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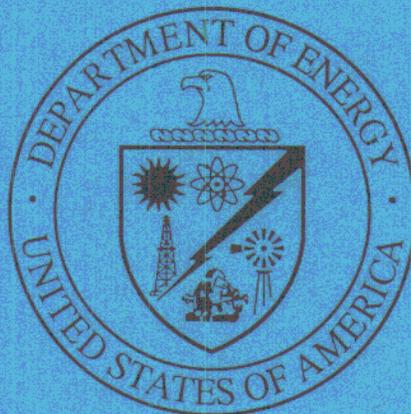
PROPOSAL FOR  
RISK-BASED NO FURTHER ACTION  
ENVIRONMENTAL RESTORATION SITE 88B  
FIRING SITE: INSTRUMENTATION POLES  
CENTRAL COYOTE TEST AREA  
OPERABLE UNIT 1334

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September 1997

Environmental  
Restoration  
Project



United States Department of Energy  
Albuquerque Operations Office

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CENTRAL COYOTE TEST AREA  
OPERABLE UNIT 1334  
September 1997**

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

Prepared for  
the U. S. Department of Energy

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## ACRONYMS AND ABBREVIATIONS

CEARP	Comprehensive Environmental Assessment and Response Program
COC	constituent(s) of concern
cpm	count(s) per minute
DOE	U.S. Department of Energy
DOU	Document of Understanding
EOD	Explosives Ordnance Disposal
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
HE	high explosive(s)
HPLC	High Pressure Liquid Chromatography
HQ	Hazard Quotient
KAFB	Kirtland Air Force Base
mg/kg	milligram(s) per kilogram
mrem	millirem(s)
NaI	sodium iodide
NFA	no further action
NMED	New Mexico Environment Department
OB	Oversight Bureau
pCi/g	picocuries per gram
PID	photoionization detector
PVC	polyvinyl chloride
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SVOC	semivolatile organic compound(s)
SWMU	solid waste management unit(s)
TCLP	toxicity characteristic leaching procedure
UXO	unexploded ordnance
VCM	voluntary corrective measures
VOC	volatile organic compound(s)

## 1.0 INTRODUCTION

### 1.1 Description of ER Site 88B

Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 88B (Figure 1-1) is located in the northeastern portion of the Central Coyote Test Range approximately 1,500 feet west of Arroyo del Coyote at the Greystone Manor Site (ER Site 62). This site encompasses ER Site 88A, Former Ranch House, which was also part of this overall investigation. ER Site 88B consists of a wooden instrumentation pole; remnants of steel cable guy wires; a small pit where a second instrument pole was located; a wire mesh grid on the ground between the instrument pole and pit; and a debris mound containing pieces of burned metal, electrical components, and wood (located approximately 100 feet south of the former ranch house). The outer boundary of the combined site is defined by the traces of a circular perimeter road.

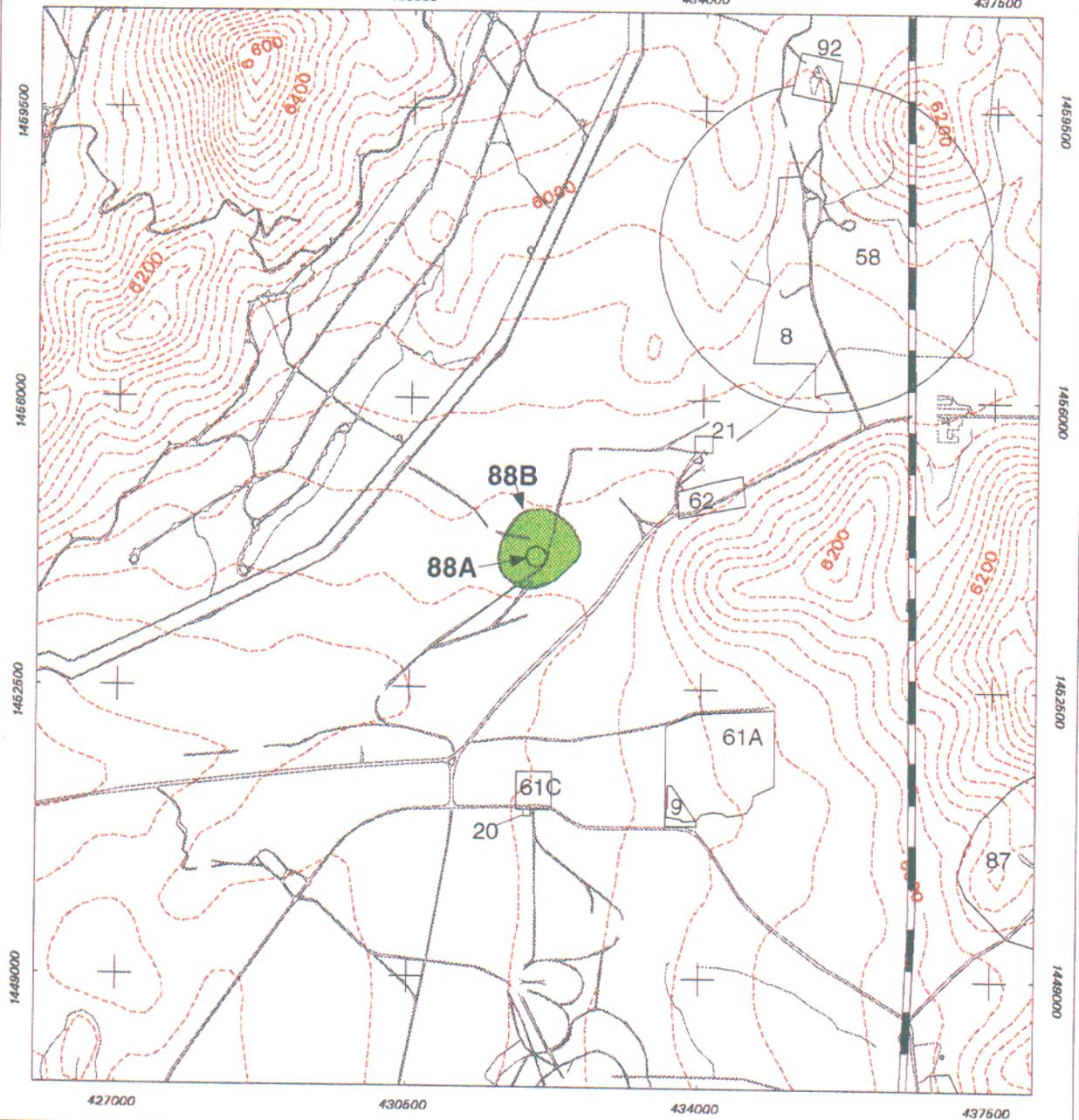
ER Site 88B lies on land owned by KAFB and permitted to the U.S. Department of Energy (DOE). This site is located 1,500 feet west of Arroyo del Coyote at the Greystone Manor Site (ER Site 62). The site covers 15.5 acres of land at a mean elevation of 5,815 feet above sea level (SNL/NM April 1994). Current and projected land use for ER Site 88B is industrial.

The geologic and hydrologic conditions at ER Site 88B are expected to be similar to those measured at the Greystone Manor well, located approximately 100 feet east of the instrumentation poles. The well was originally completed in the early 1900s to a depth of 54 feet below ground surface. To prevent collapse, a small polyvinyl chloride (PVC) pipe was inserted into the original steel casing. Water is present in the lower 2 to 3 feet and is interpreted to originate from groundwater movement along the alluvial-bedrock contact. As such, depth to groundwater at ER Site 88B is estimated to be 51 feet (SNL/NM April 1994).

For a detailed discussion regarding the local setting at ER Site 88B, refer to the Sampling and Analysis Plan included as Section 6.1.

### 1.2 No Further Action Basis

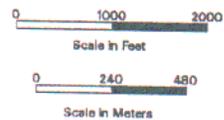
Review and analysis of all relevant data for ER Site 88B indicate that concentrations of constituents of concern (COC) are less than applicable risk assessment action levels. Thus, ER Site 88B is being proposed for a No Further Action (NFA) decision based on confirmatory sampling data demonstrating that COCs that may have been released from this solid waste management unit (SWMU) into the environment pose an acceptable level of risk under current and projected future land use, per NFA Criterion 5 of the ER Document of Understanding (DOU) (NMED 1996).



### Legend

-  Road
-  40 Foot Contour
-  KAFB Boundary
-  Other ER Site
-  ER Site 88

**Figure 1-1  
Location of ER Site 88B,  
Firing Site:  
Instrumentation Pole**



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## 2.0 HISTORY OF ER SITE 88B

### 2.1 Historical Operations

The design of the ER Site 88B facility appears to resemble a typical explosives firing test site because of its wooden instrumentation pole. The period of operation, whether the site was actually used or not (beyond the destruction of the Ranch House by explosives sometime between 1969 and 1971), the purpose of the instrumentation pole, and the purpose or origin of the debris mound were not determined during interviews or archival searches. Historic aerial photographs (USGS 1951, USGS 1967) show two instrumentation poles, dating the period of operation possibly from the early 1950s to late 1960s. Potential wastes associated with a firing site might include pieces of metal shrapnel and residual HE. Although large pieces of shrapnel and explosives are generally picked up or burned after a test, finely divided material could have remained in the test area. Whether the debris mound was associated with explosive firing test site activities, or whether it occurred as the result of other unrelated activities such as KAFB military training maneuvers, is not known.

### 2.2 Previous Audits, Inspections, and Findings

ER Site 88B was identified during investigations conducted under the Comprehensive Environmental Assessment and Response Program (CEARP) (DOE 1987) and the Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA) (EPA 1987). The CEARP determined that there was not enough information to calculate a hazard ranking score for the site. At that time, a wooden instrumentation pole and its guy wires were identified. The regulatory disposition of the solid waste management unit (SWMU) remained uncertain, however, because no conclusion could be reached on whether hazardous waste or constituents were handled at the site. Insufficient information also prevented calculating a Hazard Ranking System score for the SWMU.

Subsequent to the CEARP inspection, the U.S. Environmental Protection Agency (EPA) conducted an RFA. The RFA report (EPA 1987) noted the presence of these same items reported in the CEARP and identified the SWMU in Section VII, "Other Areas of Concern," which addresses areas that do not meet the regulatory definition of a SWMU.

The features identified in the CEARP and RFA investigations are now known as ER Site 88B. ER Site 88A is defined as the rubble associated with the former Ranch House that lies to the east of the features identified in the CEARP and RFA reports. Background inquiries have not identified the activities that are related to the site structures or any current or former SNL/NM employees that participated in tests at this site.

### 3.0 EVALUATION OF RELEVANT EVIDENCE

The following are discussions of the evidence presented in support of a decision of NFA for ER Site 88B.

#### 3.1 Unit Characteristics and Operating Practices

There are currently no physical or administrative controls at ER Site 88B. There is no visual evidence of explosive tests at ER Site 88B (e.g., pieces of shrapnel) indicating that the site released hazardous waste or constituents into the environment. The debris mound contains burned wood, electrical components, wire, and metal. The debris mound has been removed as a voluntary corrective measure (VCM), and the waste from this removal has been disposed of properly.

#### 3.2 Results of SNL/NM ER Project Sampling/Surveys

##### 3.2.1 Summary of Prior Investigations

The following sources of information, presented in chronological order, were used to evaluate ER Site 88B:

- Interviews with current and retired SNL/NM facility personnel
- Aerial photographs (USGS 1951, USGS 1967)
- Field notes and photographs from several inspections conducted by SNL/NM ER Staff
- One UXO/HE survey of the area (1993)
- One surface gamma radiation survey of the area (1994)
- Cultural-resources survey (Hoagland and Dello-Russo 1995)
- Sensitive-species survey (IT Corporation 1995)
- RCRA Facility Investigation (RFI) surface soil sampling (including on-site and site-specific background samples) (1995 and 1997).

##### 3.2.2 Reports, Documents, and Interviews

No records were located indicating when this facility was constructed. ER Project interviews with current and former SNL/NM employees provided no information regarding tests conducted

at this facility. There are no operating records for the tests that were conducted during the 1950s. Aerial photographs indicate that the site was constructed around 1951 (USGS 1951). The site was still visible in aerial photographs in 1967 (USGS 1967), and it remains unchanged today.

### 3.2.3 Unexploded Ordnance and High Explosive Survey

In November 1993, KAFB EOD conducted a UXO/HE survey at the site. No live UXO/HE or significant UXO/HE debris was found (Young 1994).

### 3.2.4 Surface Gamma Radiation Survey

In January 1994, RUST Geotech Inc. conducted a surface gamma radiation survey at the site. The survey used crutch-mounted sodium-iodide scintillometers. The area inside and outside the boundaries was surveyed. No anomalies (above background readings of 8 to 12 microrentgen per hour) related to DOE testing activities were found during this survey (SNL/NM 1997), although two fragments of radioactive Fiesta Ware™ ceramics were identified and removed. Uranium is bound within the colorful surface glaze of this pottery.

### 3.2.5 Cultural-Resources Survey

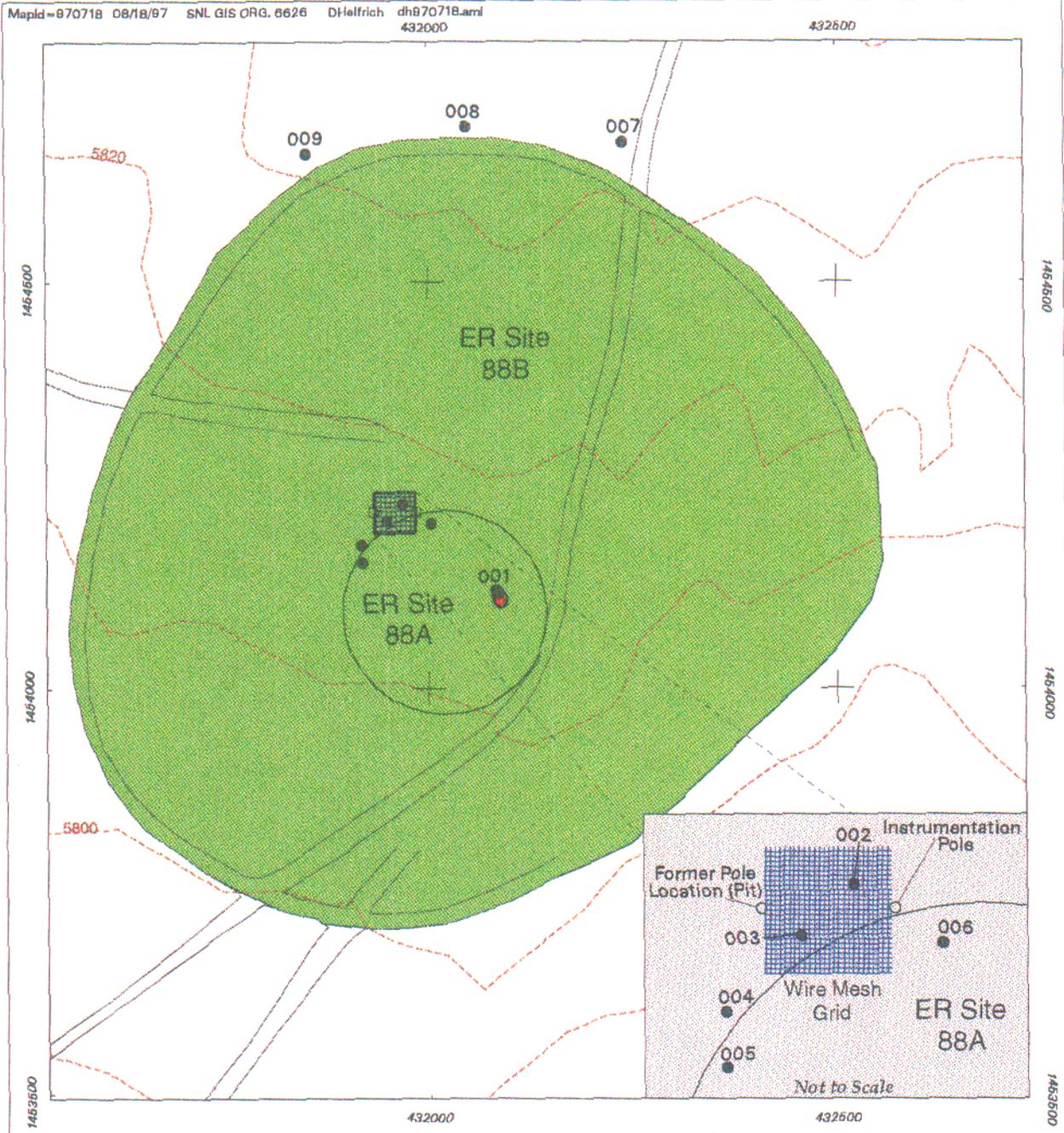
ER Site 88B is located within the boundary of Cultural Resource Site LA 47900. This archaeological site is documented as primarily being the remains of a historic homestead with a very minor prehistoric (Pueblo II-Pueblo III) component represented by two artifacts (Hoagland and Dello-Russo 1995) (Section 6.2). LA 47900 is currently assessed as being potentially eligible to the National Register of Historic Places under criterion (d), "likely to yield information in prehistory or history." In consultation with the State Historic Preservation Office, the DOE/Kirtland Area Office indicated that there would be no adverse effects on the potentially eligible cultural resources as a result of sampling and debris mound removal activities at ER Site 88B (Lacy 1996).

### 3.2.6 Sensitive-Species Survey

No sensitive species were identified at ER Site 88B (IT Corporation 1995).

### 3.2.7 Surface Soil Sampling

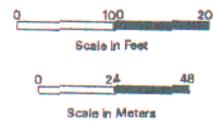
In April 1995 and January 1997, surface soil samples were collected at nine sample locations, including six on-site locations (001 through 006) and three site-specific background locations about 50 feet northeast of the ER Site 88B boundary (007 through 009) (Figure 3-1). Because of constraints regarding the potential cultural resource at ER Site 88B, sampling in the debris mound was delayed until January 1997, when the State Historic Preservation Office was able to make a determination on the effects of sampling on that potential resource. At each location (except 001, which was collected under the debris mound after it was removed), samples were



### Legend

- Sample Location
- Instrumentation Pole
- Road
- - - 10 Foot Contour
- Mound
- Wire Mesh Grid
- ER Site 88

**Figure 3-1**  
**Soil Sampling Locations**  
**at ER Site 88, Firing Site:**  
**Instrumentation Pole**



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collected at two depth intervals, 0 to 0.5 and 0.5 to 1 foot. Field screening for volatile organic compounds (VOC) and beta-gamma and gamma radiation was performed at each sampling location. Sample analyses were conducted at both on-site and off-site laboratories in accordance with standard EPA Methods: EPA Method 6010/7000 for RCRA metals plus beryllium, EPA Method 8330 or equivalent High Pressure Liquid Chromatography (HPLC), and EPA Method 8240 for VOCs. Gamma spectroscopy analyses were performed at the SNL/NM Radiation Protection Sample Diagnostics Laboratory. Isotopic uranium and thorium analyses were performed off site using alpha spectroscopic techniques. All samples were field-screened for organic compounds and radioactivity using both a photoionization detector (PID) and a beta-gamma (pancake) probe. Chemical analytical results for surface soil samples are summarized in Table 3-1. Radiological results for these surface soil samples are summarized in Tables 3-2 and 3-3.

Field screening for VOCs was performed using a PID. There were no detectable VOCs at any sample location or depth interval. Radiation field screening measurements were taken on all soil samples using a pancake Geiger-Mueller (GM) beta-gamma probe, as well as a 2- by 2-inch NaI gamma scintillometer. These radiation field measurements were compared to background radiation measurements. No radiation above background levels (80 counts per minute [cpm] pancake GM and 10,465 cpm for NaI scintillometer) was identified in any soil sample.

Review and analysis of relevant surface soil chemical data for ER Site 88B indicate that the concentrations of COCs at this site are below the SNL/NM and NMED-OB agreed-upon sitewide background levels at all locations with the exception of beryllium (maximum 1.0B mg/kg; at sample locations 002 and 005) and cadmium (maximum 0.74B mg/kg; at sample locations 002 and 004). Neither HE nor VOCs were detected in any of the samples.

Review and analysis of relevant surface soil radiological data for ER Site 88B indicate that the concentrations of COCs at this site are below the SNL/NM and NMED-OB agreed-upon Canyons Area background levels at all locations with the exception of Th-232 (1.12 pCi/g maximum; sample numbers 004 and 006) and Ra-228 (1.16 pCi/g; sample number 002). Site-specific background sample locations also showed Th-228 levels (range 0.90 to 1.69 pCi/g; sample numbers 007 through 009) and Th-232 levels (range 1.14 to 1.64 pCi/g; sample numbers 007 and 008) were above SNL/NM and NMED-OB agreed-upon canyons background levels. Since the site-specific locations were also elevated, this indicates that elevated thorium activities are probably naturally occurring at ER Site 88B.

In January 1997 a soil sample was also collected from within the debris mound and analyzed for toxicity characteristic leaching procedure (TCLP) metals (EPA Methods 1311 and 6020) to characterize the waste stream for disposal. Upon analysis of the TCLP data, SNL/NM Waste Operations determined that this material was acceptable for off-site waste disposal. The debris from the mound was placed in plastic-lined 55-gallon drums and removed off site for proper disposal.

Table 3-1  
 Summary of ER Site 88B RFI Surface Soil Sample Analytical Results, April 1995 and January 1997

Sample Number	Sample Attributes			Metals (EPA 8010/7000) (mg/kg)										High Explosives (EPA Method 8330)	VOCs (EPA Method 8240) (ug/L)
	Sample Date	ER Sample ID (Figure 3-1)	Sample Depth (ft)	As	Ba	Be	Bi	Cd	Cr	Hg	Se	Pb	Ag		
32498	1/9/97	88B-GR-001-0-0.5-S	0-0.5	1.7J	57	0.4	0.21	7.5	ND*	ND	8.5	0.15	ND	ND	
22722	4/26/95	88B-GR-002-0-S	0-0.5	5.6	152	0.87B	ND	15.6	ND	ND	16.5	ND	ND	NA	
22723	4/26/95	88B-GR-002-6-S	0.5-1.0	4.4	157	0.76B	ND	13.6	ND	ND	14.3	ND	ND	ND	
22724	4/26/95	88B-GR-002-6-SD	0.5-1.0	3.8	157	0.77B	0.74B	13.8	ND	ND	12.1	ND	ND	ND	
22725	4/26/95	88B-GR-003-0-S	0-0.5	4.0	115	0.66B	ND	12.6	ND	ND	9.7	ND	ND	NA	
22726	4/26/95	88B-GR-003-6-S	0.5-1.0	3.5	126	0.65B	ND	12.6	ND	ND	11.2	ND	ND	NA	
22727	4/26/95	88B-GR-004-0-S	0-0.5	2.6	106	0.55B	0.69B	10.4	ND	ND	9.2	ND	ND	NA	
22728	4/26/95	88B-GR-004-6-S	0.5-1.0	4.5	102	0.68B	ND	12.6	ND	ND	10.7	ND	ND	NA	
22729	4/26/95	88B-GR-005-0-S	0-0.5	2.3	87.1	0.48B	ND	9.4	ND	ND	8.1	ND	ND	NA	
22730	4/26/95	88B-GR-005-6-S	0.5-1.0	7.0	105	1.0B	ND	17.1	ND	ND	13.3	ND	ND	NA	
22731	4/26/95	88B-GR-006-0-S	0-0.5	2.1	86.5	0.49B	ND	8.9	ND	ND	9.6	ND	ND	NA	
22732	4/26/95	88B-GR-006-6-S	0.5-1.0	3.7	151	0.82B	ND	14.0	ND	ND	12.2	ND	ND	NA	
22733	4/26/95	88B-GR-007-0-S	0-0.5	2.7	94.2	0.51B	ND	8.5	ND	ND	10.1	ND	ND	NA	
22734	4/26/95	88B-GR-007-6-S	0.5-1.0	2.6	125	0.52B	ND	9.5	ND	ND	7.3	ND	ND	NA	
22735	4/26/95	88B-GR-008-0-S	0-0.5	2.9	108	0.60B	ND	10.7	ND	ND	10.8	ND	ND	NA	
22736	4/26/95	88B-GR-008-6-S	0.5-1.0	4.2	135	0.74B	ND	12.7	ND	ND	12.1	ND	ND	NA	
22737	4/26/95	88B-GR-009-0-S	0-0.5	2.2	90.1	0.47B	ND	7.7	ND	ND	8.7	ND	ND	NA	
22738	4/26/95	88B-GR-009-6-S	0.5-1.0	3.6	106	0.62B	ND	10.4	ND	ND	11.3	ND	ND	NA	
Practical Quantitation Limit (mg/kg)				1.0	1.0	0.2	0.5	1.0	0.1	0.77	5.0	1.0	NA	NA	
<b>Surface Sample Quality Assurance/Quality Control Samples (in mg/L)</b>															
22739	4/26/95	88B-GR-010-0-EB	NA	ND	ND	ND	ND	7.9B	ND	ND	2.1B	ND	ND	NA	
22740	4/26/95	88B-GR-011-0-TB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	
22741	4/26/95	88B-GR-012-0-TB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND	
22742	4/26/95	88B-GR-013-0-FB	NA	ND	ND	ND	8B	ND	ND	ND	2.1B	ND	ND	14**	
32504	1/9/97	88B-GR-000-TB	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	ND*	
32503	1/9/97	88B-GR-000-EB	NA	ND	ND	ND	ND	0.019*J	ND	0.22J	ND	ND	ND	5.6J**	
Practical Quantitation Limit (mg/L)				0.01	0.01	0.002	0.005	0.01	0.0002	0.005	0.003	0.010	NA	NA	
Background Maximum Value (T Corporation 1996)				9.8	246	0.75	0.64	18.8	0.055	3.0	18.9	< 0.5	NA	NA	

Notes: mg/kg - Milligrams per kilogram; mg/L - Milligrams per liter; ug/L - Micrograms per liter.

Metals: As - arsenic; Ba - barium; Be - beryllium; Bi - bismuth; Cd - cadmium; Cr - chromium; Hg - mercury; Se - selenium; Pb - lead; Ag - silver.

J - Concentration below the practical quantitation limit (PQL); B - Analyte was detected in the laboratory method blank.

ND - Not detected at the PQL; UTL - Upper tolerance limit; NA - Not applicable.

ND\* - VOCs detected (ug/L); Actone 17J; Chlorobenzene 1.2J; Trichloroethene 1.1J; Toluene 1.2J; Benzene 1.4J.

\*Analyzed beyond 28 day holding time \*\*Value is for acetone.

Table 3-2  
 Summary of ER Site 88B RFI Surface Soil Sampling On-Site Radiological Results, April 1995

Sample Number	Sample Attributes		Radionuclides by Gamma Spec (pCi/g)							
	Sample Date	ER Sample ID (Figure 3-1)	Sample Depth (ft)	U-235	U-238	Th-232	Th-234	Ra-226	Ra-228	Cs-137
22722	4/26/95	88B-GR-002-0-S	0-0.5	ND	ND	0.922	0.826	2.53	0.852	0.381
22723	4/26/95	88B-GR-002-6-S	0.5-1.0	ND	ND	1.020	2.29	2.33	0.608	ND
22724	4/26/95	88B-GR-002-6-SD	0.5-1.0	ND	ND	0.644	1.57	1.44	1.16	0.00627
22725	4/26/95	88B-GR-003-0-S	0-0.5	ND	ND	0.819	ND	1.04	0.44	0.0424
22727	4/26/95	88B-GR-004-0-S	0-0.5	ND	ND	1.12	1.2	1.45	0.855	0.137
22729	4/26/95	88B-GR-005-0-S	0-0.5	ND	ND	0.538	0.964	1.03	0.618	0.0992
22731	4/26/95	88B-GR-006-0-S	0-0.5	ND	ND	1.08	ND	1.45	0.63	0.575
22733	4/26/95	88B-GR-007-0-S	0-0.5	ND	ND	0.0813	ND	2.31	0.955	0.176
22734	4/26/95	88B-GR-007-6-S	0.5-1.0	ND	ND	0.789	0.925	1.68	0.514	ND
22735	4/26/95	88B-GR-008-0-S	0-0.5	ND	ND	0.89	ND	1.77	0.96	0.148
22736	4/26/95	88B-GR-008-6-S	0.5-1.0	ND	ND	0.889	1.16	1.67	0.847	ND
22737	4/26/95	88B-GR-009-0-S	0-0.5	ND	ND	0.686	1.27	1.72	0.879	0.0464
22738	4/26/95	88B-GR-009-6-S	0.5-1.0	ND	1.42	0.688	1.4	1.28	1.088	ND
Background Maximum Value (IT Corporation 1996)				0.16	2.31	1.03	2.31	2.6	1.088	1.063

Notes: pCi/g - Picocuries per gram; ft - Foot.

Radionuclides: U-235 - uranium 235; U-238 - uranium 238; Th-232 - thorium 232; Th-234 - thorium 234; Ra-226 - radium 226; Cs-137 - cesium 137.

ND - Not detected.

Table 3-3  
 Summary of ER Site 88B RFI Surface Soil Sampling Off-Site Radiological Results, April 1995

Sample Attributes		Isotopic Uranium and Thorium by Alpha Spectroscopy (pCi/g)						
Sample Number	ER Sample ID (Figure 3-1)	Sample Depth (ft)	U-233/234	U-235	U-238	Th-228	Th-230	Th-232
22733	88B-GR-007-0-S	0-0.5	0.736	0.065	0.69	1.37	1.13	1.43
22734	88B-GR-007-6-S	0.5-1.0	0.826	0.067	0.0793	1.19	0.93	1.15
22735	88B-GR-008-0-S	0-0.5	0.60	0.066	0.66	1.18	0.965	1.14
22736	88B-GR-008-6-S	0.5-1.0	0.860	0.049	0.863	1.68	1.21	1.64
22737	88B-GR-009-0-S	0-0.5	0.805	0.018	0.809	0.9	0.754	0.89
22738	88B-GR-009-6-S	0.5-1.0	0.809	0.053	0.778	1.11	0.993	1.022
Background Maximum Value (IT Corporation 1996)			2.31	0.16	2.31	1.08*	2.31**	1.03

Notes: pCi/g - Picocuries per gram; ft - Foot.

Radionuclides: U-233/234 - uranium 233/234; U-235 - uranium 235; U-238 - uranium 238; Th-228 - thorium 228;

Th-230 - thorium 230; Th-232 - thorium 232.

ND - Not detected.

\*Assume Th-228 is in equilibrium with its parent, Ra-228.

\*\*Assume Th-230 is in equilibrium with its parent, U-234.

The human health risk assessment indicates that none of the constituents found in elevated concentrations at ER Site 88B pose unacceptable risk under the industrial land-use scenario. The ecological risk assessment indicates that none of the constituents found in elevated concentrations at ER Site 88B pose unacceptable risk to indicator species.

### **3.2.7.1**      *Quality Assurance/Quality Control Results*

Two equipment blanks, three trip blanks and a field blank were analyzed for metals, HE, and VOCs (Table 3-1). No HE compounds were detected (Table 3-1). Low concentrations of chromium (7.9B and 8B mg/L) and lead (2.1B mg/L) were detected in the April 1995 equipment and field blanks. Low levels of mercury (0.019J mg/L) and lead (0.22J mg/L) were detected in the January 1997 equipment blank (Table 3-1). None of these metal concentrations indicated potential problems with the soil data.

VOCs were detected in the April 1995 field blank and in the January 1997 trip and equipment blanks (Table 3-1). Acetone was detected in all three of these blanks (5.6 to 17J mg/L). The January 1997 trip blank also contained chlorobenzene (1.2J mg/L), trichlorethene (1.1J mg/L), toluene (1.2J mg/L), and benzene (1.4J mg/L). None of these concentrations indicated potential problems with the soil data.

## **3.3**            **Gaps In Information**

The original (i. e., pre-RFI) gaps in information for ER Site 88B included lack of reliable data on the actual uses of the site and the possible contaminants associated with them. The RFI focused on the distribution of contaminants within the area and underneath the debris mound. The nature and extent of metals, radionuclides, VOCs, and HE in soils was characterized for this site in order to develop human and environmental risk scenarios, as well as to make an NFA determination.

## **3.4**            **Risk Evaluation**

ER Site 88B had relatively minor contamination consisting of some nonradioactive metals and explosives. Because of the location of the site on KAFB, the designated industrial land-use scenario, and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust inhalation. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land use for human health evaluation (DOE and USAF 1996); the residential land-use scenario is provided for perspective only. The results are summarized below, and the detailed assessment parameters and assumptions are presented in Section 6.3.

### **3.4.1**            **Human Health Risk Assessment**

ER Site 88B has been recommended for industrial land use (DOE and USAF 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in

Section 6.3. Due to the presence of several metals in concentrations greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. Besides metals, any VOCs detected above their reporting limits and any radionuclide compounds either detected above background levels and/or minimum detectable activities were included in this assessment. The Risk Assessment Process provides a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The risk assessment report calculated the Hazard Index and excess cancer risk for both an industrial and residential land-use settings.

In summary, the Hazard Index calculated for ER Site 88B nonradiological COCs is 0.02 for an industrial land-use setting, which is substantially less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental risk is determined by subtracting risk associated with background from potential nonradiological COC risk. The incremental Hazard Index is zero. The excess cancer risk for ER Site 88B nonradiological COCs is  $6 \times 10^{-8}$  for an industrial land-use setting, which is at the low end of the suggested range of acceptable risk of  $10^{-4}$  to  $10^{-6}$  (EPA 1989). The incremental excess cancer risk for ER Site 88B is zero.

The residential land-use scenarios for this site are provided only for comparison in the risk assessment report (Section 6.3). The report concludes that ER Site 88B does not have significant potential to affect human health under an industrial land-use scenario.

### 3.4.2 Ecological Risk Assessment

It was also necessary to perform an ecological risk assessment analysis for ER Site 88B (Section 6.3). This risk assessment process provides a quantitative evaluation of the potential adverse ecological effects to indicator species caused by constituents in the site's soil. The risk assessment report calculated the Hazard Quotient (HQ) for representative plant, deer mouse, and burrowing owl species as ecological receptors.

Potential risks were indicated for all three ecological receptors at ER Site 88B; however, the use of the maximum measured concentration or one-half the detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions. Although the HQ for plants exposed to chromium exceeded unity, the actual background concentration of 18.8 mg/kg is greater than the on-site maximum of 17.1 mg/kg. No ecological risks are therefore predicted from exposure to chromium. (Chromium was carried through the ecological risk assessment to be consistent with the human health risk process.) Although RDX and 1,3-dinitrobenzene produced HQs greater than 1 for the deer mouse using one-half the detection limits, none of the explosive compounds were detected. Due to insufficient toxicity data for HE compounds, potential risk estimates could not be determined for the terrestrial plant or the burrowing owl. Because none of the HE compounds (using one-half the detection limits) resulted in HQs greater than 2 for the deer mouse, and the home range for the burrowing owl is 128 times greater than that of the mouse, it is unlikely that the burrowing owl would be adversely affected by any HE compounds at this site. No protected vertebrate species are expected to occur in the area. Potential adverse effects to plant, mammalian, and avian populations associated with ER Site 88B are expected to be insignificant.

#### **4.0 RATIONALE FOR NO FURTHER ACTION DECISION**

Based on field investigation data and the human and environmental health assessments, an NFA determination is being recommended for ER Site 88B for the following reasons:

- No VOCs or radionuclides were detected during the field-screening program.
- No VOCs or HE compounds were detected in any site soil samples.
- Except for four detections of beryllium and two detections of cadmium, all metal concentrations detected in site soil samples were below the NMED-OB maximum background values.
- There is no indication of radiological contamination.
- A VCM to characterize and dispose of potentially hazardous materials in a debris mound was completed in January 1997.
- Risk assessments for human health do not show adverse effects under the future industrial land-use scenario.
- Risk assessments for ecological receptors indicate some potential risk under a conservative scenario, but it is expected to be insignificant.

Based on the evidence provided above, ER Site 88B is proposed for an NFA based on Criterion 5 of the ER DOU (NMED 1996).

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## **6.0 ANNEXES**

- 6.1 Sampling and Analysis Plan**
- 6.2 Cultural Resources Survey**
- 6.3 Risk Assessment**

**Section 6.1**  
**Sampling and Analysis Plan**

**SAMPLE AND ANALYSIS PLAN FOR  
ENVIRONMENTAL RESTORATION SITE 88B,  
FIRING SITE: INSTRUMENTATION POLES  
OPERABLE UNIT 1334  
JANUARY 1995**

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

Prepared for the  
United States Department of Energy

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## 1.0 DESCRIPTION AND HISTORY

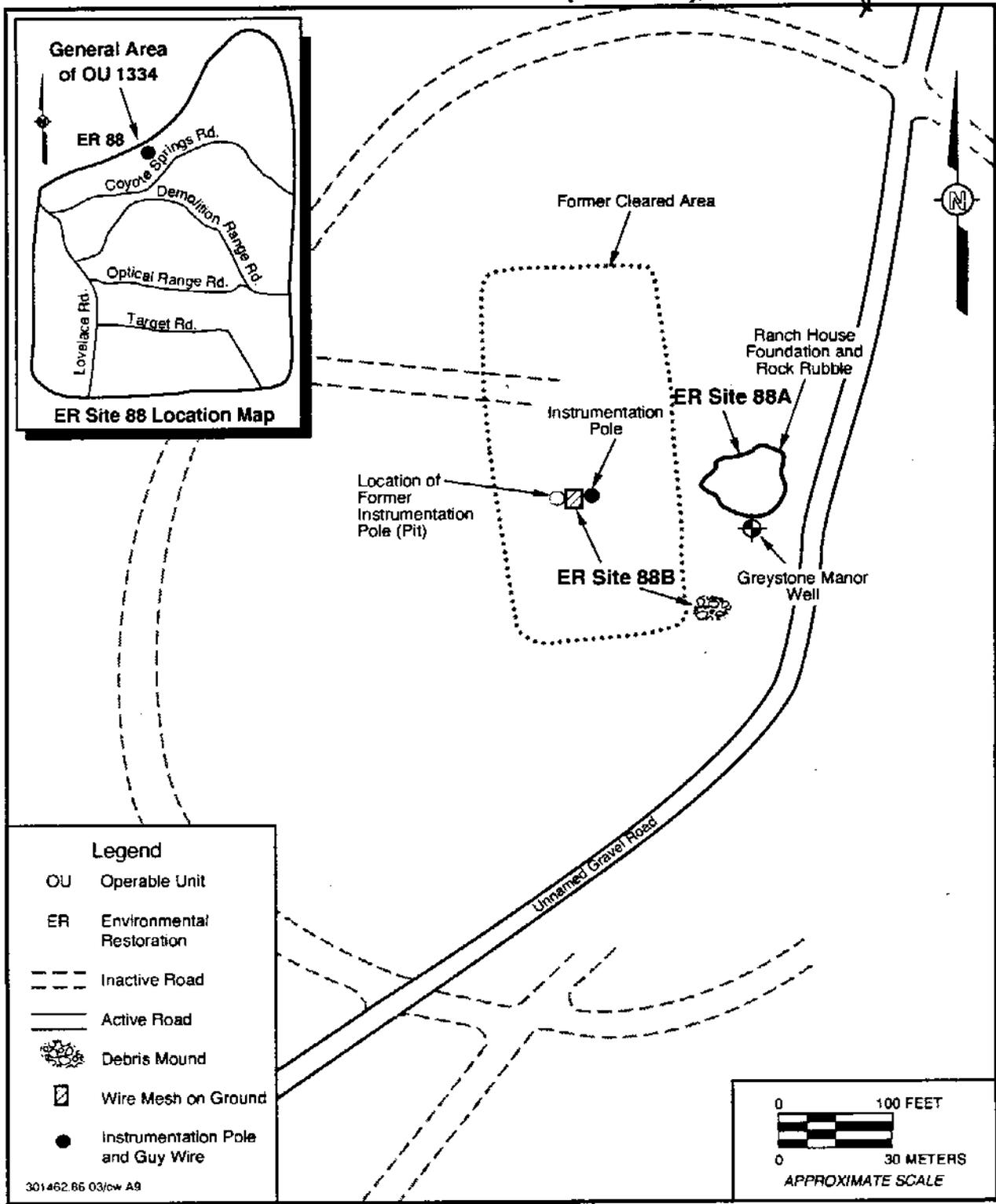
Environmental Restoration (ER) Site 88B (Figure 1-1) consists of two wooden instrumentation poles (only one of which remains at the site); with associated guy wires and a debris mound. The boundary of the site is defined by the traces of a former circular road around the site.

One wooden instrumentation pole supported by two steel cable guy wires lies approximately 100 feet (ft) west of the former Ranch House. A second instrumentation pole visible, in historical aerial photographs (USGS 1951; USGS 1967), was located approximately 50 ft west of this pole. A small pit is now present at this location. There is a guy wire base approximately 84 ft northwest of this pit, and a guy wire lies on the ground near the base. Remnants of a 60-ft by 48-ft wire mesh screen within a wood frame are present on the ground on the west side of the pole and east of the pit. The wire mesh screen appears to be anchored to the ground by metal fasteners in several locations. A plastic anchor lies at the center point of the wire mesh screen.

A debris mound containing pieces of burned metal and wood is located approximately 100 ft south of the former Ranch House (ER Site 88A).

The period of operation and the purpose of the instrumentation poles, wire mesh screen, and plastic anchor were not determined during interviews or archival searches. The resemblance of ER Site 88B to other explosives firing test sites with similar wood poles makes it likely that ER Site 88B was also a firing site. Potential wastes associated with a firing site might include pieces of metal shrapnel and residual high explosives (HE). Although large pieces of shrapnel and explosives are generally picked up or burned after a test, finely divided material could remain in the test area (88-29).

Whether the burned debris mound was associated with this solid waste management unit (SWMU) or whether it occurred as the result of other activities is unknown. Residual material identified in the debris mound includes pieces of burned metal and wood.



**Figure 1-1**  
**Location and Site Map of ER Site 88B, Firing Site:**  
**Instrumentation Poles**

## 2.0 PREVIOUS INVESTIGATIONS

ER Site 88 (now divided into ER Sites 88A and 88B) was first listed as a potential release site based on the Comprehensive Environmental Assessment and Response Program (CEARP) interviews in 1985 (DOE September 1987), which identified a wooden instrumentation pole and its associated guy wires and a wire mesh screen. The regulatory disposition of the SWMU remained uncertain, however, because no conclusion could be reached on whether hazardous waste or constituents were handled at the site. Insufficient information also prevented calculating a Hazard Ranking System score for the SWMU.

Subsequent to the CEARP inspection, the United States (U.S.) Environmental Protection Agency (EPA) conducted a Resource Conservation and Recovery Act (RCRA) Facility Assessment (RFA). The RFA report (EPA April 1987) noted the presence of these same items reported in the CEARP and identified the SWMU in Section VII, "Other Areas of Concern," which addresses areas that do not meet the regulatory definition of a SWMU.

The features identified in the CEARP and RFA investigations are now known as ER Site 88B. ER Site 88A is defined as the rubble associated with the former Ranch House that lies to the east of the features identified in the CEARP and RFA reports.

Recent background investigations conducted by the Sandia National Laboratories/New Mexico (SNL/NM) ER Project have not identified the activities that are related to the utility poles and wire mesh, or any current or former SNL/NM employees that participated in tests at this site.

In November 1993, Kirtland Air Force Base Explosive Ordnance Disposal (EOD) conducted a visual survey of the site for the presence of unexploded ordnance (UXO)/HE on the ground surface. No live ordnance or unexpended HE was identified at the site during this survey. Several items of ordnance debris were removed from the site.

In January 1994, RUST Geotech Inc. conducted a surface radiation survey at the site. The survey used a scintillometer containing a sodium-iodide detector to measure gamma radiation. No anomalies related to U.S. Department of Energy testing activities were found during this survey (RUST Geotech Inc. July 1994). Two fragments of ceramic dinnerware having uranium pigment (Fiesta Ware™) were found.

## **3.0 CONCEPTUAL MODEL**

### **3.1 Initial Conceptual Model**

It is thought that HE may have been used at the site for firing tests, based on its similarity to other firing sites that contain instrumentation poles. The initial conceptual model developed for ER Site 88B (Figure 3-1) consists of contaminant release by surface/air bursts, particulate aerosol dispersal on ground surface, and some test debris that may have been disposed in the debris mound. The debris mound and debris may be related to former Ranch House activities or testing at the instrumentation poles. Available data do not conclusively demonstrate the presence or absence of hazardous waste or constituents at ER Site 88B. Past activities at the site are not documented, but potential waste associated with the firing site activities might include finely divided HE fragments and shrapnel containing metals.

### **3.2 Existing Information on the Nature and Extent of Contamination**

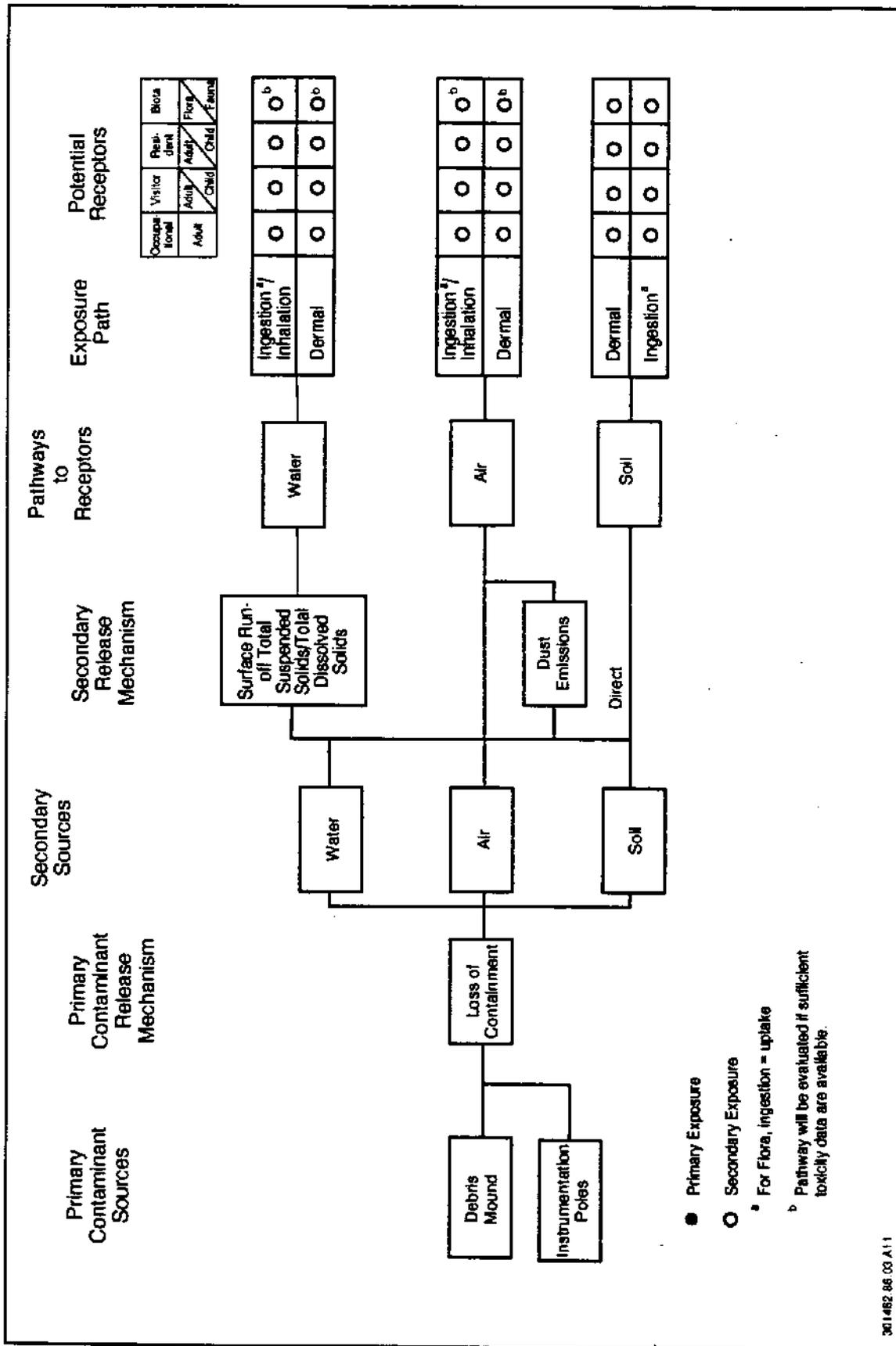
Figure 1-1 shows the surficial distribution of features at ER Site 88B. Visible debris associated with the surficial features include guy wires, a wire mesh screen, and a small debris mound that contains burned wood and metal. Potential constituents of concern (COC) at the site may include metals and HE. The subsurface distribution of possible COCs is unknown. There is no physical evidence that suggests the presence of hazardous constituents, and there is no documented record of burial activities at this site. The nature and extent of potential contaminants in the soil is unknown, and no significant contamination is expected at this site.

### **3.3 Potential Contaminant Migration Pathways**

Figure 3-1 illustrates the potential contaminant migration pathways of air, soil, and surface water, if COCs are present at ER Site 88B. Because scattered materials and the debris mound are nonengineered features subject to wind erosion and transport, air is a potential pathway. Soil surrounding the instrumentation poles and debris mound may contain COCs, and contact with such soil results in a direct exposure pathway. The surface-water pathway to receptors is viable but unlikely, because the distance to the nearest arroyo channel is approximately 1,000 ft. The depth to ground water at this site is approximately 51 ft (SNL/NM October 1994), based on the depth to ground water in the Greystone Manor well (approximately 100 ft east of the firing pole). The limited precipitation and the low infiltration rates (SNL/NM February 1994) preclude ground water as a primary pathway.

### **3.4 Potential Public Health and Environmental Impacts**

Public health and environmental impacts that may be associated with ER Site 88B (Figure 3-1) include ingestion/inhalation and dermal exposure to receptors through the air, soil,



**Figure 3-1**  
**Flow Diagram of Conceptual Model for ER Site 88B**

and surface-water pathways. Because hazardous materials are not thought to be present on the site, all exposure pathways are considered secondary.

#### 4.0 DATA NEEDS/DATA QUALITY OBJECTIVES

The primary data need for ER Site 88B (Table 4-1) is to characterize the nature and concentrations of possible COCs in the soil surrounding the firing poles, the debris, and the soil below the debris mound. Grab soil samples will be taken from randomly selected locations around the instrumentation pole, and judgmental samples will be taken of debris and soil below the debris mound. These samples will be analyzed for COCs to determine whether past activities released COCs to the environment. If COCs are detected above action levels or background concentrations, the site will be investigated through an Operable Unit (OU) 1334 RCRA Facility Investigation (RFI), as described in the Program Implementation Plan (PIP) (SNL/NM February 1994) and in Chapter 4.0 of the OU 1334 RFI Work Plan (SNL/NM October 1994). There are no additional data needs for physical or environmental media characterization (e.g., permeability, geology, etc.) at this site. To comply with National Environmental Policy Act requirements, a sensitive species survey was performed at the site in 1994 (IT August 1994).

**Table 4-1  
Summary of Data Requirements for Characterization of ER Site 88B**

Data Type	Data Needs	Action
Source characterization	<ul style="list-style-type: none"> <li>• Characterize site background for soil (metals and radionuclides)</li> <li>• Characterize the nature and extent of potential COCs in soil surrounding the instrumentation poles</li> <li>• Characterize the material in the debris pile for waste disposal purposes</li> <li>• Characterize the nature and extent of COCs in the soil underlying the debris pile</li> </ul>	<ul style="list-style-type: none"> <li>• Collect soil samples from area north of perimeter road and analyze for metals and radionuclides</li> <li>• Place grid over instrumentation poles and collect random soil samples from around pole and collect judgmental soil samples from mesh area; analyze for COCs in Table 7-1</li> <li>• Collect judgmental sample of debris material; analyze for RCRA Waste Characteristics as shown in Table 7-1</li> <li>• Collect soil sample from under the debris pile and analyze for COCs in Table 7-1</li> </ul>
Environmental characterization	<ul style="list-style-type: none"> <li>• None</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>
Potential receptors	<ul style="list-style-type: none"> <li>• None</li> </ul>	<ul style="list-style-type: none"> <li>• None</li> </ul>

COC = Constituents of Concern  
ER = Environmental Restoration  
RCRA = Resource Conservation and Recovery Act

## 5.0 VOLUNTARY CORRECTIVE MEASURE FOR ER SITE 88B

The radiological point-source anomaly, associated with two pieces of Fiesta Ware™, will be removed by SNL/NM as part of a voluntary corrective measure (VCM) scheduled for February 1995.

## **6.0 SAMPLING PLAN**

Appendix G of the OU 1334 RFI Work Plan (SNL/NM October 1994) describes the specific technical approaches for performing UXO/HE, radiological, and land surveys at ER sites. Quality control (QC) samples (including duplicates, matrix spikes, field blanks, trip blanks, and equipment rinsates) will be collected as specified in the generic Quality Assurance Project Plan (QAPjP) of the PIP (SNL/NM February 1994). Chapter 7.0 summarizes specific quality assurance (QA) and QC samples collected for this sample and analysis plan. The sample management office will screen all samples collected for laboratory analysis for gross alpha, beta, and gamma activity to meet U.S. Department of Transportation sample shipping requirements. Samples will be collected in accordance with the methods presented in Appendix G of the OU 1334 RFI Work Plan (SNL/NM October 1994).

### **6.1 Sampling Plan Objectives and Technical Approach**

The sampling program at ER Site 88B is designed to collect adequate samples to meet the data needs presented in Table 4-1. Specifically, sampling will be conducted at the site to determine whether regulated hazardous waste or constituents (including HE and metals) are present above action levels or background concentrations. Figure 6-1 shows the decision logic for sampling activities at ER Site 88B. Following UXO/HE and land surveys, intrusive sampling will be conducted to investigate the nature and extent of possible COCs in the soil and debris. Samples will be collected as described on Figure 6-1. Field-screening for radioactivity and volatile organic compounds (VOC) vapors will be conducted to monitor the site for health and safety purposes, to identify areas of potential contamination, and to guide in identifying the sample locations. The sections below provide detail on the ER Site 88B sampling plan.

### **6.2 Nonintrusive Surveys**

UXO/HE and radiation surveys were performed in November 1993 and January 1994. No activities have occurred since then that would change conditions at the site.

### **6.3 Intrusive Sampling**

Surface- and near-surface soil samples will be collected to characterize the site background, the area surrounding the instrumentation pole, and the area underlying the debris mound. Additionally, a debris sample will be collected from the debris mound for waste characterization. Appendix G of the OU 1334 RFI Work Plan (SNL/NM October 1994) presents collection procedures and methods.

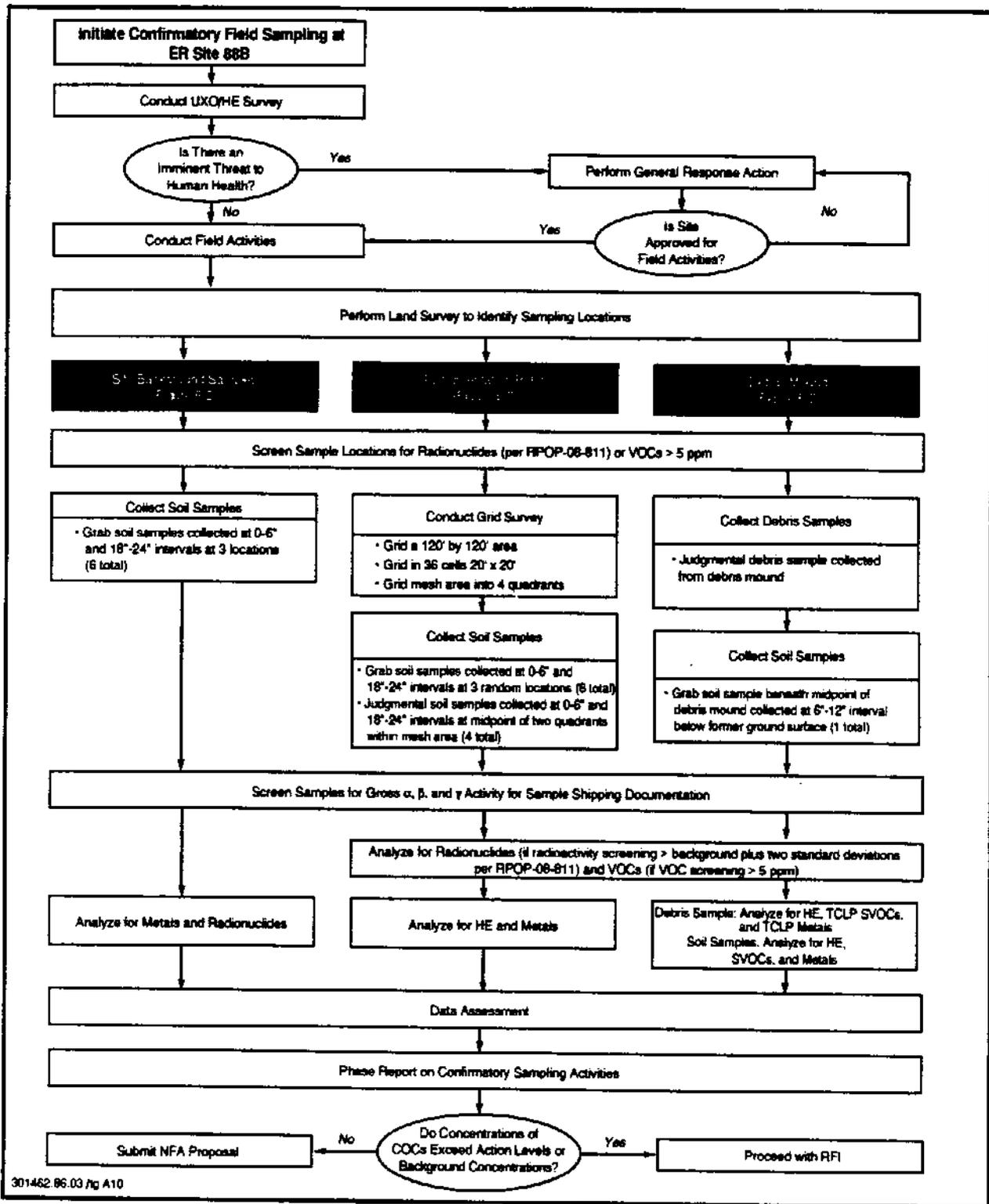


Figure 6-1  
Decision Logic for Sampling Activities at ER Site 88B

### Site Background Samples

Surface- and near-surface soil samples will be collected at three locations (Figure 6-2) to determine site-specific background concentrations for metals and radionuclides. The background concentrations will be compared to metal concentrations found in soils to determine whether COCs have been released to the environment.

### Instrumentation Poles

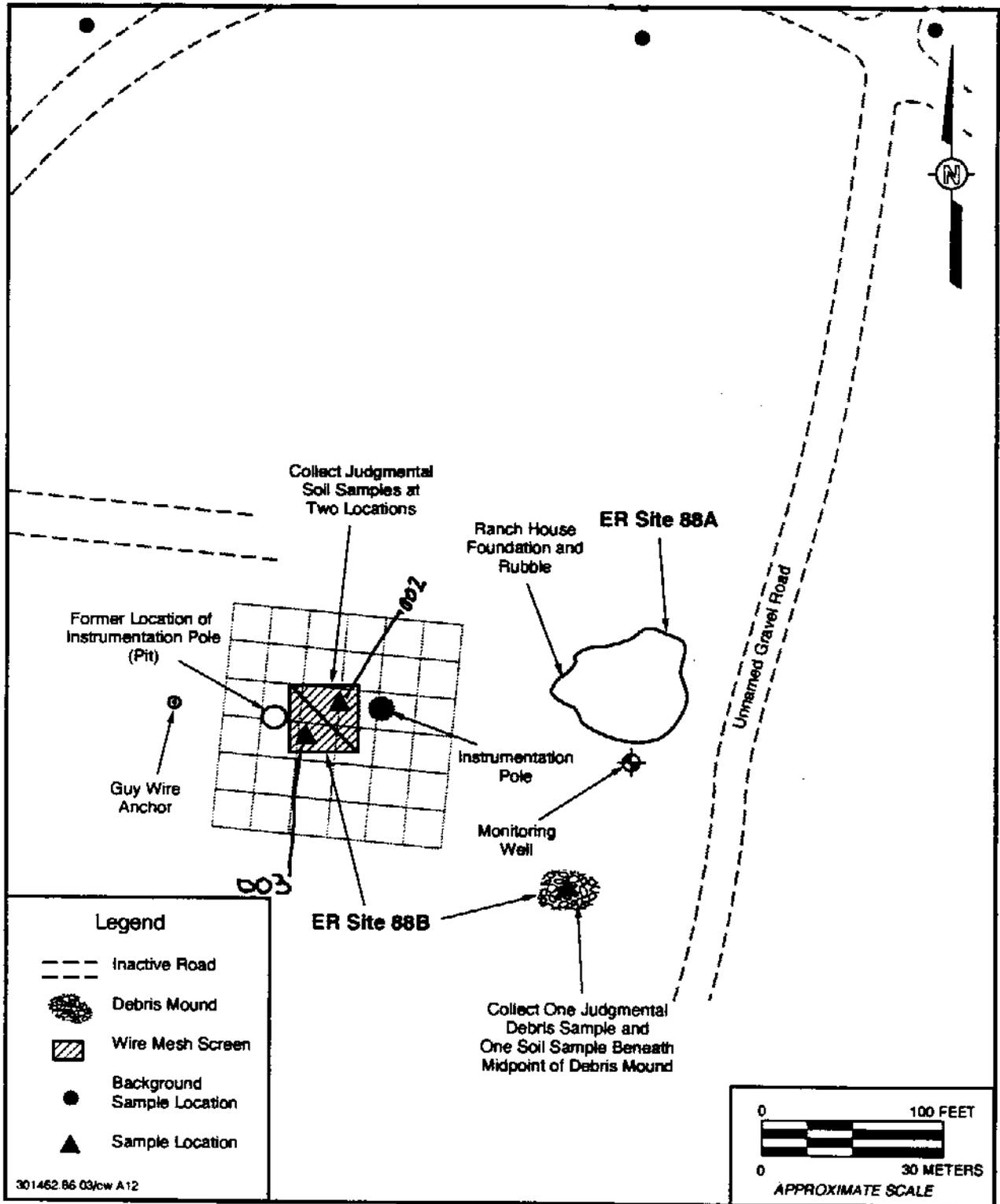
Soil samples will be collected from three random locations within a grid area (Figure 6-3). The samples will be analyzed for HE and metals to determine whether the soil contains hazardous constituents above action levels or background concentrations. In addition, two judgmental soil samples will be collected from the mesh area (Figure 6-2). Soil samples from the mesh area will be analyzed for HE and metals.

### Debris Mound

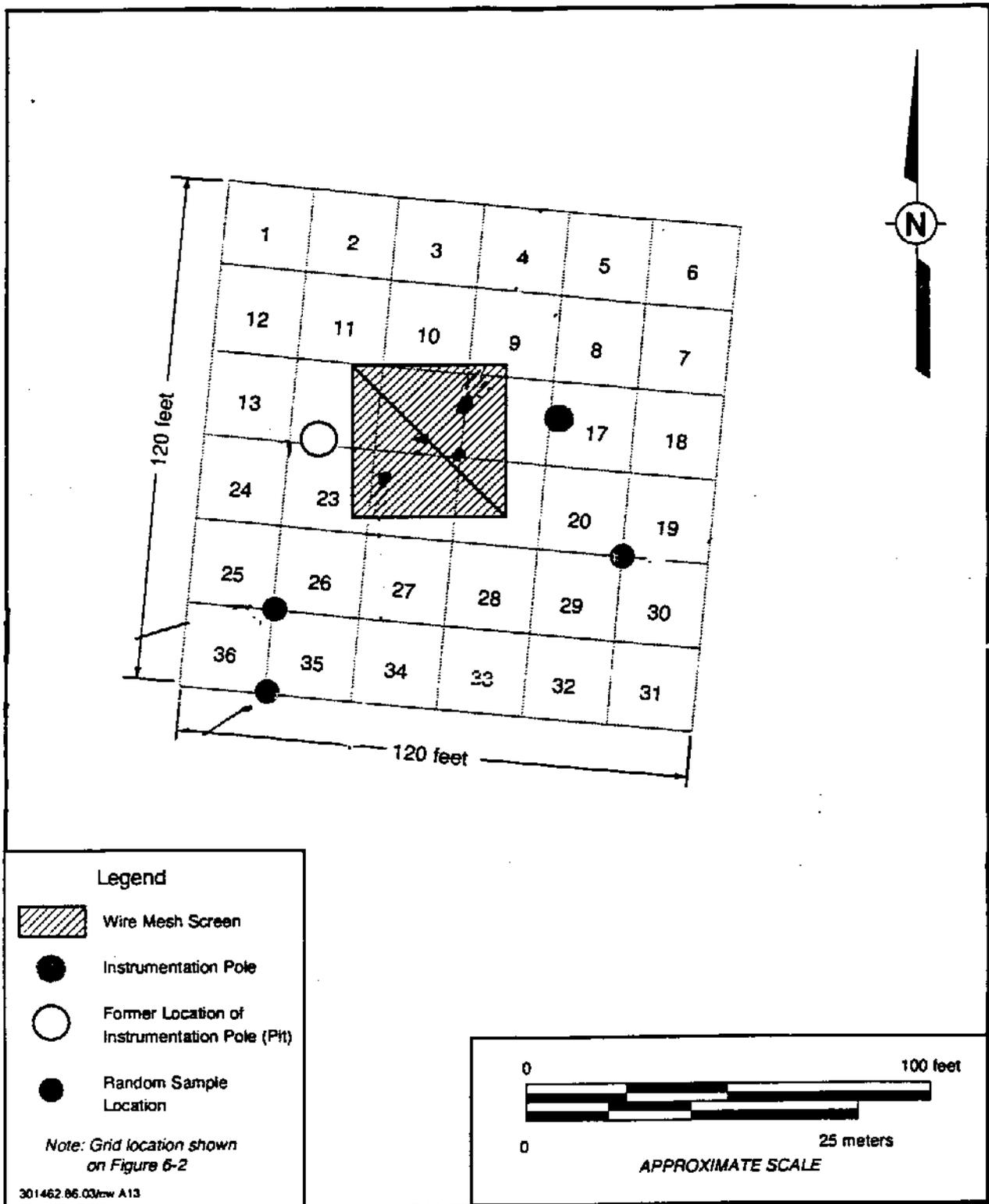
A judgmental debris sample will be collected from within the mound and will be analyzed for HE, toxicity characteristic leaching procedure (TCLP) semivolatile organic compounds (SVOC), and TCLP metals. Additionally, one near-surface soil sample will be collected from beneath the midpoint of the debris mound (Figure 6-2) to determine whether COCs have been released to the environment. The sample from beneath the debris mound will be analyzed for HE, SVOCs, and metals.

## **6.4 Contingency Sampling**

If any of the soil or sediment samples from ER Site 88B contain COCs above action levels or background concentrations, an OU 1334 RFI will be conducted in order to reevaluate the site for additional sampling needs.



**Figure 6-2**  
**Judgmental Sampling Locations at ER Site 88B,**  
**Firing Site: Instrumentation Poles (88B)**



**Figure 6-3**  
**Grid Sample Locations at ER Site 88B,**  
**Firing Site: Instrumentation Poles (83B)**

## 7.0 ANALYTICAL METHODS AND REQUIREMENTS

This chapter defines ER Site 88B specific analyte lists for HE compounds, metals, and radionuclides; methods of analysis; and QA/QC protocol for duplicate samples, matrix spikes, equipment rinsates, and field and trip blanks. Determined from knowledge of historical operations gained during archival activities, not all analytes provided by particular EPA methods will be required at ER Site 88B. The generic QAPjP (Annex II of the PIP [SNL/NM February 1994]) and Appendix G of the OU 1334 RFI Work Plan (SNL/NM October 1994) contain sample size and container requirements.

### 7.1 Analyte Lists

The following lists analytes referenced in Chapter 5.0 of the OU 1334 RFI Work Plan (SNL/NM October 1994):

- Metals, including arsenic, barium, beryllium, cadmium, chromium, lead, mercury, selenium, and silver
- Radionuclides, including lead-210, radium-226, radium-228, thorium-228, thorium-230, thorium-232, uranium-234, uranium-235/236, and uranium-238
- SVOC, VOC, and polychlorinated biphenyl (PCB) analytes consistent with standard EPA Methods listed in Section 7.3 of the OU 1334 RFI Work Plan (SNL/NM October 1994)

### 7.2 Analytical Methods

Soil and debris samples will be digested according to EPA Method 3050, followed by analysis (SW-846 protocol) for one or more of the following analyte lists:

- HE compounds by EPA Method 8330
- Metals by EPA Methods 6010/7000
- SVOCs by EPA Method 8270
- VOCs by EPA Method 8240
- PCBs by EPA Method 8080

Debris samples will undergo a TCLP extraction (EPA Method 1311) prior to analysis for one or more of the analytes listed above. Analytical methods for the TCLP extract are identical to those listed above. Radionuclide analysis may also be performed on digested soil samples as follows:

- Lead-210, radium-226, and radium-228 by gamma spectroscopy
- Thorium-228, thorium-230, thorium-232, uranium-234, uranium-235/236, and uranium-238 by alpha spectroscopy

The generic QAPjP (Annex II of the PIP [SNL/NM February 1994]) does not currently specify methods for radionuclide analysis. However, analytical laboratories will submit results and counting errors, blank results, duplicate results and relative percent difference, tracer or spike results and recoveries, instrument calibration documentation, control standard results, detection limit determinations, and all raw data.

### **7.3 Site-Specific Requirements**

ER Site 88B samples and specific QA/QC samples will be analyzed according to the methods listed in Table 7-1. Site background soil samples will be analyzed for the same suite of analytes as those collected for site characterization. Analytical requirements for ER Site 88B include

- Site background soil samples—metals and radionuclides
- Instrumentation poles—grid area and mesh area: HE and metals
- Debris mound—debris mound: HE, TCLP SVOCs, and TCLP metals
- Soil beneath debris mound: HE, SVOCs, and metals

If field-screening indicates radioactivity greater than background plus two standard deviations as discussed in Radiation Protection Operating Procedure (RPOP-08-811) and/or VOCs greater than 5 parts per million, samples will be analyzed for radionuclides by alpha and gamma spectroscopy and/or for VOCs by gas chromatography/mass spectrometry.

### **7.4 QA/QC Requirements**

Laboratory QA/QC requirements for number of duplicates, matrix spikes and matrix spike duplicates, equipment rinsates, and field and trip blanks will follow the requirements presented in the generic QAPjP (Annex II of the PIP [SNL/NM February 1994]). The analytical laboratory will provide Level III data in a report format that meets all requirements of the generic QAPjP (SNL/NM February 1994) and of sufficient quality to support risk assessment calculations, if needed.





## 8.0 INVESTIGATION DERIVED WASTE

Section 4.3.4.2 of the PIP (SNL/NM February 1994) and Appendix G of the OU 1334 RFI Work Plan (SNL/NM October 1994) discuss the general procedures for the management of ER Project investigation-derived waste (IDW). The Waste Management Plan for VCMs and no further action confirmatory sampling in OU 1334, Central Coyote Test Field (SNL/NM November 1994) describes specific IDW management procedures for this task.

## 9.0 REFERENCES

### 9.1 ER Site References

ER Site Reference Number	Reference
88-29.	Peters, K. Telephone Conversation with W. Drake, IT Corporation, Albuquerque, New Mexico. January 13, 1993.

### 9.2 Reference Documents

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.

DOE, see Department of Energy.

EPA, see U.S. Environmental Protection Agency.

IT, see IT Corporation.

IT Corporation (IT), August 1994, draft. "Sensitive Species Survey Results Environmental Restoration Project Sandia National Laboratories/New Mexico," IT Corporation, Albuquerque, New Mexico.

RUST Geotech Inc., July 1994, draft. "Sandia Surface Radiological Surveys Report," RUST Geotech Inc. Technical Support Program for Sandia National Laboratories.

Sandia National Laboratories (SNL/NM), November 1994. "Waste Management Plan for VCMs and NFA Confirmatory Sampling in ADS 1334, Central Coyote Test Field," Sandia National Laboratories, Albuquerque, New Mexico.

Sandia National Laboratories (SNL/NM), October 1994, draft. "RFI Work Plan for Operable Unit 1334, Sandia National Laboratories, Albuquerque," Albuquerque, New Mexico.

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

SNL/NM, see Sandia National Laboratories.

U.S. Environmental Protection Agency (EPA), April 1987. "Final RCRA Facility Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico.

### **9.3 Operating Procedures**

RPOP-08-811 Sandia National Laboratories (SNL/NM), Draft. "Radiological Surveys of Soil Samples," Sandia National Laboratories, Albuquerque, New Mexico.

### **9.4 Aerial Photographs**

United States Geological Survey (USGS), 1967. Aerial Photograph, VBUG (Mt)-2-85, Albuquerque, New Mexico.

United States Geological Survey (USGS), 1951. Aerial Photograph, RT-1-74, Albuquerque, New Mexico.

USGS, see United States Geological Survey.

**Section 6.3**  
**Risk Assessment**



**ER SITE 88B: RISK ASSESSMENT ANALYSIS**

**I. Site Description and History**

Sandia National Laboratories/New Mexico (SNL/NM) Environmental Restoration (ER) Site 88B is located in the northeast portion of the Central Coyote Test Range, approximately 1,500 feet west of Arroyo del Coyote, the Greystone Manor Site (ER Site 62). The site consists of one wooden instrumentation pole; remnants of steel cable guy wires (including insulated ground attachments); the rubble remains of a former ranch house (designated ER Site 88A); a small pit where a second instrument pole was located; a wire mesh grid on the ground between the instrument pole and pit; and a debris mound containing pieces of burned metal, electrical components, and wood (located approximately 100 feet south of the former ranch house).

The period of operation, whether the site was actually used (beyond the destruction of the Ranch House by explosives), and the purpose of the instrumentation poles and associated facilities could not be determined during interviews or archival searches. Historic aerial photographs show two instrumentation poles, dating the period of operation possibly from the early 1950s to late 1960s. The resemblance of ER Site 88B to other explosives firing test sites with similar wood poles makes it likely that ER Site 88B was also a firing site.

Potential wastes associated with a firing site might include pieces of metal shrapnel and residual high explosives (HE). Although large pieces of shrapnel and explosives are generally picked up or burned after a test, finely divided material could have remained in the test area. Whether the debris mound with burned metal and wood was associated with explosive firing test site activities or it occurred as the result of other unrelated activities such as Kirtland Air Force Base (KAFB) military training maneuvers, is not known.

**II. Human Health Risk Assessment Analysis**

Risk assessment of this site includes a number of steps, which 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:

Step 1.	Site data are described that provide information on the potential contaminants of concern (COC), as well as the relevant physical characteristics and properties of the site.
Step 2.	Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3.	The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4.	Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.

Step 5.	Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide.
Step 6.	These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) to determine whether further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7.	Uncertainties in the previous steps are discussed.

### II.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 88B No Further Action Proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for the entire site. Maximum concentrations reported from on-site and off-site laboratories were combined into a single table to provide conservative risk calculations. Chemicals that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment (EPA 1989). Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are explosives and metals.

### II.2 Step 2. Pathway Identification

ER Site 88B has been designated with an industrial future land-use scenario (DOE and USAF 1996) (see Appendix 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for chemical COCs and direct gamma exposure for radiological contaminants. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust and volatile organic constituents. No contamination at depth is suspected, and therefore, no pathways to the groundwater are considered. Depth to groundwater at ER Site 88B is approximately 51 feet below ground surface. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered not to be significant. Intake routes through plant, meat, or milk ingestion are not considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

**PATHWAY IDENTIFICATION**

<b>Chemical Constituents</b>	<b>Radionuclide Constituents</b>
Soil ingestion	Soil ingestion
Inhalation (dust)	Inhalation (dust and volatiles)
Plant uptake (residential only)	Plant uptake (residential only)
	Direct gamma

**II.3 Steps 3-5. Calculation of Hazard Indices and Cancer Risks**

Steps 3 through 5 are discussed in this section. These steps include the discussion of the tiered approach in eliminating potential COCs from further consideration in the risk assessment process and the calculation of intakes from all identified exposure pathways, the discussion of the toxicity information, and the calculation of the hazard indices and cancer risks.

The risks from the COCs at ER Site 88B were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to the SNL/NM background screening level for this area (IT Corporation 1997a). If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) program (USGS 1994). For the radiological COCs, site-specific background samples were taken and, if maximum concentrations exceeded the SNL/NM background screening level, these site-specific background values were used.

The maximum concentration of each COC was used in order to provide a conservative estimate of the associated risk. If any nonradiological COCs were above either the SNL/NM background screening levels or the USGS background value, all nonradiological COCs 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.

Second, if any nonradiological COC failed the initial screening step, the maximum concentration for each nonradiological COC was compared with action levels calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264 1990) and Risk Assessment Guidance for Superfund (RAGS) (EPA 1989) documentation. If there are ten or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than ten COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using reasonable maximum exposure (RME) methods and equations promulgated in RAGS (EPA 1989). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of the nonradiological COCs at their respective upper tolerance limit (UTL) or 95th-percentile background concentration in the soil were also calculated. For toxic compounds, the combined effects were calculated by summing the individual hazard quotients

for each compound into a total Hazard Index. This Hazard Index is compared to the recommended guideline of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of  $10^{-4}$  to  $10^{-6}$ .

### II.3.1 Comparison to Background and Action Levels

Nonradioactive ER Site 88B COCs are listed in Table 1, and radioactive COCs are listed in Tables 2 and 3. All tables show the associated 95th-percentile or UTL background levels (IT Corporation 1997a) or maximum site-specific background values.

The SNL/NM background levels have not yet been approved by the EPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the KAFB. This report was submitted for regulatory review in early 1997. The values shown in Table 1 supersede the background values described in an interim background study report (IT Corporation 1996).

Several compounds have maximum measured values greater than background screening levels. Therefore, all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 16.5 milligrams per kilogram (mg/kg). The EPA intentionally does not provide any toxicological data on lead, and therefore no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2,000 mg/kg (EPA 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA 1994). The maximum concentration value for lead at this site is less than both of those screening values, and therefore, lead is eliminated from further consideration in this risk assessment.

Because several COCs had maximum values greater than background screening levels, all COCs proceed to the proposed Subpart S action level screening procedure. Because the ER Site 88B sample set had more than ten COCs that continued past the first screening level (including HE compounds that do not have background screening concentrations), the proposed Subpart S screening process was skipped. All remaining COCs must have a Hazard Index value and cancer risk value calculated.

Radioactive contamination does not have predetermined action levels analogous to those proposed in Subpart S, and therefore this step in the screening process is not performed for radionuclides. Since no radionuclides exceeded site-specific background, the radiological portion of the risk assessment was carried no further.

### II.3.2 Identification of Toxicological Parameters

Table 4 shows the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs.

**Table 1**  
**Nonradioactive COCs at ER Site 88B and Comparison to the**  
**Background Screening Values**

<b>COC Name</b>	<b>Maximum Concentration (mg/kg)</b>	<b>SNL/NM 95th % or UTL Level (mg/kg)</b>	<b>Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?</b>
Arsenic	7.0	9.8	Yes
Barium	157	246	Yes
Beryllium	1.0 B	0.75	No
Cadmium	0.74 B	0.64	No
Chromium, total*	17.1	NC	NA
Lead	16.5	18.9	Yes
Mercury	0.05**	0.055	Yes
Selenium	0.35**	3.0	Yes
Silver	0.15	<0.5	NA

NC - not calculated.

NA - not applicable.

B - constituent was found in blank.

\*\* concentrations are assumed to be one-half of the detection limit.

\*total chromium assumed to be chromium VI (most conservative).

^ uncertainty due to detection limits.

**Table 2**  
**Radioactive COCs from ER Site 88B and Comparison to the**  
**SNL/NM Background Screening Values**

<b>COC Name</b>	<b>Maximum Concentration (pCi/g)</b>	<b>SNL/NM 95th % or UTL Level (pCi/g)</b>	<b>Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?</b>
U-238 <sup>1</sup>	2.29	2.31	Yes
U-235	ND	0.16	Yes
Th-232	1.12	1.03	No
Ra-228	1.16	1.08	No

Note 1: Maximum U-238 implied by the maximum detected concentration of its short-lived daughter, Th-234.

**Table 3**  
**Radioactive COCs from ER Site 88B and Comparison to the**  
**Site-Specific Background Screening Values**

<b>COC Name</b>	<b>Maximum Concentration (pCi/g)</b>	<b>Maximum Site-Specific Background Value (pCi/g)</b>	<b>Is Maximum COC Concentration Less Than or Equal to the Applicable Site-Specific Background Screening Value?</b>
Th-232	1.12	1.64	Yes
Ra-228	1.16	1.64 <sup>1</sup>	Yes

Note 1: Ra-228 background assumed to be that of its parent nuclide, Th-232 during site-specific background sampling.

**Table 4**  
**Nonradioactive Toxicological Parameter Values for ER Site 88B COCs**

COC Name	RfD <sub>o</sub> (mg/kg/d)	RfD <sub>inh</sub> (mg/kg/d)	Confidence	Sf <sub>o</sub> (kg-d/mg)	SF <sub>inh</sub> (kg-d/mg)	Cancer Class <sup>^</sup>
Arsenic	0.0003	--	M	1.5	15.1	A
Barium	0.07	0.000143	M	--	--	D
Beryllium	0.005	--	L	4.3	8.4	B2
Cadmium	0.0005	0.0000571	H	--	6.3	B1
Chromium, total*	0.005	--	L	--	42	A
Mercury	0.0003	0.0000857	M	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	L	--	--	D
2,4,6-Trinitrotoluene	0.0005	--	M	0.03	--	C
2,4-Dinitrotoluene	0.002	--	H	--	--	B2
2,6-Dinitrotoluene	0.001	--	--	--	--	B2
2-Nitrotoluene	0.01	--	--	--	--	--
3-Nitrotoluene	0.01	--	--	--	--	--
4-Nitrotoluene	0.01	--	--	--	--	--
HMX	0.05	--	--	--	--	--
1,3-Dinitrobenzene	0.0001	--	L	--	--	D
RDX	0.003	--	--	0.11	--	--
1,3,5-Trinitrobenzene	0.00005	--	L	--	--	D
Tetryl	0.01	--	--	--	--	--
2-Am-4,6-DNT**	--	--	--	0.68	--	--
4-AM-2,6-DNT**	--	--	--	0.68	--	--
Nitrobenzene	0.0005	0.000571	L	--	--	D

\*Total chromium assumed to be chromium VI (most conservative).

\*\*Toxicological parameter values for dinitrotoluene mixture.

RfD<sub>o</sub> - oral chronic reference dose in mg/kg-day.

RfD<sub>inh</sub> - inhalation chronic reference dose in mg/kg-day.

Confidence - L = low, M = medium, H = high.

SF<sub>o</sub> - oral slope factor in (mg/kg-day)<sup>-1</sup>.

SF<sub>inh</sub> - inhalation slope factor in (mg/kg-day)<sup>-1</sup>.

<sup>^</sup> EPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen.

B1 - probable human carcinogen. Limited human data are available.

B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.

C - possible human carcinogen.

D - not classifiable as to human carcinogenicity.

E - evidence of noncarcinogenicity for humans.

-- information not available.

### II.3.3 Exposure Assessment and Risk Characterization

Section II.3.3.1 describes the exposure assessment for this risk assessment. Section II.3.3.2 provides the risk characterization, including the Hazard Index value and the excess cancer risk for both the potential nonradiological COCs and associated background for industrial and residential land uses.

#### II.3.3.1 Exposure Assessment

Appendix 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based upon RAGS (EPA 1989). The parameters are based on information from RAGS (EPA 1989), as well as other EPA guidance documents, and reflect the RME approach advocated by RAGS (EPA 1989).

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

#### II.3.3.2 Risk Characterization

Table 5 shows that for the ER Site 88B nonradioactive COCs, the Hazard Index value is 0.02, and the excess cancer risk is  $6 \times 10^{-6}$  for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 6 shows that, assuming the maximum background concentrations of the ER Site 88B associated nonradiological background constituents, the Hazard Index is 0.03, and the excess cancer risk is  $7 \times 10^{-6}$  for the designated industrial land-use scenario.

For the residential land-use scenario, the Hazard Index value increases to 2, and the excess cancer risk is  $9 \times 10^{-5}$ . The numbers presented included exposure from soil ingestion, dust and volatile inhalation, and plant uptake. 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 even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 6 shows that for the ER Site 88B associated nonradiological background constituents, the Hazard Index increases to 2, and the excess cancer risk is  $1 \times 10^{-4}$ .

**Table 5**  
**Nonradioactive Risk Assessment Values for ER Site 88B COCs**

COC Name	Maximum Concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	7.0	0.02	4E-6	0.40	8E-5
Barium	157	0.00	--	0.02	--
Beryllium	1.0 B	0.00	2E-6	0.00	8E-6
Cadmium	0.74 B	0.00	3E-10	0.60	4E-10
Chromium, total*	17.1	0.00	5E-8	0.01	6E-8
Mercury	0.05**	0.00	--	0.09	--
Selenium	0.35**	0.00	--	0.12	--
Silver	0.15	0.00	--	0.01	--
2,4,6-Trinitrotoluene	0.14**	0.00	2E-9	0.00	7E-9
2,4-Dinitrotoluene	0.15**	0.00	--	0.07	--
2,6-Dinitrotoluene	0.14**	0.00	--	0.00	--
2-Nitrotoluene	0.14**	0.00	--	0.00	--
3-Nitrotoluene	0.14**	0.00	--	0.00	--
4-Nitrotoluene	0.14**	0.00	--	0.00	--
HMX	1.2**	0.00	--	0.00	--
1,3-Dinitrobenzene	0.14**	0.00	--	0.01	--
RDX	0.6**	0.00	3E-8	0.00	1E-7
1,3,5-Trinitrobenzene	0.14**	0.00	--	0.01	--
Tetryl	0.36**	0.00	--	0.00	--
2-Am-4,6-DNT^	0.14**	0.00	4E-8	0.00	2E-7
4-Am-2,6-DNT^	0.14**	0.00	4E-8	0.00	2E-7
Nitrobenzene	0.15**	0.00	--	0.34	--
<b>TOTAL</b>		<b>0.02</b>	<b>6E-6</b>	<b>2</b>	<b>9E-5</b>

\* total chromium assumed to be chromium VI (most conservative).

\*\* concentrations are assumed to be one-half of the detection limit.

B - parameter found in blank.

^ - used toxicological parameter values for dinitrotoluene mixture in calculation.

-- information not available.

**Table 6**  
**Risk Assessment Values for ER Site 88B Background Constituents**

Constituent Name	Background Concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	9.8	0.03	6E-6	0.56	1E-4
Barium	246	0.00	--	0.04	--
Beryllium	0.75	0.00	1E-6	0.00	6E-6
Cadmium	0.64	0.00	3E-10	0.52	4E-10
Chromium, total*	NC	--	--	--	--
Mercury	0.055	0.00	--	0.09	--
Selenium	3.0	0.00	--	1.06	--
Silver	<0.5	--	--	--	--
<b>TOTAL</b>		<b>0.03</b>	<b>7E-6</b>	<b>2</b>	<b>1E-4</b>

-- information not available.

\* total chromium assumed to be chromium VI (consistent with Table 5).

NC - not calculated.

#### II.4 Step 6. Comparison of Risk Values to Numerical Guidelines

The risk assessment analyses considered the evaluation of the potential for adverse health effects for both an industrial land-use scenario, which is the designated land-use scenario for this site, and a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated for the nonradioactive COCs is 0.02; this is much less than the numerical guideline of 1 suggested in RAGS (EPA 1989). The excess cancer risk is estimated at  $6 \times 10^{-6}$ . In RAGS, the EPA suggests that a range of values ( $10^{-6}$  to  $10^{-4}$ ) be used as the numerical guideline; the value calculated for this site is in the low end of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.03. The excess cancer risk is estimated at  $7 \times 10^{-6}$ . Incremental risk is determined by subtracting risk associated with background from potential nonradiological 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 discussed within the text. The incremental Hazard Index and the incremental cancer risk are zero for the industrial land-use scenario. These incremental risk calculations indicate insignificant risk to human health from the COCs, considering an industrial land-use scenario.

For the residential land-use scenario, the calculated Hazard Index for the nonradioactive COCs is 2, which is above the numerical guidance. The excess cancer risk is estimated at  $9 \times 10^{-5}$ ; this value is at the upper limit of the suggested acceptable risk range. The Hazard Index for

associated background for the residential land-use scenario is 2. The excess cancer risk is estimated at  $1 \times 10^{-4}$ . For the residential land-use scenario, the incremental Hazard Index and the incremental cancer risk are zero. The incremental Hazard Index indicates insignificant contribution to human health risk from the COCs, considering a residential land-use scenario.

## II.5 Step 7 Uncertainty Discussion

The data used to characterize ER Site 88B, Firing Site: Instrumentation Pole, were provided by nine surface samples located around the instrument pole, the debris mound, and outside the boundary of the site for site-specific background. These samples were deemed sufficient to establish whether residues from the above-ground testing were detectable. The constituents of concern for the site are primarily depleted uranium, metals, and HE residue. The soil samples were analyzed for HE by EPA Method 8330, the eight RCRA metals by EPA Method 6010, mercury by EPA Method 7471, and isotopic uranium by method EPI A-011B. Quality assurance/quality control samples for the sampling event consisted of one duplicate at one location and two equipment rinsate field blanks for the site COCs. All but one of the samples were sent off site to a Contract Laboratory Program (CLP) laboratory for analysis. The sample from the debris mound was analyzed by the on-site laboratory. One sample from each location was analyzed by gamma spectroscopy at the SNL/NM on-site radiological laboratory. The data provided by the CLP laboratory are considered definitive data suitable for use in a risk assessment analysis.

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to established numerical guidelines for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate insignificant risk to human health from nonradiological COCs when considering the industrial land-use scenario.

For the radiological COCs, the conclusion is that no radiological contamination exists on site.

The potential effects on human health for the nonradiological COCs are greater when considering the residential land-use scenario. Incremental risk between potential nonradiological COCs and associated background also indicates an increased contribution of risk from the nonradiological COCs. The increased effects on human health are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels) contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 88B is designated as an industrial land-use area (DOE and USAF 1996), the likelihood of significant plant uptake in this area is highly unlikely. The uncertainty in this conclusion is considered to be small.

Because of the location, history of the site, and the future land-use (DOE and USAF 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the COCs are found in surface and near-surface soils and because of the location and physical characteristics of the site, there is little uncertainty in the exposure pathways relevant to the analysis.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs were used to provide conservative results.

Table 4 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (EPA 1996b) and Integrated Risk Information System (IRIS) (EPA 1988, 1997a) databases. Where values are not provided, information is not available from HEAST, IRIS, or EPA regions. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical guidelines. Though the residential land-use Hazard Index is above the numerical guideline and the excess cancer risk is near the upper limit of the acceptable risk range, it has been determined that future land-use at this locality will not be residential (DOE and USAF 1996). The overall uncertainty in all of the steps in the risk assessment process is considered insignificant with respect to the conclusion reached.

## II.6 Summary

ER Site 88B, the Firing Site: Instrumentation Pole, had contamination consisting of some nonradioactive metals and explosives. Because of the location of the site on KAFB, the designated industrial land-use scenario (DOE and USAF 1996), and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust inhalation. Plant uptake was included as an exposure pathway for the residential land-use scenario. This site is designated for industrial land-use (DOE and USAF 1996); the residential land-use scenario is provided for perspective only.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations for the nonradiological COCs show that for the industrial land-use scenario the Hazard Index (0.02) is significantly less than the accepted numerical guidance (1) from the EPA. The estimated cancer risk ( $6 \times 10^{-6}$ ) is in the low end of the suggested acceptable risk range. The incremental Hazard Index and the incremental cancer risk are zero for the industrial land-use scenario. Incremental risk calculations indicate insignificant risk to human health from the nonradiological COCs, considering an industrial land-use scenario.

The uncertainties associated with the calculations are considered small relative to the conservativeness of the risk assessment analysis. It is therefore concluded that this site does not have significant potential to affect human health under an industrial land-use scenario.

### III. Ecological Risk Assessment

#### III.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPEC) in soils from ER Site 88B. The ecological risk assessment process performed for this site is a screening-level assessment that follows the methodology presented in IT (1997) and SNL/NM (1997). The methodology was based on screening level guidance presented by the EPA (EPA 1992, 1996c, 1997b) and by Wentzel et al. (1996) and is consistent with a phased approach. This assessment utilizes conservatism in the estimation of ecological risks; however, ecological relevance and professional judgment are also incorporated as recommended by the EPA (1996c) and Wentzel et al. (1996) to ensure that the predicted exposures of selected ecological receptors reasonably reflect those expected to occur at the site.

#### III.2 Ecological Pathways

ER Site 88B is located in grassland habitat north of Arroyo del Coyote and approximately 0.4 mile southwest of Coyote Springs. The site is vegetated and shows little sign of past disturbance, including premilitary use, as evidenced by the ruins of a stone house in the center of the site (ER Site 88A). The dominant grasses include galleta (*Hilaria jamesii*), black grama (*Bouteloua eriopoda*), Indian ricegrass (*Oryzopsis hymenoides*), and threeawn (*Aristida* spp.). Shrubs and subshrubs include broom snakeweed (*Gutierrezia sarothrae*), cane cholla (*Opuntia imbricata*), and one-seed junipers (*Juniperus monosperma*) that are widely scattered at the site. A sensitive-species study conducted at the site on May 24, 1994 (IT 1995), found one example of the grama grass cactus (*Pediocactus papyracanthus*) and two of Wright's pincushion cactus (*Mammillaria wrightii*) near the northern border on the site. At that time, both of these species were listed as endangered by the New Mexico Forestry and Resource Conservation Division, and the grama grass cactus was a federal candidate species (C2). Both have since been removed from all sensitive-species designations. Currently, no sensitive species are known to occur at this site.

The most significant exposure routes for terrestrial receptors are direct uptake by plants and ingestion by wildlife. Direct uptake of COPECs from soil was assumed to be the major route of exposure of plants to COPECs, with exposure of plants to wind-blown soil assumed to be minor. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994).

#### III.3 Constituents of Potential Ecological Concern

The COCs at this site are metals and HE. Following the screening process used for the selection of potential COCs for the human health risk assessment, the inorganic COCs were screened against background UTLs. Four inorganic analytes (beryllium, cadmium, chromium, and silver) were identified as COPECs at ER Site 88B. HE was not detected; however,

because explosive compounds do not have calculated background values, they are carried into the risk assessment analysis. Radiological field screening and gamma spectroscopy results were within the normal background range.

#### III.4 Receptors and Exposure Modeling

A nonspecific perennial plant was used as the receptor to represent plant species at the site. Two wildlife receptors (deer mouse and burrowing owl) were used to represent wildlife use of the site. Exposure modeling for the wildlife receptors was limited to the food ingestion pathway. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion. Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled as an omnivore (50 percent of its diet is plants and 50 percent is soil invertebrates), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet is deer mice). Both were modeled with soil ingestion comprising 2 percent of the total dietary intake. Table 7 presents the species-specific factors used in modeling exposures in the wildlife receptors. Although home range is also included in this table, exposures for this screening-level assessment were modeled using an area use factor of 1, implying that all food items and soil ingested are from the site being investigated.

The maximum measured COPEC concentrations in soil were used to conservatively estimate potential exposures and risks to plants and wildlife at this site. One-half the detection limits from the on-site laboratory were used for the HE compounds, which were not otherwise detected but were retained due to the high detection limit.

Table 8 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 9 presents the maximum concentrations of COPECs in soil, the derived concentrations in the various food-chain elements, and the modeled dietary exposures for each of wildlife receptor species.

#### III.5 Toxicity Benchmarks

Benchmark toxicity values for the plant and wildlife receptors are presented in Table 10. For plants, the benchmark soil concentrations are based on the lowest-observed-adverse-effect level (LOAEL), with the adverse effect being a 20 percent reduction of growth. For wildlife, the toxicity benchmarks are based on the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. An avian toxicity value for beryllium was not found in the literature. In addition, insufficient toxicity data for the HE compounds precluded estimating potential risk to the terrestrial plant (with the exception of HMX, RDX, tetryl, and 2,4,6-trinitrotoluene) and the burrowing owl.

**Table 7**  
**Exposure Factors for Ecological Receptors**  
**at Environmental Restoration Site 88B,**  
**Sandia National Laboratories, New Mexico**

Receptor Species	Class/Order	Trophic Level	Body Weight (kg) <sup>a</sup>	Food Intake Rate (kg/d) <sup>b</sup>	Dietary Composition <sup>c</sup>	Home Range (acres)
Deer Mouse ( <i>Peromyscus maniculatus</i> )	Mammalia/ Rodentia	Omnivore	0.0239 <sup>d</sup>	0.00372	Plants: 50% Invertebrates: 50% (+ Soil at 2% of intake)	0.27 <sup>e</sup>
Burrowing owl ( <i>Speotyto cunicularia</i> )	Aves/ Strigiformes	Carnivore	0.155 <sup>f</sup>	0.0173	Rodents: 100% (+ Soil at 2% of intake)	34.6 <sup>g</sup>

<sup>a</sup>Body weights are in kilograms wet weight..

<sup>b</sup>Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kilograms dry weight per day.

<sup>c</sup>Dietary compositions are generalized for modeling purposes. Default soil intake value of 2 percent of food intake.

<sup>d</sup>From Silva and Downing (1995).

<sup>e</sup>From EPA (1993), based on the average home range measured in semiarid shrubland in Idaho.

<sup>f</sup>From Dunning (1993).

<sup>g</sup>From Haug et al. (1993).

**Table 8**  
**Transfer Factors Used in Exposure Models for Constituents of Potential Ecological**  
**Concern at Environmental Restoration Site 88B,**  
**Sandia National Laboratories, New Mexico**

Constituent of Potential Ecological Concern	Soil-to-Plant Transfer Factor	Soil-to-Invertebrate Transfer Factor	Food-to-Muscle Transfer Factor
Beryllium	$1.00 \times 10^{-2a}$	$1.00 \times 10^{0b}$	$1.00 \times 10^{-3c}$
Cadmium	$5.50 \times 10^{-1a}$	$6.00 \times 10^{-1d}$	$5.50 \times 10^{-4a}$
Chromium	$4.00 \times 10^{-2a}$	$1.30 \times 10^{-1e}$	$3.00 \times 10^{-2c}$
Silver	$1.00 \times 10^{0c}$	$2.50 \times 10^{-1d}$	$5.00 \times 10^{-3c}$
HMX	$2.74 \times 10^{1f}$	$1.36 \times 10^{1g}$	$3.42 \times 10^{-8f}$
RDX	$1.22 \times 10^{1f}$	$1.45 \times 10^{1g}$	$1.46 \times 10^{-7f}$
Tetryl	$4.31 \times 10^{0f}$	$1.59 \times 10^{1g}$	$9.32 \times 10^{-7f}$
2,4,6-trinitrotoluene	$4.60 \times 10^{0f}$	$1.58 \times 10^{1g}$	$8.28 \times 10^{-7f}$
2-amino-4,6-dinitrotoluene	$2.78 \times 10^{0f}$	$1.65 \times 10^{1g}$	$2.04 \times 10^{-6f}$
4-amino-2,6-dinitrotoluene	$2.78 \times 10^{0f}$	$1.65 \times 10^{1g}$	$2.04 \times 10^{-6f}$
2,4-dinitrotoluene	$2.78 \times 10^{0f}$	$1.65 \times 10^{1g}$	$2.04 \times 10^{-6f}$
2,6-dinitrotoluene	$3.93 \times 10^{0f}$	$1.60 \times 10^{1g}$	$1.10 \times 10^{-6f}$
3-nitrotoluene	$1.49 \times 10^{0f}$	$1.74 \times 10^{1g}$	$6.25 \times 10^{-6f}$
2-nitrotoluene	$1.81 \times 10^{0f}$	$1.71 \times 10^{1g}$	$4.37 \times 10^{-6f}$
4-nitrotoluene	$1.65 \times 10^{0f}$	$1.73 \times 10^{1g}$	$5.17 \times 10^{-6f}$
1,3,5-trinitrobenzene	$8.96 \times 10^{0f}$	$1.49 \times 10^{1g}$	$2.52 \times 10^{-7f}$
1,3-dinitrobenzene	$5.33 \times 10^{0f}$	$1.56 \times 10^{1g}$	$6.37 \times 10^{-7f}$
Nitrobenzene	$3.30 \times 10^{0f}$	$1.63 \times 10^{1g}$	$1.50 \times 10^{-6f}$

<sup>a</sup>From Baes et al. (1984).

<sup>b</sup>Default value.

<sup>c</sup>From NCRP (1989).

<sup>d</sup>From Stafford et al. (1991).

<sup>e</sup>From Ma (1992).

<sup>f</sup>From equations developed in Travis and Arms (1988).

<sup>g</sup>From equations developed in Connell and Markwell (1990).

**Table 9**  
**Media Concentrations for Constituents of Potential**  
**Ecological Concern at Environmental Restoration Site 88B,**  
**Sandia National Laboratories, New Mexico**

Constituent of Potential Ecological Concern	Soil (maximum) <sup>a</sup>	Plant Foliage <sup>a,b</sup>	Soil Invertebrate <sup>a,b</sup>	Deer Mouse Tissues <sup>a,c</sup>
Beryllium	$1.00 \times 10^0$	$1.00 \times 10^{-2}$	$1.00 \times 10^0$	$1.64 \times 10^{-3}$
Cadmium	$7.4 \times 10^{-1}$	$4.07 \times 10^{-1}$	$4.44 \times 10^{-1}$	$7.57 \times 10^{-4}$
Chromium (total)	$1.71 \times 10^1$	$6.84 \times 10^{-1}$	$2.22 \times 10^0$	$1.68 \times 10^{-1}$
Silver	$1.5 \times 10^{-1}$	$1.50 \times 10^{-1}$	$3.75 \times 10^{-2}$	$1.51 \times 10^{-3}$
HMX	$1.20 \times 10^0$	$3.29 \times 10^{-1}$	$1.63 \times 10^{-1}$	$2.63 \times 10^{-6}$
RDX	$6.0 \times 10^{-1}$	$7.30 \times 10^0$	$8.72 \times 10^0$	$3.66 \times 10^{-6}$
Tetryl	$3.60 \times 10^{-1}$	$1.55 \times 10^0$	$5.73 \times 10^0$	$1.06 \times 10^{-5}$
2,4,6-trinitrotoluene	$1.40 \times 10^{-1}$	$6.45 \times 10^{-1}$	$2.21 \times 10^0$	$3.70 \times 10^{-6}$
2-amino-4,6-dinitrotoluene	$1.40 \times 10^{-1}$	$3.89 \times 10^{-1}$	$2.31 \times 10^0$	$8.64 \times 10^{-6}$
4-amino-2,6-dinitrotoluene	$1.40 \times 10^{-1}$	$3.89 \times 10^{-1}$	$2.31 \times 10^0$	$8.64 \times 10^{-6}$
2,4-dinitrotoluene	$1.50 \times 10^{-1}$	$4.17 \times 10^{-1}$	$2.48 \times 10^0$	$9.26 \times 10^{-6}$
2,6-dinitrotoluene	$1.40 \times 10^{-1}$	$5.50 \times 10^{-1}$	$2.24 \times 10^0$	$4.82 \times 10^{-6}$
3-nitrotoluene	$1.40 \times 10^{-1}$	$2.08 \times 10^{-1}$	$2.44 \times 10^0$	$2.59 \times 10^{-5}$
2-nitrotoluene	$1.40 \times 10^{-1}$	$2.54 \times 10^{-1}$	$2.40 \times 10^0$	$1.82 \times 10^{-5}$
4-nitrotoluene	$1.40 \times 10^{-1}$	$2.31 \times 10^{-1}$	$2.42 \times 10^0$	$2.14 \times 10^{-5}$
1,3,5-trinitrobenzene	$1.40 \times 10^{-1}$	$1.25 \times 10^{-1}$	$2.09 \times 10^0$	$1.32 \times 10^{-6}$
1,3-dinitrobenzene	$1.40 \times 10^{-1}$	$7.46 \times 10^{-1}$	$2.19 \times 10^0$	$2.92 \times 10^{-6}$
Nitrobenzene	$1.5 \times 10^{-1}$	$4.95 \times 10^{-1}$	$2.44 \times 10^0$	$6.90 \times 10^{-6}$

<sup>a</sup>Milligrams per kilogram. All are based on dry weight of the media.

<sup>b</sup>Product of the soil concentration and the corresponding transfer factor.

<sup>c</sup>Product of the average concentration in food times the food-to-muscle transfer factor times the wet weight-dry weight conversion factor of 3.125 (from EPA 1993).

**Table 10**  
**Toxicity Benchmarks for Ecological Receptors at**  
**Environmental Restoration Site 88B,**  
**Sandia National Laboratories, New Mexico**

Constituent of Potential Ecological Concern	Plant Benchmark <sup>a</sup> (mg/Kg)	Mammalian NOAELs (mg/kg/d)			Avian NOAELs (mg/kg/d)		
		Mammalian Test Species <sup>b</sup>	Test Species NOAEL <sup>c</sup>	Deer Mouse NOAEL <sup>d</sup>	Avian Test Species <sup>e</sup>	Test Species NOAEL <sup>f</sup>	Burrowing Owl NOAEL <sup>g</sup>
Beryllium	10	Lab rat	0.66	1.29	---	---	---
Cadmium	3	Lab rat <sup>h</sup>	0.008	0.0156	Mallard	1.45	1.45
Chromium (total)	1	Lab rat	2737	5354	Black duck	1.0	1.0
Silver	2	Lab rat <sup>i</sup>	17.8 <sup>j</sup>	34.8	---	---	---
HMX	---	Lab rat	10 <sup>j</sup>	19.6	---	---	---
RDX	---	Lab rat	0.3 <sup>j</sup>	0.587	---	---	---
Tetryl	---	Lab rat	13 <sup>j</sup>	25.4	---	---	---
2,4,6-trinitrotoluene	---	Lab rat	1.6 <sup>k</sup>	3.13	---	---	---
2-amino-4,6-dinitrotoluene	---	Lab rat	2.81 <sup>l</sup>	5.50	---	---	---
4-amino-2,6-dinitrotoluene	---	Lab rat	1.93 <sup>l</sup>	3.78	---	---	---
2,4-dinitrotoluene	---	Lab rat	0.54 <sup>l</sup>	1.06	---	---	---
2,6-dinitrotoluene	---	Lab rat	0.36 <sup>l</sup>	0.704	---	---	---
3-nitrotoluene	---	Lab rat	2.16 <sup>l</sup>	4.23	---	---	---
2-nitrotoluene	---	Lab rat	1.79 <sup>l</sup>	3.50	---	---	---
4-nitrotoluene	---	Lab rat	3.94 <sup>l</sup>	7.71	---	---	---
1,3,5-trinitrobenzene	---	Lab rat	0.37 <sup>m</sup>	0.724	---	---	---
1,3-dinitrobenzene	---	Lab rat	0.08 <sup>h,l</sup>	0.156	---	---	---
Nitrobenzene	---	Lab mouse	1.17 <sup>m</sup>	1.24	---	---	---

<sup>a</sup>From Will and Suter (1995).

<sup>b</sup>From Sample et al. (1996), except where noted. Body weights (in kilograms) for no-observed-adverse-effect level (NOAEL) conversion are: lab mouse, 0.030; lab rat, 0.350 (except where noted and for cadmium, 0.303).

<sup>c</sup>From Sample et al. (1996), except where noted.

<sup>d</sup>Based on NOAEL conversion methodology presented in Sample et al. (1996), using a deer mouse body weight of 0.239 kilograms and a mammalian scaling factor of 0.25.

<sup>e</sup>From Sample et al. (1996).

<sup>f</sup>Based on 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.

<sup>g</sup>--- designates insufficient toxicity data.

<sup>h</sup>Body weight of 0.303 kg was used for the NOAEL conversion (Sample et al. 1996).

<sup>i</sup>From EPA (1997a).

<sup>j</sup>From Talmage et al. (1996).

<sup>k</sup>From Ryon (1987).

<sup>l</sup>Estimated using lethal dose that will result in death of 50 percent of the test population (LD<sub>50</sub>) information specific to the compound (e.g., RTECS, 1997) and LD<sub>50</sub> and NOAEL information for 2,4,6-trinitrotoluene as described in Sample et al. (1996).

<sup>m</sup>Estimated using LD<sub>50</sub> information specific to the compound (e.g., RTECS, 1997) and LD<sub>50</sub> and NOAEL information for m-dinitrobenzene as described in Sample et al. (1996).

### III.6 Risk Characterization

The maximum soil concentrations and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. The results of these comparisons are presented in Table 11. Hazard quotients (HQ) are used to quantify the comparison with the benchmarks for plants and wildlife exposure. Maximum soil concentrations for all the inorganic COPECs did not exceed their respective plant benchmark values. Total chromium is within the background range. One-half the detection limit resulted in an HQ greater than 1 for deer mice exposed to 1,3-dinitrobenzene (HQ = 1.46) and RDX (HQ = 2.13). No HQ exceeded unity for the burrowing owl.

### III.7 Uncertainties

Many uncertainties are associated with the characterization of ecological risks at ER Site 88B. These uncertainties result in the use of assumptions in estimating risk that may lead to an overestimation or underestimation of the true risk presented at a site. For this screening level risk assessment, assumptions are made that are more likely to overestimate risk rather than to underestimate it. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of the maximum measured soil concentration or maximum detection limit to evaluate risk, the use of wildlife toxicity benchmarks based upon laboratory NOAEL values or estimated NOAELs based on toxicity information on surrogate compounds (e.g., many of the munitions), the use of maximum transfer factors found in the literature for modeling plant and mouse tissue concentrations, the use of earthworm-based transfer factors or a default factor of 1.0 for modeling COPECs into soil invertebrates, and the use of 1.0 as the use factor for wildlife receptors regardless of seasonal use or home range size. In addition, risks to plants (with the exclusion of HMX, RDX, tetryl, and 2,4,6-trinitrotoluene) and birds from exposure to the HE compounds could not be estimated due to the lack of toxicity information.

### III.8 Summary

Potential risks were indicated for all three ecological receptors at ER Site 88B; however, the use of the maximum measured concentration or one-half the detection limit to evaluate risk provided a conservative exposure scenario for the risk assessment and may not reflect actual site conditions. Although the HQ for plants exposed to chromium exceeded unity, the actual background concentration of 18.8 mg/kg is greater than the on-site maximum of 17.1 mg/kg. No ecological risks are therefore predicted from exposure to chromium. (Chromium was carried through the ecological risk assessment to be consistent with the human health risk process.) Although RDX and 1,3-dinitrobenzene produced HQs greater than 1 for the deer mouse using one-half of the detection limits, none of the explosive compounds were detected. Due to insufficient toxicity data for HE compounds, potential risk estimates could not be determined for the terrestrial plant or the burrowing owl. Because none of the HE compounds (using one-half the detection limits) resulted in HQs greater than 2 for the deer mouse and the home range for the burrowing owl is 128 times greater than that of the mouse, it is unlikely that the burrowing

**Table 11**  
**Comparisons to Toxicity Benchmarks for**  
**Ecological Receptors at**  
**Environmental Restoration Site 88B,**  
**Sandia National Laboratories, New Mexico**

Constituent of Potential Ecological Concern	Plant Hazard Quotient <sup>a</sup>	Deer Mouse Hazard Quotient	Burrowing Owl Hazard Quotient
Beryllium	$1.00 \times 10^{-1}$	$6.33 \times 10^{-2}$	--- <sup>b</sup>
Cadmium	$2.47 \times 10^{-1}$	$3.63 \times 10^{-2}$	$1.20 \times 10^{-3}$
Chromium (total)	<b><math>1.71 \times 10^{-1}</math></b>	$5.22 \times 10^{-5}$	$5.69 \times 10^{-2}$
Silver	$7.50 \times 10^{-2}$	$4.32 \times 10^{-4}$	---
HMX	---	$1.96 \times 10^{-1}$	---
RDX	$5.50 \times 10^{-3}$	<b><math>2.13 \times 10^0</math></b>	---
Tetryl	$1.44 \times 10^{-2}$	$2.23 \times 10^{-2}$	---
2,4,6-trinitrotoluene	$4.67 \times 10^{-3}$	$7.29 \times 10^{-2}$	---
2-amino-4,6-dinitrotoluene	$1.75 \times 10^{-3}$	$3.83 \times 10^{-2}$	---
4-amino-2,6-dinitrotoluene	---	$5.58 \times 10^{-2}$	---
2,4-dinitrotoluene	---	$2.14 \times 10^{-1}$	---
2,6-dinitrotoluene	---	$3.09 \times 10^{-1}$	---
3-nitrotoluene	---	$4.89 \times 10^{-2}$	---
2-nitrotoluene	---	$5.91 \times 10^{-2}$	---
4-nitrotoluene	---	$2.68 \times 10^{-2}$	---
1,3,5-trinitrobenzene	---	$3.60 \times 10^{-1}$	---
1,3-dinitrobenzene	---	<b><math>1.46 \times 10^0</math></b>	---
Nitrobenzene	---	$1.79 \times 10^{-1}$	---

<sup>a</sup>**Bold** text indicates potential ecological risk.

<sup>b</sup>--- designates insufficient toxicity data available for risk estimation purposes.

owl would be adversely affected by any HE compounds at this site. No protected vertebrate species are expected to occur in the area. Potential adverse impacts to plant, mammalian, and avian populations associated with ER Site 88B are expected to be insignificant.

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**APPENDIX 1.**

## **Sandia National Laboratories Environmental Restoration Program**

### **EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION**

#### **BACKGROUND**

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

The default exposure routes and parameter values suggested are those that SNL views as resulting in a Reasonable Maximum Exposure (RME) value. Subject to comments and recommendations by the USEPA Region VI and NMED, SNL proposes that these default exposure routes and parameter values be used in future risk assessments.

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

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

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

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

Based on the location of the SNL ER sites 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 ER sites, there does not presently occur any consumption of fish, shell fish, fruits, vegetables, meat, eggs, or dairy products that originate on-site. Additionally, no potential for swimming in surface water is present due to the high-desert environmental conditions. As documented in the RESRAD computer code manual (ANL 1993), risks resulting from immersion in contaminated air or water are not significant compared to risks from other radiation exposure routes.

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

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

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

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

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

**Table 1. Exposure Pathways Considered for Various Land Use Scenarios**

Industrial	Recreational	Residential
Ingestion of contaminated drinking water	Ingestion of contaminated drinking water	Ingestion of contaminated drinking water
Ingestion of contaminated soil	Ingestion of contaminated soil	Ingestion of contaminated soil

Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)	Inhalation of airborne compounds (vapor phase or particulate)
Dermal contact	Dermal contact	Dermal contact
External exposure to penetrating radiation from ground surfaces	External exposure to penetrating radiation from ground surfaces	Ingestion of fruits and vegetables
		External exposure to penetrating radiation from ground surfaces

### EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA 1989a and 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). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993).

#### Generic Equation for Calculation of Risk Parameter Values

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

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

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

where

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

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

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the 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 range of  $10^{-4}$  to  $10^{-6}$ . The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) 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 Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989a) and the RESRAD Manual (ANL 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are

Table 2. Default Parameter Values for Various Land Use Scenarios

Parameter	Industrial	Recreational	Residential
<b>General Exposure Parameters</b>			
Exposure frequency (d/y)	***	***	***
Exposure duration (y)	30 <sup>a,b</sup>	30 <sup>a,b</sup>	30 <sup>a,b</sup>
Body weight (kg)	70 <sup>a,b</sup>	56 <sup>a,b</sup>	70 adult <sup>a,b</sup> 15 child
Averaging Time (days) for carcinogenic compounds (=70 y x 365 d/y)	25550 <sup>a</sup>	25550 <sup>a</sup>	25550 <sup>a</sup>
for noncarcinogenic compounds (=ED x 365 d/y)	10950	10950	10950
<b>Soil Ingestion Pathway</b>			
Ingestion rate	100 mg/d <sup>c</sup>	6.24 g/y <sup>d</sup>	114 mg-y/kg-d <sup>e</sup>
<b>Inhalation Pathway</b>			
Inhalation rate (m <sup>3</sup> /yr)	5000 <sup>a,b</sup>	146 <sup>d</sup>	5475 <sup>a,b,d</sup>
Volatilization factor (m <sup>3</sup> /kg)	chemical specific	chemical specific	chemical specific
Particulate emission factor (m <sup>3</sup> /kg)	1.32E9 <sup>a</sup>	1.32E9 <sup>a</sup>	1.32E9 <sup>a</sup>
<b>Water Ingestion Pathway</b>			
Ingestion rate (L/d)	2 <sup>a,b</sup>	2 <sup>a,b</sup>	2 <sup>a,b</sup>
<b>Food Ingestion Pathway</b>			
Ingestion rate (kg/yr)	NA	NA	138 <sup>b,d</sup>
Fraction ingested	NA	NA	0.25 <sup>b,d</sup>
<b>Dermal Pathway</b>			
Surface area in water (m <sup>2</sup> )	2 <sup>b,e</sup>	2 <sup>b,e</sup>	2 <sup>b,e</sup>
Surface area in soil (m <sup>2</sup> )	0.53 <sup>b,e</sup>	0.53 <sup>b,e</sup>	0.53 <sup>b,e</sup>
Permeability coefficient	chemical specific	chemical specific	chemical specific

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

<sup>a</sup> RAGS, Vol 1, Part B (EPA 1991).

<sup>b</sup> Exposure Factors Handbook (EPA 1989b)

<sup>c</sup> EPA Region VI guidance.

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

<sup>e</sup> Dermal Exposure Assessment (EPA 1992).

suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

### Summary

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

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