrators and/or biomagnifiers." March 3, 1997.

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

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

This page intentionally left blank.

APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

Sandia National Laboratories/New Mexico (SNL/NM) uses a default set of exposure routes and associated default parameter values 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 are invoked for risk assessments unless site-specific information suggests other parameter values. Because many SNL/NM solid waste management units (SWMUs) 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 facilitates the risk assessments and subsequent review.

The default exposure routes and parameter values used 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 will use these default exposure routes and parameter values in future risk assessments.

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base. Approximately 240 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 and the biological resources present. When evaluating potential human health risk the current or reasonably foreseeable land use negotiated and approved for the specific SWMU/AOC, aggregate, or watershed will be used. The following references generally document these land uses: *Workbook: Future Use Management Area 2 (DOE et al. September 1995); Workbook: Future Use Management Area 1 (DOE et al. October 1995); Workbook: Future Use Management Areas 3, 4, 5, and 6 (DOE and USAF January 1996); Workbook: Future Use Management Area 7 (DOE and USAF March 1996)*. 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. Therefore, 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 1989) 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 shellfish
- 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 is currently no consumption of fish, shellfish, 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 shellfish
- 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

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

Based upon this evaluation, for future risk assessments the exposure routes that will be considered are shown in Table 1.

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 (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only	Dermal contact (nonradiological constituents only) soil only
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equation for calculating potential intakes via these routes is shown below. The equations are taken from “Assessing Human Health Risks Posed by Chemicals: Screening-Level Risk Assessment” (NMED March 2000) and “Technical Background Document for Development of Soil Screening Levels” (NMED December 2000). Equations from both documents are based upon the “Risk Assessment Guidance for Superfund” (RAGS): Volume 1 (EPA 1989, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). RESRAD is the only code designated by the U.S. Department of Energy (DOE) in DOE Order 5400.5 for the evaluation of radioactively contaminated sites (DOE 1993). The Nuclear Regulatory Commission (NRC) has approved the use of RESRAD for dose evaluation by licensees involved in decommissioning, NRC staff evaluation of waste disposal requests, and dose evaluation of sites being reviewed by NRC staff. EPA Science Advisory Board reviewed the RESRAD model. EPA used RESRAD in their rulemaking on radiation site cleanup regulations. RESRAD code has been verified, undergone several benchmarking analyses, and been included in the International Atomic Energy Agency’s VAMP and BIOMOVS II projects to compare environmental transport models.

Also shown are the default values SNL/NM ER will use in RME risk assessment calculations for industrial, recreational, and residential land-use 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) or by directly accessing the RESRAD websites at: http://web.ead.anl.gov/resrad/home2/ or http://web.ead.anl.gov/resrad/documents/.

Generic Equation for Calculation of Risk Parameter Values

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

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

= C x (CR x EFD/BW/AT) x Toxicity Effect (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.

For nonradiological constituents of concern (COCs), 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. For radionuclides, the calculated radiation exposure, expressed as TEDE is compared directly to the exposure guidelines of 15 millirem per year (mrem/year) for industrial and recreational future use and 75 mrem/year for the unlikely event that institutional control of the site is lost and the site is used for residential purposes (EPA 1997).

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk of 1E-5 for nonradiological 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 from radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site. This estimated dose is used to calculate an assumed risk. However, this calculated risk is presented for illustration purposes only, not to determine compliance with regulations.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989) and are outlined below. The RESRAD Manual (ANL 1993) describes similar equations for the calculation of radiological exposures.

Soil Ingestion

A receptor can ingest soil or dust directly by working in the contaminated soil. Indirect ingestion can occur from sources such as unwashed hands introducing contaminated soil to food that is then eaten. An estimate of intake from ingesting soil will be calculated as follows:

$$I_s = \frac{C_s * IR * CF * EF * ED}{BW * AT}$$

where:

I_s = Intake of contaminant from soil ingestion (milligrams [mg]/kilogram [kg]-day)
C_s = Chemical concentration in soil (mg/kg)
IR = Ingestion rate (mg soil/day)
CF = Conversion factor (1E-6 kg/mg)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

It should be noted that it is conservatively assumed that the receptor only ingests soil from the contaminated source.

Soil Inhalation

A receptor can inhale soil or dust directly by working in the contaminated soil. An estimate of intake from inhaling soil will be calculated as follows (EPA August 1997):

$$I_s = \frac{C_s * IR * EF * ED * \left(1/_{VF} \; or \; 1/_{PEF} \right)}{BW * AT}$$

where:

I_s = Intake of contaminant from soil inhalation (mg/kg-day)
C_s = Chemical concentration in soil (mg/kg)
IR = Inhalation rate (cubic meters [m^3]/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
VF = soil-to-air volatilization factor (m^3/kg)
PEF = particulate emission factor (m^3/kg)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Soil Dermal Contact

$$D_a = \frac{C_s * CF * SA * AF * ABS * EF * ED}{BW * AT}$$

where:

D_a = Absorbed dose (mg/kg-day)
C_s = Chemical concentration in soil (mg/kg)
CF = Conversion factor (1E-6 kg/mg)
SA = Skin surface area available for contact (cm^2/event)
AF = Soil to skin adherence factor (mg/cm^2)
ABS = Absorption factor (unitless)
EF = Exposure frequency (events/year)

ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Ingestion

A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water will be calculated as follows (EPA August 1997):

$$I_w = \frac{C_w * IR * EF * ED}{BW * AT}$$

where:

I_w = Intake of contaminant from water ingestion (mg/kg/day)
C_w = Chemical concentration in water (mg/liter [L])
IR = Ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Inhalation

The amount of a constituent taken into the body via exposure to volatilization from showering or other household water uses will be evaluated using the concentration of the constituent in the water source (EPA 1991 and 1992). An estimate of intake from volatile inhalation from groundwater will be calculated as follows (EPA 1991):

$$I_w = \frac{C_w * K * IR_i * EF * ED}{BW * AT}$$

where:

I_w = Intake of volatile in water from inhalation (mg/kg/day)
C_w = Chemical concentration in water (mg/L)
K = volatilization factor (0.5 L/m^3)
IR_i = Inhalation rate (m^3/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged—days)

For volatile compounds, volatilization from groundwater can be an important exposure pathway from showering and other household uses of groundwater. This exposure pathway will only be evaluated for organic chemicals with a Henry's Law constant greater than $1x10^{-5}$ and with a molecular weight of 200 grams/mole or less (EPA 1991).

Tables 2 and 3 show the default parameter values suggested for use by SNL/NM at SWMUs, based upon the selected land-use scenarios for nonradiological and radiological COCs, respectively. References are given at the end of the table indicating the source for the chosen parameter values. SNL/NM uses default values that are consistent with both regulatory guidance and 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.

<u>Summary</u>

SNL/NM will use the described default exposure routes and parameter values 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 NMED has requested this scenario to be considered to provide perspective of the risk under the more restrictive land-use scenario. 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. 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 Nonradiological Exposure Parameter Values for Various Land-Use scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency (day/yr)	250[a,b]	8.7 (4 hr/wk for 52 wk/yr)[a,b]	350[a,b]
Exposure Duration (yr)	25[a,b,c]	30[a,b,c]	30[a,b,c]
Body Weight (kg)	70[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]	70 Adult[a,b,c] 15 Child[a,b,c]
Averaging Time (days) for Carcinogenic Compounds (= 70 yr x 365 day/yr) for Noncarcinogenic Compounds (= ED x 365 day/yr)	25,550[a,b] 9,125[a,b]	25,550[a,b] 10,950[a,b]	25,550[a,b] 10,950[a,b]
Soil Ingestion Pathway			
Ingestion Rate (mg/day)	100[a,b]	200 Child[a,b] 100 Adult[a,b]	200 Child[a,b] 100 Adult[a,b]
Inhalation Pathway			
Inhalation Rate (m^3/day)	20[a,b]	15 Child[a] 30 Adult[a]	10 Child[a] 20 Adult[a]
Volatilization Factor (m^3/kg)	Chemical Specific	Chemical Specific	Chemical Specific
Particulate Emission Factor (m^3/kg)	1.36E9[a]	1.36E9[a]	1.36E9[a]
Water Ingestion Pathway			
Ingestion Rate (liter/day)	2.4[a]	2.4[a]	2.4[a]
Dermal Pathway			
Skin Adherence Factor (mg/cm^2)	0.2[a]	0.2 Child[a] 0.07 Adult[a]	0.2 Child[a] 0.07 Adult[a]
Exposed Surface Area for Soil/Dust (cm^2/day)	3,300[a]	2,800 Child[a] 5,700 Adult[a]	2,800 Child[a] 5,700 Adult[a]
Skin Adsorption Factor	Chemical Specific	Chemical Specific	Chemical Specific

[a]Technical Background Document for Development of Soil Screening Levels (NMED December 2000).
[b]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[c]Exposure Factors Handbook (EPA August 1997).
ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not available.
wk = Week(s).
yr = Year(s).

Table 3
Default Radiological Exposure Parameter Values for Various Land-Use scenarios

Parameter	Industrial	Recreational	Residential
General Exposure Parameters			
Exposure Frequency	8 hr/day for 250 day/yr	4 hr/wk for 52 wk/yr	365 day/yr
Exposure Duration (yr)	25[a,b]	30[a,b]	30[a,b]
Body Weight (kg)	70 Adult[a,b]	70 Adult[a,b]	70 Adult[a,b]
Soil Ingestion Pathway			
Ingestion Rate	100 mg/day[c]	100 mg/day[c]	100 mg/day[c]
Averaging Time (days) (= 30 yr x 365 day/yr)	10,950[d]	10,950[d]	10,950[d]
Inhalation Pathway			
Inhalation Rate (m^3/yr)	7,300[d,e]	10,950[e]	7,300[d,e]
Mass Loading for Inhalation g/m^3	1.36 E-5[d]	1.36 E-5 [d]	1.36 E-5 [d]
Food Ingestion Pathway			
Ingestion Rate, Leafy Vegetables (kg/yr)	NA	NA	16.5[c]
Ingestion Rate, Fruits, Non-Leafy Vegetables & Grain (kg/yr)	NA	NA	101.8[b]
Fraction Ingested	NA	NA	0.25[b,d]

[a]Risk Assessment Guidance for Superfund, Vol. 1, Part B (EPA 1991).
[b]Exposure Factors Handbook (EPA August 1997).
[c]EPA Region VI guidance (EPA 1996).
[d]For radionuclides, RESRAD (ANL 1993).
[e]SNL/NM (February 1998).
EPA = U.S. Environmental Protection Agency.
g = Gram(s)
hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
NA = Not applicable.
wk = Week(s).
yr = Year(s).

References

ANL, see Argonne National Laboratory.

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

DOE, see U.S. Department of Energy.

DOE and USAF, see U.S. Department of Energy and U.S. Air Force.

EPA, see U.S. Environmental Protection Agency.

New Mexico Environment Department (NMED), March 2000. "Assessing Human Health Risks Posed by Chemical: Screening-level Risk Assessment," Hazardous and Radioactive Materials Bureau, NMED, March 6, 2000.

New Mexico Environment Department (NMED), December 2000. "Technical Background Document for Development of Soil Screening Levels," Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, December 18, 2000.

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

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

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

U.S. Department of Energy, U.S. Air Force, and U.S. Forest Service, September 1995. "Workbook: Future Use Management Area 2," prepared by the Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates, the U.S. Air Force, and the U.S. Forest Service.

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

U.S. Department of Energy and U.S. Air Force (DOE and USAF), January 1996. "Workbook: Future Use Management Areas 3,4,5,and 6," prepared by the Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates, and the U.S. Air Force.

U.S. Department of Energy and U.S. Air Force (DOE and USAF), March 1996. “Workbook: Future Use Management Area 7,” prepared by the Future Use Logistics and Support Working Group in cooperation with U.S. Department of Energy Affiliates and the U.S. Air Force.

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

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

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

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

U.S. Environmental Protection Agency (EPA), August 1997. *Exposure Factors Handbook*, EPA/600/8-89/043, U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1997. (OSWER No. 9200.4-18) *Establishment of Cleanup Levels for CERCLA Sites with Radioactive Contamination*, U.S. EPA Office of Radiation and Indoor Air, Washington D.C, August 1997.

This page intentionally left blank.

APPENDIX 2
CALCULATION OF THE UPPER CONFIDENCE LIMITS OF MEAN CONCENTRATIONS

For conservatism, Sandia National Laboratories/New Mexico uses the maximum concentration of the constituents of concern (COCs) for initial risk calculation. If the maximum concentrations produce risk above New Mexico Environment Department (NMED) guidelines, conservatism with this approach is evaluated and, if appropriate, a more realistic approach is applied. When the site has been adequately characterized, an estimate of the mean concentration of the COCs is more representative of actual site conditions. The NMED has proposed the use of the 95% upper confidence limit (UCL) of the mean to represent average concentrations at a site (NMED December 2000). The 95% UCL is calculated according to NMED guidance (Tharp June 2002) using the U.S. Environmental Protection Agency ProUCL program (EPA April 2002). Attached are the outputs from that program and the calculated UCLs used in the risk analysis.

<u>References</u>

EPA, see U.S. Environmental Protection Agency.

New Mexico Environment Department (NMED), December 2000. "Technical Background Document for Development of Soil Screening Levels," Hazardous Waste Bureau and Ground Water Quality Bureau Voluntary Remediation Program, New Mexico Environment Department, Santa Fe, New Mexico. December 18, 2000.

NMED, see New Mexico Environment Department.

Tharp, T. (Weston Solutions, Inc.), June 2002. *Personal communication* with K. Olsen (Hazardous Waste Bureau, New Mexico Environment Department). June 12, 2002.

U.S. Environmental Protection Agency (EPA), April 2002. *ProUCL User's Guide*, U.S. Environmental Protection Agency, Washington, D.C.

ATTACHMENT

SWMU 28-2					
Summary Statistics for		As		Summary Statistics for	ln(As)
Number of Samples		21		Minimum	1.163151
Minimum		3.2		Maximum	3.020425
Maximum		20.5		Mean	1.92753
Mean		7.967619		Standard Deviation	0.553824
Median		8.15		Variance	0.306721
Standard Deviation		4.648127			
Variance		21.60509		Shapiro-Wilk Test Statisitic	0.920696
Coefficient of Variation		0.583377		Shapiro-Wilk 5% Critical Value	0.908
Skewness		1.308242		Data are Lognormal at 5% Significance Leve	
95	% UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t		9.717008		MLE Mean	8.011597
				MLE Standard Deviation	4.800019
95	% UCL (Adjusted for Skewness)			MLE Coefficient of Variation	0.599134
Adjusted-CLT		9.945407		MLE Skewness	2.012467
Modified-t		9.765269		MLE Median	6.872512
				MLE 80% Quantile	10.9738
95	% Non-parametric UCL			MLE 90% Quantile	14.0019
CLT		9.636002		MLE 95% Quantile	17.0913
Jackknife		9.717008		MLE 99% Quantile	24.92132
Standard Bootstrap		9.626843			
Bootstrap-t		10.29777		MVU Estimate of Median	6.82249
Chebyshev (Mean, Std)		12.38887		MVU Estimate of Mean	7.945716
				MVU Estimate of Std. Dev.	4.621856
				MVU Estimate of SE of Mean	1.003968
				UCL Assuming Lognormal Distribution	
				95% H-UCL	10.31315
				95% Chebyshev (MVUE) UCL	12.32191
				99% Chebyshev (MVUE) UCL	17.93508
				Recommended UCL to use:	
				H-UCL	

General Statistics

SWMU 28-2				
Summary Statistics for	Barium		Summary Statistics for	ln(Barium)
Number of Samples	21		Minimum	4.087656
Minimum	59.6		Maximum	7.539027
Maximum	1880		Mean	5.698287
Mean	442.7762		Standard Deviation	0.868174
Median	235		Variance	0.753727
Standard Deviation	468.336			
Variance	219338.6		Shapiro-Wilk Test Statisitic	0.944597
Coefficient of Variation	1.057726		Shapiro-Wilk 5% Critical Value	0.908
Skewness	2.010353		Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t	619.0412		MLE Mean	434.9149
			MLE Standard Deviation	461.2773
95 % UCL (Adjusted for Skewness)			MLE Coefficient of Variation	1.060615
Adjusted-CLT	658.7852		MLE Skewness	4.374935
Modified-t	626.5135		MLE Median	298.3559
			MLE 80% Quantile	621.3499
95 % Non-parametric UCL			MLE 90% Quantile	910.4063
CLT	610.8791		MLE 95% Quantile	1244.431
Jackknife	619.0412		MLE 99% Quantile	2247.695
Standard Bootstrap	603.7818			
Bootstrap-t	736.7022		MVU Estimate of Median	293.0451
Chebyshev (Mean, Std)	888.2526		MVU Estimate of Mean	424.7798
			MVU Estimate of Std. Dev.	415.0448
			MVU Estimate of SE of Mean	88.42994
			UCL Assuming Lognormal Distribution	
			95% H-UCL	691.8446
			95% Chebyshev (MVUE) UCL	810.2369
			99% Chebyshev (MVUE) UCL	1304.647
			Recommended UCL to use:	
			H-UCL	

SMWU 28-2	
Summary Statistics for	Chromium, total
Number of Samples	21
Minimum	2.66
Maximum	22.2
Mean	11.84761905
Median	10.5
Standard Deviation	5.847027368
Variance	34.18772905
Coefficient of Variation	0.4935191911
Skewness	0.2830714788
Shapiro-Wilk Test Statisitic	0.9606285319
Shapiro-Wilk 5% Critical Value	0.908
Data are Normal at 5% Significance Level	
Recommended UCL to use	Student's-t
95 % UCL (Assuming Normal Data)	
Student's-t	14.04823162
95 % UCL (Adjusted for Skewness)	
Adjusted-CLT	14.03054608
Modified-t	14.06136754
95 % Non-parametric UCL	
CLT	13.94633052
Jackknife	14.04823162
Standard Bootstrap	13.88697583
Bootstrap-t	14.25148228
Chebyshev (Mean, Std)	17.40925144

SWMU 28-2				
Summary Statistics for			Lead	
Number of Samples			21	
Minimum			74.8	
Maximum			484	
Mean			223.3238	
Median			218	
Standard Deviation			96.32342	
Variance			9278.202	
Coefficient of Variation			0.431317	
Skewness			1.202188	
Shapiro-Wilk Test Statisitic			0.91038	
Shapiro-Wilk 5% Critical Value			0.908	
Data are Normal at 5% Significance Level				
Recommended UCL to use			Student's-t	
95	% UCL (Assuming Normal Data)			
Student's-t			259.5765	
95	% UCL (Adjusted for Skewness)			
Adjusted-CLT			263.7898	
Modified-t			260.4955	
95	% Non-parametric UCL			
CLT			257.8978	
Jackknife			259.5765	
Standard Bootstrap			256.6394	
Bootstrap-t			268.0972	
Chebyshev (Mean, Std)			314.9457	

General Statistics

SWMU 28-2				
Summary Statistics for	Mercury		Summary Statistics for	ln(Mercury
Number of Samples	21		Minimum	-4.439656
Minimum	0.0118		Maximum	0.019803
Maximum	1.02		Mean	-1.901885
Mean	0.223348		Standard Deviation	0.958078
Median	0.163		Variance	0.917913
Standard Deviation	0.229258			
Variance	0.052559		Shapiro-Wilk Test Statisitic	0.96188
Coefficient of Variation	1.026463		Shapiro-Wilk 5% Critical Value	0.908
Skewness	2.418579		Data are Lognormal at 5% Significance Leve	
95 % UCL (Assuming Normal Data)			Estimates Assuming Lognormal Distribution	
Student's-t	0.309632		MLE Mean	0.236235
			MLE Standard Deviation	0.289719
95 % UCL (Adjusted for Skewness)			MLE Coefficient of Variation	1.226401
Adjusted-CLT	0.333849		MLE Skewness	5.523785
Modified-t	0.314033		MLE Median	0.149287
			MLE 80% Quantile	0.335441
95 % Non-parametric UCL			MLE 90% Quantile	0.511323
CLT	0.305637		MLE 95% Quantile	0.721916
Jackknife	0.309632		MLE 99% Quantile	1.386253
Standard Bootstrap	0.304754			
Bootstrap-t	0.375906		MVU Estimate of Median	0.146057
Chebyshev (Mean, Std)	0.441416		MVU Estimate of Mean	0.22922
			MVU Estimate of Std. Dev.	0.253345
			MVU Estimate of SE of Mean	0.053447
			UCL Assuming Lognormal Distribution	
			95% H-UCL	0.40427
			95% Chebyshev (MVUE) UCL	0.462193
			99% Chebyshev (MVUE) UCL	0.761016
			Recommended UCL to use:	
			H-UCL	

Annex F

ANNEX F
Data Validation Reports

Sample Findings Summary

Site: VCA and Sampling at Site 28-2 **AR/COC:** 605645 **Data Type:** Organic and Inorganic

Sample ID	479-45-8 (tetryl)	19406-51-0 (4-amino-2,6-dinitrotoluene)	99-08-1 (3-nitrotoluene)		7440-39-3 (barium)	7440-47-3 (chromium)	7782-49-2 (selenium)
059653-002 / S282-GR-109-0-SS	UJ, A	UJ, A					
059654-002 / S282-GR-110-0-SS	UJ, A	UJ, A					
059655-002 / S282-GR-111-0-SS	UJ, A	UJ, A					
059656-002 / S282-GR-112-0-SS	UJ, A	UJ, A					
059656-007 / S282-GR-112-0-DUP	UJ, A	UJ, A					
059657-002 / S282-GR-113-0-SS	UJ, A	UJ, A					
059658-002 / S282-GR-114-0-SS	UJ, A	UJ, A					
059659-002 / S282-GR-115-0-SS	UJ, A	UJ, A					
059660-002 / S282-GR-116-0-SS	UJ, A	UJ, A					
059653-002 RE / S282-GR-109-0-SS RE							
059654-002 RE / S282-GR-110-0-SS RE							
059655-002 RE / S282-GR-111-0-SS RE							
059656-002 RE / S282-GR-112-0-SS RE	**EPA8330: All results UJ, HT.**						
059656-007 RE / S282-GR-112-0-DUP RE							
059657-002 RE / S282-GR-113-0-SS RE							
059658-002 RE / S282-GR-114-0-SS RE							
059659-002 RE / S282-GR-115-0-SS RE							
059660-002 RE / S282-GR-116-0-SS RE							
059661-001 / S282-GR-119-0-EB			NJ				
059661-005 / S282-GR-117-0-EB					J, B3	J, B3	
059653-005 / S282-GR-109-0-SS					J, P1		UJ, B3
059654-005 / S282-GR-110-0-SS					J, P1		J, B, B3
059655-005 / S282-GR-111-0-SS					J, P1		J, B, B3
059656-005 / S282-GR-112-0-SS					J, P1		J, B, B3
059656-006 / S282-GR-112-0-DUP					J, P1		J, B, B3
059657-005 / S282-GR-113-0-SS					J, P1		J, B, B3
059658-005 / S282-GR-114-0-SS					J, P1		J, B, B3
059659-005 / S282-GR-115-0-SS					J, P1		J, B, B3
059660-005 / S282-GR-116-0-SS					J, P1		J, B, B3

Validated By: Kevin A Lambert **Date:** 9/05/03

Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123
Phone: 505-299-5201
Fax: 505-299-6744
Email: minteer@aol.com

MEMORANDUM

DATE: September 5, 2003

TO: File

FROM: Kevin Lambert

SUBJECT: Organic Data Review and Validation – SNL
VCA and Sampling at Site 28-2, AR/COC No. 605645, SDG No. 66796/66799 (GEL), and Project/Task No. 7213.02.02.05

See the attached Data Validation Worksheets for supporting documentation on the data review and validation. Data are evaluated using SNL/NM ER Project AOP 00-03.

Summary

All samples were prepared and analyzed with accepted procedures using method EPA8330 HE. All compounds were successfully analyzed. Problems were identified with the data package that result in the qualification of data.

1. HE: For the equipment blank (EB), the case narrative states the confirmation RPD for 3-nitrotoluene was > 70%. As a result based on professional judgment the associated sample result will be qualified "NJ."

2. HE: The LCS %R for tetryl (11%) and 4-amino-2,6-dinitrotoluene (75%) were < the lower QC acceptance limit (65% and 79% respectively). Associated sample results were non-detect (ND) and will be qualified "UJ, A."

3. HE: All soil samples were reextracted out of holding time and reanalyzed due to an LCS QC failure. Sample results for the reanalysis were ND and will be qualified "UJ, HT."

Data are acceptable and QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times

All samples were extracted and analyzed within the prescribed holding times and properly preserved except as noted above in the summary section.

Calibration

The initial calibration and continuing calibration data met QC acceptance criteria.

Blanks

No target analytes were detected in the blanks except as follows.

HE: Tetryl was detected in one or more of blanks (MB, EB) associated with the samples. However, the sample results are ND and as a result no data will be qualified.

Surrogates

The surrogate recoveries met QC acceptance criteria.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

The MS/MSD was run on a sample from another SNL SDG and met QC acceptance criteria. No data will be qualified as a result.

Laboratory Control Sample (LCS)

The LCS met QC acceptance criteria except as noted above in the summary section. It should be noted that no LCSD was provided with the SDG. No data will be qualified as a result. Laboratory precision was assessed using the MS/MSD, which met QC acceptance criteria.

Detection Limits/Dilutions

All detection limits were properly reported; no dilutions were required

Confirmation

Confirmation analysis met QC acceptance criteria for the applicable analyses except as noted above in the summary section.

Other QC

An EB and field duplicate pair were submitted on the ARCOC. There are no "required" review criteria for field duplicate analyses comparability; no data will be qualified as a result.

No field blank (FB) was submitted on the ARCOC.

No other specific issues were identified which affect data quality.

Analytical Quality Associates, Inc.
616 Maxine NE
Albuquerque, NM 87123
Phone: 505-299-5201
Fax: 505-299-6744
Email: minteer@aol.com

MEMORANDUM

DATE: September 5, 2003

TO: File

FROM: Kevin Lambert

SUBJECT: Inorganic Data Review and Validation – SNL
VCA and Sampling at Site 28-2, AR/COC No. 605645, SDG No. 66796/66799 (GEL), and Project/Task No. 7213.02.02.05

See the attached Data Validation Worksheets for supporting documentation on the data review and validation. Data are evaluated using SNL/NM ER Project AOP 00-03.

Summary

The samples were prepared and analyzed with accepted procedures using methods EPA6010 ICP and EPA7470A/7471A CVAA. Problems were identified with the data package that result in the qualification of data.

1. ICP: The following target analytes were detected (≥ DL) in one or more of the blanks (ICB, CCB) associated with the equipment blank (EB). The associated sample results will be qualified as noted below.

Sample 66799-001	Barium and chromium were < 5x the CCB concentration and will be qualified "J, B3."
	Beryllium and selenium were non-detect (ND) or > 5x the blank concentrations; no data will be qualified as a result.

2. ICP: The following target analytes were detected (≥ DL) in one or more of the blanks (CCB, MB, EB). The associated sample results will be qualified as noted below.

Sample 66796-001	Barium, chromium, selenium, and arsenic were ND or > 5x the blank concentrations; no data will be qualified as a result.
Samples 66796-002 to -009	Selenium was < 5x the MB concentration and will be qualified "J, B."
	Barium, chromium, and arsenic were ND or > 5x the blank concentrations; no data will be qualified as a result.

3. ICP: The following target analytes were detected in one or more of the blanks (CCB) at negative concentration with absolute value > the DL but < the RL. The associated sample results will be qualified as noted below.

Sample 66796-001	Selenium was ND and will be qualified "UJ, B3."
Samples 66796-002 to -009	Selenium was < 5x the DL and will be qualified "J, B3."

4. ICP and CVAA: The replicate RPD for the following target analytes did meet QC acceptance criteria for soils. The associated sample results will be qualified as noted below.

Samples 66796-001 to -009	The replicate RPD for barium (40%) was > 35%. The associated results were detect and will be qualified "J, P1." The replicate RPD for nickel (23%), lead (33%) and mercury (34%) were < 35%; no data will be qualified as a result.

Data are acceptable and reported QC measures appear to be adequate. The following sections discuss the data review and validation.

Holding Times/Preservation

All samples were analyzed within the prescribed holding times and properly preserved for the applicable analyses.

Calibration

The initial and continuing calibration data met QC acceptance criteria for the applicable analyses.

Blanks

No target analytes were detected in the blanks for the applicable analyses except as mentioned above in the summary section.

ICP Interference Check Sample (ICS)

ICP: The ICS data met QC acceptance criteria.

Matrix Spike (MS)

The MS met QC acceptance criteria for the applicable analyses except as follows.

ICP: It should be noted the MS %R limits do not apply for barium and lead since the sample concentrations are > 4x the spike concentrations. No data will qualified as a result.

Replicate

The replicate met QC acceptance criteria for the applicable analyses except as mentioned above in the summary section.

Laboratory Control Sample (LCS)

The LCS met QC acceptance criteria for the applicable analyses. It should be noted that no LCSD was provided with the SDG. No data will be qualified as a result. Laboratory precision was assessed using the replicate, which met QC acceptance criteria except as mentioned above in the summary section.

ICP Serial Dilution

ICP: The serial dilution met QC acceptance criteria.

Detection Limits/Dilutions

All detection limits were properly reported for the applicable analyses. No dilutions were required except as follows.

ICP: The soil samples were diluted the standard 2x. Sample 66769-009 was diluted 5x for barium in order to bring raw values within the linear range of the instrument.

Other QC

An EB and a field duplicate pair were submitted on the ARCOCs. The field duplicate RPD for mercury (24%) was > 20% (see Data Validation Worksheets). There are no "required" review criteria for field duplicate analyses comparability; no data will be qualified as a result.

No field blank (FB) was submitted on the ARCOC.

No other specific issues were identified which affect data quality.

Data Validation Summary

Site/Project: VCA & Sampling at Site 28-2 Project/Task #: 7213.02.02.05 # of Samples: 20 Matrix: 18 soil, 2 aqueous

AR/COC #: 605645 Laboratory Sample IDs: 66796-001 to -018

Laboratory: GEL 66799-001, -002 (EBs)

SDG #: 66796, 66799

QC Element	Analysis									
	Organics				Inorganics				RAD	Other
	VOC	SVOC	Pesticide/ PCB	HPLC (HE)	ICP/AES	GFAA/ AA	CVAA (Hg)	CN		
1. Holding Times/Preservation				UJ	✓	NA	✓			
2. Calibrations				✓	J, UJ		✓			
3. Method Blanks				✓	J		✓			
4. MS/MSD				✓	✓		✓			
5. Laboratory Control Samples				UJ	✓		✓		NA	
6. Replicates		NA			J		✓			
7. Surrogates				✓						
8. Internal Standards										
9. TCL Compound Identification										
10. ICP Interference Check Sample					✓					
11. ICP Serial Dilution					✓					
12. Carrier/Chemical Tracer Recoveries										
13. Other QC				NJ	J		✓			

J = Estimated
U = Not Detected
UJ = Not Detected, Estimated
R = Unusable

Check (√) = Acceptable
Shaded Cells = Not Applicable (also "NA")
NP = Not Provided
Other: ______

Reviewed By: Kevin A Lambert Date: 9-05-03

Holding Time and Preservation

Site/Project: VCA & Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66796-010RE to -018RE

Laboratory: GEL SDG #: 66796

\# of Samples: 9 Matrix: ~~aqueous~~ soil KAL

Sample ID	Analytical Method	Holding Time Criteria	Days Holding Time was Exceeded	Preservation Criteria	Preservation Deficiency	Comments
66796-010RE	EPA8330 HE	14days	15 days			One or more of the LCS spiking analytes were not within the QC limits; All samples in the batch were reextracted and reanalyzed; All reanalysis calibration, sample results and QC data are provided. Associated results are ND and are qualified "UJ, HT"
-011						
-012						
-013			16 days	NA		
-014						
-015						
-016						
-017						
-018						

Reviewed By: Kevin A Lambert Date: 9-05-03

High Explosives (SW 846 Method 8330)

Site/Project: VCA & Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66799-002 (EB)

Laboratory: GEL SDG #: 66799

Methods: EPA 8330 (HE)

# of Samples: 1 Matrix: aqueous Batch #s: 200387/200386

CAS #	NAME	TAL	Intercept	Curve R^2 .99	CCV %D 20%	Method Blanks U (1)	LCS	LCSD	LCS RPD 20%	MS	MSD	MS RPD 20%	Field Dup. RPD	Equip. Blanks U	Field Blanks U		
2691-41-0	HMX	✓	✓	✓	✓	✓	✓	✓	✓	NA							
121-82-4	RDX	✓	✓	✓	✓	✓	✓	✓	✓								
99-35-4	1,3,5-Trinitrobenzene	✓	✓	✓	✓	✓	✓	✓	✓								
99-65-0	1,3-dinitrobenzene	✓	✓	✓	✓	✓	✓	✓	✓								
98-95-3	Nitrobenzene	✓	✓	✓	✓	✓	✓	✓	✓								
479-45-8	Tetryl	✓	✓	✓	✓	0.0676 JP	✓	✓	✓								
118-96-7	2,4,6-trinitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
35572-78-2	2-amino-4,6-dinitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
19406-51-0	4-amino-2,6-dinitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
121-14-2	2,4-dinitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
606-20-2	2,6-dinitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
88-72-2	2-nitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
99-99-0	4-nitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
99-08-1	3-nitrotoluene	✓	✓	✓	✓	✓	✓	✓	✓								
78-11-5	PETN																

Sample	SMC %REC	SMC RT	Sample	SMC %REC	SMC RT
~~Met Criteria~~					

NA - Not Applicable

Comments: (1) Tetryl was detected in the MB sample result was ND, no data qualified as a result

(2) The confirmation RPD for 3-nitrotoluene was ~~>40%~~ >70%, as a result ~~the~~ KAL based on professional judgment data ~~with~~ KAL will be qualified "NJ" See Case Narrative

Confirmation (2)

Sample	CAS #	RPD > 25%	Sample	CAS #	RPD > 25%
66799-002	99-08-1	~~>40%~~ >70% KAL			

Solids-to-aqueous conversion:
mg / kg = µg / g:[(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

Reviewed By: Kevin A Lambert Date: 9-05-03

High Explosives (SW 846 Method 8330)

Site/Project: VCA & Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66796-010 to -018

Laboratory: GEL SDG #: 66796

Methods: EPA 8330 (HE)

\# of Samples: 9 Matrix: ~~aqueous~~ soil KAL Batch #s: 200966/200965

CAS #	NAME	TAL	Intercept	Curve R^2	CCV %D	Method Blanks	LCS (1)	LCSD	LCS RPD	MS	MSD	MS RPD	Field. Dup. RPD	Equip. Blanks (2)	Field Blanks		
				.99	20%	U			20%			20%		U	U		
2691-41-0	HMX	✓	✓	✓	✓	✓	✓	NA		✓	✓	✓	✓	✓	NA		
121-82-4	RDX	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
99-35-4	1,3,5-Trinitrobenzene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
99-65-0	1,3-dinitrobenzene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
98-95-3	Nitrobenzene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
479-45-8	Tetryl	✓	✓	✓	✓	✓	11 (65)			✓	✓	✓	✓	0.0906 JP ~~0.090~~ KAL			
118-96-7	2,4,6-trinitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
35572-78-2	2-amino-4,6-dinitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
19406-51-0	4-amino-2,6-dinitrotoluene	✓	✓	✓	✓	✓	75 (79)			✓	✓	✓	✓	✓			
121-14-2	2,4-dinitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
606-20-2	2,6-dinitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
88-72-2	2-nitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
99-99-0	4-nitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
99-08-1	3-nitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
78-11-5	PETN																

NA- Not Applicable

Sample	SMC %REC	SMC RT	Sample	SMC %REC	SMC RT
~~Met Criteria~~					

Confirmation

Sample	CAS #	RPD > 25%	Sample	CAS #	RPD > 25%
~~NA - Results ND~~					

Comments:

(1) The LCS %R for tetryl (11) & 4-A-2,6-DNT (75) were < the lower limits (65 & 79 respectively) but > 10%. Associated results were ND and are qualified "UJ, A".

(2) Tetryl ~~KAL~~ was detected in the EB. ~~assoc~~ KAL associated results were ND, No data qualified as a result

Solids-to-aqueous conversion:
mg / kg = µg / g:[(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

Reviewed By: Kevin A Lambert Date: 9-05-03

High Explosives (SW 846 Method 8330)

Site/Project: VCA # Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66796-010RE to -018RE

Laboratory: GEL SDG #: 66796

Methods: EPA 8330 (HE)

\# of Samples: 9 Matrix: ~~aqueous~~ soil KAL Batch #s: 203692/203690

CAS #	NAME	TAL	Intercept	Curve R^2	CCV %D	Method Blanks	LCS	LCSD	LCS RPD	MS	MSD	MS RPD	Field Dup. RPD	① Equip. Blanks	Field Blanks		
				.99	20%	U			20%			20%		U	U		
2691-41-0	HMX	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	NA		
121-82-4	RDX	✓					✓										
99-35-4	1,3,5-Trinitrobenzene	✓					✓										
99-65-0	1,3-dinitrobenzene	✓					✓										
98-95-3	Nitrobenzene	✓					✓										
479-45-8	Tetryl	✓					✓							0.0906 JP			
118-96-7	2,4,6-trinitrotoluene	✓					✓	NA						✓			
35572-78-2	2-amino-4,6-dinitrotoluene	✓					✓										
19406-51-0	4-amino-2,6-dinitrotoluene	✓					✓										
121-14-2	2,4-dinitrotoluene	✓					✓										
606-20-2	2,6-dinitrotoluene	✓					✓										
88-72-2	2-nitrotoluene	✓					✓										
99-99-0	4-nitrotoluene	✓					✓										
99-08-1	3-nitrotoluene	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓			
78-11-5	PETN																
															✓		

Sample	SMC %REC	SMC RT	Sample	SMC %REC	SMC RT
Met Criteria					

NA - Not Applicable

Comments: ① Tetryl was detected in the EB, associated results were ND, no data qualified as a result

Note: See Holding Time Worksheet for further discussion on these samples

Confirmation

Sample	CAS #	RPD > 25%	Sample	CAS #	RPD > 25%
NA - Results ND					

Solids-to-aqueous conversion:

mg / kg = µg / g:[(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

Reviewed By: Kevin A Lambert Date: 9-05-03

Inorganic Metals

Site/Project: VCA & Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66799-001 (EB)

Laboratory: GEL SDG #: 66799 ~~-001~~ KAL

Methods: EPA6010B(ICP), EPA7470A(CVAA)

\# of Samples: 1 Matrix: Aqueous Batch #s: 201353/201352 (ICP), 201566/201565 (CVAA)

CAS #/ Analyte	QC Element																		
	TAL	ICV	CCV	ICB	CCB	Method Blanks	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD	ICS AB	Serial Dilu-tion	Field Dup. RPD	Equip. Blanks	Field Blanks	5x Blk ①
7429-90-5 Al																			
7440-39-3 Ba	✓	✓	✓	✓	0.000229	✓	✓			✓			✓	✓	✓				0.0011
7440-41-7 Be	✓	✓	✓	✓	0.000206	✓	✓			✓			✓	✓	✓				0.0010
7440-43-9 Cd	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓				
7440-70-2 Ca																			
7440-47-3 Cr	✓	✓	✓	✓	0.000663	✓	✓			✓			✓	✓	✓				0.0033
7440-48-4 Co																			
7440-50-8 Cu																			
7439-89-6 Fe																			
7439-95-4 Mg																			
7439-96-5 Mn																			
7440-02-0 Ni	✓	✓	✓	✓	✓	✓	✓	NA		✓			✓	✓	✓		NA		
7440-09-7 K																			
7440-22-4 Ag	✓	✓	✓	✓	✓	✓	✓			✓	NA		✓	✓	✓				
7440-23-5 Na																			
7440-62-2 V																			
7440-66-6 Zn																			
							~~✓~~ KAL												
7439-92-1 Pb	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓				
7782-49-2 Se	✓	✓	✓	0.00416	✓	✓	✓			✓			✓	✓	✓				0.0208
7440-38-2 As	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓				
7440-36-0 Sb																			
7440-28-0 Tl																			
7439-97-6 Hg	✓	✓	✓	✓	✓	✓	✓			✓			✓	NA	NA				
Cyanide CN																			

KAL

Notes: Shaded rows are RCRA metals. **Solids-to-aqueous conversion:** mg / kg = µg / g : [(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

NA - Not Applicable

Comments:

① Ba & Cr < 5x blank, qualified J, B3
Be & Se were ND, no data qualified as a result

Reviewed By: Kevin A Lambert Date: 9-05-03

Inorganic Metals

Site/Project: VCA # Sampling @ Site 28-2 AR/COC #: 605645 Laboratory Sample IDs: 66796-001 to -009

Laboratory: GEL SDG #: 66796

Methods: EPA6010B (ICP), EPA7471A (CVAA)

# of Samples: 9 Matrix: soil Batch #s: 202036/202035, 200319/200318

CAS #/ Analyte	TAL	ICV	CCV	ICB	CCB ug/l	Method Blanks mg/kg	LCS	LCSD	LCSD RPD	MS	MSD	MSD RPD	Rep. RPD ②	ICS AB	Serial Dilution	Field Dup. RPD ③	Equip. Blanks ug/l	Field Blanks	5x Blk ①	5x DL
7429-90-5 Al																		NA		
7440-39-3 Ba	✓	✓	✓	✓	✓	✓	✓			N/A			40(20)	✓	✓	18	0.000326J		1.63	
7440-41-7 Be	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	3	✓			
7440-43-9 Cd	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	0.044Δ	✓			
7440-70-2 Ca																				
7440-47-3 Cr	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	0.45	0.000636J		3.18	
7440-48-4 Co																				
7440-50-8 Cu																				
7439-89-6 Fe																				
7439-95-4 Mg								N/A												
7439-96-5 Mn																				
7440-02-0 Ni	✓	✓	✓	✓	✓	✓	✓			✓	N/A		23(20)	✓	✓	2	✓			
7440-09-7 K																				
7440-22-4 Ag	✓	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	0.053Δ	✓			
7440-23-5 Na																				
7440-62-2 V																				
7440-66-6 Zn																				
7439-92-1 Pb	✓	✓	✓	✓	✓	✓	✓			N/A			33(20)	✓	✓	12	✓			
7782-49-2 Se	✓	✓	✓	✓	-1.86J	0.279J	✓			✓			✓	✓		0.265Δ	✓		1.395	0.77
7440-38-2 As	✓	✓	✓	✓	2.96J	✓	✓			✓			✓	✓		11	✓		14.8	
7440-36-0 Sb																				
7440-28-0 Tl																				
7439-97-6 Hg	✓	✓	✓	✓	✓	✓	✓			✓			34(20)	NA	NA	24	✓			
Cyanide CN																				

Notes: Shaded rows are RCRA metals. **Solids-to-aqueous conversion:** mg / kg = µg / g : [(µg / g) x (sample mass {g} / sample vol. {ml}) x (1000 ml / 1 liter)] / Dilution Factor = µg / l

NA - Not Applicable

N/A - MS%R limits don't apply, sample [c] > 4x spike [c]

Comments: ~~① Se was ND or < 5xBlk or 5xDL or < 5xDL associated … detects are qualified J, B, B3~~ KAL

SEE OTHER PAGE

Reviewed By: Kevin A Lambert Date: 9-05-03

COC # 60564 5
SDG # 66796

2/2

Blank\Analyte	Sample # 66796 -001	-002	-003	-004	-005	-006	-007	-008	-009
EB \ Ba	>5xBlk No qual								
↓ Cr	>5x Blk No qual								
CCB \ Se -	UJ, B3	J, B3	J, B3	J, B3	J, B3	J, B3	J, B3	J, B3	J, B3
MB Se +	ND No qual	J, B	J, B	J, B	J, B	J, B	J, B	J, B	J, B
CCB As	>5x Blk No qual								

Negative Blank>=DL	Negative Blank>RL	Positive Blank>=DL	Positive Blank>RL	Descriptive Flags (if applicable)
<5XDL=J, NDs=UJ, >5XDL = no qual	<5XRL=J, NDs=R	<5X Blank=J, ND or >5X = no qual	reported value = >10X blank	B=MB, B1=TB, B2=EB, B3=ICB/CB

(1) Se was detected in CCB at negative [c] w/abs. value > DL but < RL Associated detects < 5xDL will be qualified J, B3 & NDs will be UJ, B3

(1) Se was detected in MB Associated detects < 5xBlk will be qualified J, B, NDs are Not qualified

(1) Ba, Cr, & As were detected in one or more blanks (EB, CCB), Results were > 5 x Blk, No data qualified as a result

(2) The Rep RPD for Ba, Ni, Pb, & Hg were > 20% Only Ba Rep RPD is > 35% ∴ Ba will be qualified J, P1 for all soil samples

(3) A field dup was reported and RPDs ~~were calculated~~ KAL are presented for the target analytes No "required" review criteria, No data qualified as a result

KAL
[illegible]-03

RECORDS CENTER CODE: ______

SMO ANALYTICAL DATA ROUTING FORM

PROJECT NAME: VCA and Sampling at Site 28-2
PROJECT/TASK: 7213_02.02.05
SNL TASK LEADER: Byrd
ORG/MS/CF0#: 6134/1088/CF031-02
SMO PROJECT LEAD: Palencia
SAMPLE SHIP DATE: 9/9/02

ARCOC	LAB	LAB ID	PRELIM DATE	FINAL DATE	EDD	EDD ON Q	BY
605645	GEL	66796		10/8/2002	X	X	JAC
605644	RPSD						

	NAME	DATE
REVIEW COMPLETED BY/DATE:	W. Palencia	10/11/02
CORRECTIONS REQUESTED/RECEIVED:	W. Palencia	10/14/02
PROBLEM #:	4986	10/11/02
FINAL TRANSMITTED TO/DATE:		
SENT TO VALIDATION BY/DATE:		
RUSH VALIDATION REQUIRED EST. TAT:		
VALIDATION COMPLETED BY/DATE:	KAL	8/5/03 relog
COPY TO WM BY/DATE:		
TO ERDMS OR RECORDS CENTER BY/DATE:	Conn	10/14/02

COMMENTS:

Contract Verification Review (CVR)

Project Leader BYRD   Project Name VCA & SAMPLING AT SITE 28-2   Case No. 7213_02.02.05

AR/COC No. 605645   Analytical Lab GEL   SDG No. 66796

In the tables below, mark any information that is missing or incorrect and give an explanation.

1.0 Analysis Request and Chain of Custody Record and Log-In Information

Line No.	Item	Complete? Yes	Complete? No	If no, explain	Resolved? Yes	Resolved? No
1.1	All items on COC complete - data entry clerk initialed and dated	X				
1.2	Container type(s) correct for analyses requested	X				
1.3	Sample volume adequate for # and types of analyses requested	X				
1.4	Preservative correct for analyses requested	X				
1.5	Custody records continuous and complete	X				
1.6	Lab sample number(s) provided and SNL sample number(s) cross referenced and correct	X				
1.7	Date samples received	X				
1.8	Condition upon receipt information provided	X				

2.0 Analytical Laboratory Report

Line No.	Item	Complete? Yes	Complete? No	If no, explain	Resolved? Yes	Resolved? No
2.1	Data reviewed, signature	X				
2.2	Method reference number(s) complete and correct	X				
2.3	QC analysis and acceptance limits provided (MB, LCS, Replicate)	X				
2.4	Matrix spike/matrix spike duplicate data provided (if requested)	X				
2.5	Detection limits provided; PQL and MDL (or IDL), MDA and L_c	X				
2.6	QC batch numbers provided	X				
2.7	Dilution factors provided and all dilution levels reported	X				
2.8	Data reported in appropriate units and using correct significant figures	X				
2.9	Radiochemistry analysis uncertainty (2 sigma error) and tracer recovery (if applicable) reported	N/A				
2.10	Narrative provided	X				
2.11	TAT met	X				
2.12	Hold times met		X	HE SAMPLES RERUN PAST HOLDING TIME DUE TO LCS FAILURES	X	
2.13	Contractual qualifiers provided	X				
2.14	All requested result and TIC (if requested) data provided		X	1st PAGE OF COA FOR SAMPLE #059654-005 MISSING		

Contract Verification Review (Continued)

3.0 Data Quality Evaluation

Item	Yes	No	If no, Sample ID No./Fraction(s) and Analysis
3.1 Are reporting units appropriate for the matrix and meet contract specified or project-specific requirements? Inorganics and metals reported as ppm (mg/liter or mg/Kg)? Tritium reported in picocuries per liter with percent moisture for soil samples? Units consistent between QC samples and sample data	X		
3.2 Quantitation limit met for all samples	X		
3.3 Accuracy a) Laboratory control samples accuracy reported and met for all samples		X	4-AMINO-2,6-DINITROTOLUENE & TETRYL FAILED RECOVERY LIMITS—RE-EXTRACTED LCS ACCEPTABLE
b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique	X		
c) Matrix spike recovery data reported and met	X		
3.4 Precision a) Replicate sample precision reported and met for all inorganic and radiochemistry samples		X	RPDs FOR BARIUM, LEAD, MERCURY & NICKEL OUTSIDE ACCEPTANCE LIMITS
b) Matrix spike duplicate RPD data reported and met for all organic samples	X		
3.5 Blank data a) Method or reagent blank data reported and met for all samples		X	SELENIUM DETECTED IN BLANK
b) Sampling blank (e.g., field, trip, and equipment) data reported and met		X	M-NITROTOLUENE DETECTED IN EQUIPMENT BLANK BARIUM & CHROMIUM DETECTED IN EQUIPMENT BLANK
3.6 Contractual qualifiers provided: "J"- estimated quantity; "B"-analyte found in method blank above the MDL for organic or above the PQL for inorganic; "U"- analyte undetected (results are below the MDL, IDL, or MDA (radiochemical)); "H"-analysis done beyond the holding time	X		
3.7 Narrative addresses planchet flaming for gross alpha/beta	N/A		
3.8 Narrative included, correct, and complete	X		
3.9 Second column confirmation data provided for methods 8330 (high explosives) and 8082 (pesticides/PCBs)	X		

Contract Verification Review (Continued)

4.0 Calibration and Validation Documentation

Item	Yes	No	Comments
4.1 GC/MS (8260, 8270, etc.)			
a) 12-hour tune check provided	N/A		
b) Initial calibration provided	N/A		
c) Continuing calibration provided	N/A		
d) Internal standard performance data provided	N/A		
e) Instrument run logs provided	N/A		
4.2 GC/HPLC (8330 and 8010 and 8082)			
a) Initial calibration provided	X		
b) Continuing calibration provided	X		
c) Instrument run logs provided	X		
4.3 Inorganics (metals)			
a) Initial calibration provided	X		
b) Continuing calibration provided	X		
c) ICP interference check sample data provided	X		
d) ICP serial dilution provided	X		
e) Instrument run logs provided	X		
4.4 Radiochemistry			
a) Instrument run logs provided	N/A		

Contract Verification Review (Concluded)

5.0 Problem Resolution

Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted.

Sample/Fraction No.	Analysis	Problems/Comments/Resolutions
059654-005	RCRA METALS	Ist PAGE OF COA MISSING

Were deficiencies unresolved? ▶ Yes ▶ No

Based on the review, this data package is complete. ▶ Yes ▶ No

If no, provide: nonconformance report or correction request number 4986 and date correction request was submitted:- 10-11-2002

Reviewed by: W. Palencia Date: 10-11-2002 Closed by: W. Palencia Date: 10/14/02

CONTRACT LABORATORY
ANALYSIS REQUEST AND CHAIN OF CUSTODY

Internal Lab 201227

Batch No. ~~2011221~~ SAR/WR No.

AR/COC 605645

Dept. No./Mail Stop:	6134/1088	Date Samples Shipped:	9-9-02	Contract No:	7213
Project/Task Manager:	Caroline Byrd	Carrier/Waybill No.	13160	Project/Task No.:	02.02.05
Project Name:	28-2 Mine Site VCA	Lab Contact:	EDIE KENT	SMO Authorization:	
Record Center Code:		Lab Destination:	~~Southwest Labs of Oklahoma~~ GEL		
Logbook Ref. No.:		SMO Contact/Phone:	D. Perry/ 845-0867		
Service Order No.	CF031-02	Send Report to SMO:	J. Conn/ 505-844-3185		
Location	Tech Area				
Building NA	Room NA				

Waste Characterization -RCRA Date=
Send:Preliminary/report to
Validation Required
Released by COC No.: 605644

Bill To: Sandia National Labs (Accounts Payable)
P.O. Box 5800, MS-0154
Albuquerque, NM., 87185-0154

Reference LOV(available at SMO)

Sample No.-Fraction	ER Sample ID or Sample Location Detail	Beginning Depth (ft)	ER Site No.	Date/Time(hr) Collected	Sample Matrix	Container Type	Container Volume	Preservative All@4C	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
059653-005	S282-GR-109-0-SS	0	28-2	090402/1046	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059653-002	S282-GR-109-0-SS	0	28-2	090402/1045	S	G	250mil	None	G	SA	HE	
059654-005	S282-GR-110-0-SS	0	28-2	090402/1017	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059654-002	S282-GR-110-0-SS	0	28-2	090402/1016	S	G	250mil	None	G	SA	HE	
059655-005	S282-GR-111-0-SS	0	28-2	090402/1036	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059655-002	S282-GR-111-0-SS	0	28-2	090402/1035	S	G	250mil	None	G	SA	HE	
059656-005	S282-GR-112-0-SS	0	28-2	090402/1008	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059656-002	S282-GR-112-0-SS	0	28-2	090402/1007	S	G	250mil	None	G	SA	HE	
059656-006	S282-GR-112-0-DUP	0	28-2	090402/1011	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059656-007	S282-GR-112-0-DUP	0	28-2	090402/1010	S	G	250mil	None	G	SA	HE	

RMMA ☑ Yes ☐ No Ref. No.
Sample Disposal ☐ Return to Client ☑ Disposal by lab
Turnaround Time ☐ 7 Day ☐ 15 Day ☑ 30 Day
Return Samples By: ☐ Negotiated TAT

Sample Tracking — Smo Use
Date Entered(mm/dd/yy) 09/10/02
Entered by: RK
QC inits.

Special Instructions/QC Requirements:
EDD ☑ Yes ☐ No
Raw Data Package ☑ Yes ☐ No
*Please send report to:
LTD QTY

Abnormal Conditions on Receipt

Sample Team Members

Name	Signature	Init	Company/Organization/Phone
W. Gibson	William Gibson	WG	MDM/6135/284-5232
D. Grandi	D. Grandi	DAG	Shaw/6135/263-6467

1.Relinquished by D. Grandi	Org. 6135	Date 9/5/02	Time 1005	4.Relinquished by	Org. Date Time
1. Received by	Org. 6132	Date 9/5/02	Time 1005	4. Received by	Org. Date Time
2.Relinquished by	Org. 6132	Date 9/9/02	Time 1030	5.Relinquished by	Org. Date Time
2. Received by	Org.	Date	Time	5. Received by	Org. Date Time
3.Relinquished by	Org.	Date	Time	6.Relinquished by	Org. Date Time
3. Received by	Org.	Date	Time	6. Received by	Org. Date Time

CONTRACT LABORATORY

Analysis Request And Chain Of Custody (Continuation)

AR/COC- 605645

Project Name: 28-2 Mine Site VCA		Project/Task Manger: Caroline Byrd						Project/Task No.: 02.02.05				
Location	Tech Area											
Building NA	Room NA	Reference LOV (available at SMO)										Lab use
Sample No-Fraction	ER Sample ID or Sample Location detail	Beginning Depth (ft)	ER Site No.	Date/Time (hr) Collected	Sample Matrix	Container Type	Container Volume	Preserve All@4C	Collection Method	Sample Type	Parameter & Method Requested	Lab Sample ID
059657-005	S282-GR-113-0-SS	0	28-2	090402/0952	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059657-002	S282-GR-113-0-SS	0	28-2	090402/0950	S	G	250mil	None	G	SA	HE	
059658-005	S282-GR-114-0-SS	0	28-2	090402/1005	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059658-002	S282-GR-114-0-SS	0	28-2	090402/1002	S	G	250mil	None	G	SA	HE	
059659-005	S282-GR-115-0-SS	0	28-2	090402/0957	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059659-002	S282-GR-115-0-SS	0	28-2	090402/0959	S	G	250mil	None	G	SA	HE	
059660-005	S282-GR-116-0-SS	0	28-2	090402/1026	S	G	500 mil	None	G	SA	RCRA Metals PLUS Be and Ni	
059660-002	S282-GR-116-0-SS	0	28-2	090402/1025	S	G	250mil	None	G	SA	HE	
059661-005	S282-GR-117-0-EB	0	28-2	090402/1052	DIW	P	500 mil	None	C	EB	RCRA Metals PLUS Be and Ni	
059661-002	S282-GR-119-0-EB	0	28-2	090402/1054	DIW	AG	2X 1 Liter	None	C	EB	HE	
~~059661-002~~	~~S282-GR-119-0-EB~~	~~0~~	~~28-2~~	~~090402/1056~~	~~DIW~~	~~AG~~	~~1 Liter~~	~~None~~	~~C~~	~~EB~~	~~HE~~ [illegible]	
											NON-[illegible]	
											SENT OUT ON	
											SHIPMENT #	
											13162	

Abnormal Conditions on Receipt

LAB USE

Recipient Initials________

Annex G

ANNEX G
Surface-Water Assessment for SWMU 28-2
February 12, 2004

SURFACE WATER SITE ASSESSMENT **Part B (3 pages)**

Site Information:

1a) Site # 28-2 **1b)** Building # (if applicable) NA **1c)** OU # 1332

2. Date/Time (M/D/Y H:M, 24Hr) 02/12/04 12:00pm

Site Setting:

3a) ☐ On Alluvial Plain.

3b) ☑ Within a bench of an arroyo or drainage basin (hillside)

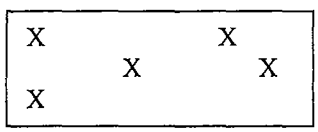
3c) ☐ In canyon floor/drainage basin, but not in an established channel.

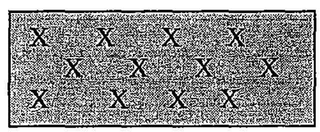
3d) ☐ Within established arroyo channel/drainage basin

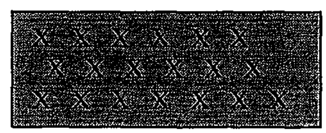
Explanation:
Hillside site - bench on hillside

4. Estimated ground and / or canopy cover at the site: (deciduous leaves, pine needles, vegetation, trees, rocks)

Estimated percent of ground cover:

a) 

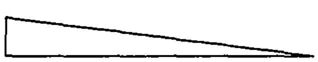
b) 

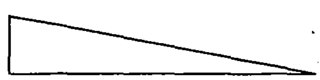
c) 

☐ 0-25% cover ☑ 25-75% cover ☐ 75-100% cover

Explanation:
Vegetation & tailings cover

5. Steepest slope at the area impacted:

a) 

b) 

c) 

☐ less than 10% ☑ 10 to 30% ☐ 30% or greater

Explanation:
Piles

SURFACE WATER SITE ASSESSMENT **Part B (3 pages)**

Runoff Factors:

Y / N

○ ✓ **6)** Is there visible evidence of runoff discharging from the site? If yes, answer a) – c) below:

○ ○ **6a)** Is runoff channelized? If yes, describe. ○ Man-made channel. ○ Natural Channel.

6b) Where does evidence of runoff terminate?

Drainage or wetland. (name)

Within bench of Canyon setting. (name)

Other (retention pond, meadow, mesa top etc)

Explanation:

○ ○ **6c)** Has runoff caused visible erosion at the site? If yes, explain. ○ Sheet ○ Rill ○ Gully

Explanation:

Run-on Factors:

Rate the potential for storm water to run on to this site: (Check **EITHER** #7 or #9)

Note: Include comments in appropriate boxes if both natural and man-made run-on exist.

○ ✓ **7.** Are structures creating run-on to the site? (buildings, roof drains, parking lots, storm drains)

Explanation:

○ ✓ **8.** Are current operations adversely impacting run-on to the site? (fire hydrants, NPDES outfalls)

Explanation:

✓ ○ **9.** Are natural drainage patterns directing stormwater onto the site?

Explanation:

Direct precipitation only.

Assessment Finding:

Y / N

○ ✓ **10.** Based on the above criteria and the assessment of this site, do soil erosion potentials exist? **(REFER TO EROSION POTENTIAL MATRIX)**

Explanation:

Well vegetated and covered site

11. Edw R Mignot — ER SW Representative

SNL / 6133 / 284-3733 — Company / Organization / Phone #

GRAM Inc.

[signature] — Task Leader or Designee

SNL / 6133 / 845 3108 — Company / Organization / Phone

Initials of Independent Reviewer. ☐ Check here when information is entered into database. ☐

Notes Recommendations & Photos. (Please attach photos)

○ ✓ **12a.** Is there visible trash / debris on the site?

○ ✓ **12b.** Is there visible trash / debris in the watercourse?

Description of existing BMP's:

None

○ ✓ **13a.** Are BMP's being properly maintained? (If no, describe in "Other Internal Notes") N/A

○ ✓ **13b.** Are BMP's effectively keeping sediment in place and reducing erosion potential? N/A

Recommended BMP's for this site:

None required

Other Internal Notes:

Surface Water Site Assessment Erosion Matrix Sheet

SWMU / IRP # 28-2

CRITERIA EVALUATED	Value	Erosion / Sediment transport Potential Factor — Low 0.1	Medium 0.5	High 1.0	Calculated Score
Site Setting (43 point max.)					
On Mesa top or hill top	1	No Multiplying Factor	Defined Based on Topgraphic Setting		
Within bench of canyon/drainage basin	4				4
Within canyon floodplain or drainage basin, but not in watercourse	13				
Within canyon bottom or drainage basin and in watercourse	17				
Estimated % ground and canopy cover	13	> 75 %	25 - 75 %	< 25 %	6.5
Slope at area impacted	13	0 - 10 %	10 - 30 %	> 30 %	6.5
Surface Water Run-off Factors (46 point max.)				Section Total	17
Visible evidence of runoff discharge? (Y/N)	5	If NO, Score 0 for Run-off Section. If YES, Score 5 and Complete Section.			0
Where does runoff terminate?	19	Other	Bench Setting	Drainage/Wetland	
Has runoff caused visible erosion? (Y/N)	22	Sheet	Rill	Gully	
		If NO, Score as 0. If YES, Caculate and Record Value.			
Surface Water Run-on Factors (11 point max.)				Section Total	0
Do structures adversely affect run-on?* (Y/N)	7	If YES, Score as 7. If NO, Score as 0.			0
Does natural drainage adversely affect site run-on?* (Y/N)	7	If YES, Score as 7. If NO, Score as 0.			7
Do current operations adversely impact site run-on? (Y/N)	4	If YES, Score as 4. If NO, Score as 0.			0
* Select either structures OR natural drainage.					
MAX. POSSIBLE EROSION MATRIX SCORE:	100	Score: < 40 = low erosion potential 40 - 60 = moderate erosion potential > 60 = high erosion potential		**Total Score**	24