



**Sandia National Laboratories/New Mexico**

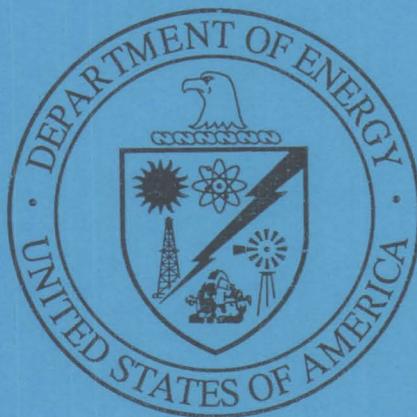
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**PROPOSAL FOR  
RISK-BASED NO FURTHER ACTION  
ENVIRONMENTAL RESTORATION SITE 226  
ACID WASTE LINE  
OPERABLE UNIT 1302**

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May 1997

**Environmental  
Restoration  
Project**



**United States Department of Energy  
Albuquerque Operations Office**

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Prepared by  
Sandia National Laboratories/New Mexico  
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Albuquerque, New Mexico

Prepared for  
U.S. Department of Energy

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## ACRONYMS

bgs	below ground surface
CAB	cellulose acetate butyrate
CEARP Program	Comprehensive Environmental Assessment and Response
COA	City of Albuquerque
COC	constituents of concern
DOE	Department of Energy
DV	data verification/validation
EPA	Environmental Protection Agency
ER	Environmental Restoration
ERDMS	ER data management system
FID	flame ionization detector
GPS	global positioning system
MDA	minimum detectable activity
ml	milliliter
mrem/yr	
MS	matrix spike
MSD	matrix spike duplicate
NEPA	National Environmental Policy Act
NFA	No Further Action
NMED	New Mexico Environmental Department
PCB	polychlorinated biphenyl
pCi/g	picoCurie per gram
PID	photoionization detector
PIP	Program Implementation Plan
ppb	parts per billion
PRS	potential release site
Pu	plutonium
RFI	RCRA Facility Investigation
SMO	SNL/NM Sample Management Office
SNL/NM	Sandia National Laboratories/New Mexico

SVOC	semi-volatile organic compound
TA	Technical Area
TAL	target analyte list
U	uranium
UTL	upper tolerance limit
VCM	Voluntary Corrective Measure
VOC	volatile organic compound

## 1.0 INTRODUCTION

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision for Environmental Restoration (ER) Site 226 determined by the risk-based analysis with confirmatory sampling criterion (NFA Criterion 5; NMED et al. 1995).

### 1.1 ER Site Identification Number and Name

ER Site 226 (herein referred to as the site) is the Old Acid Waste Line, and is included in Operable Unit 1302. The old acid waste line outfall was listed as Site 46 based on information obtained during the Comprehensive Environmental Assessment and Response Program (CEARP) Phase I interviews (DOE, 1987). The old acid waste line was distinguished from the acid waste line outfall and was designated ER Site 226 in October 1992 (Miller, 1992). The outfall is being investigated under ADS 1309, Tijeras Arroyo; the line is being investigated under ADS 1302, TA-I. The original ER site name was the Acid Waste Line (TA-I). The ER site name was changed to the Old Acid Waste Line during the development of the TA-I RFI Work Plans (SNL/NM, 1995).

### 1.2 SNL/NM NFA Process

The basis for proposing an NFA is thoroughly described in Section 4.5.3 of the Draft *Program Implementation Plan (PIP) for Albuquerque Potential Release Sites* (SNL/NM 1994a), and in Annex B of the *Environmental Restoration Document of Understanding* (NMED et al., 1995). ER Site 226 is being proposed for a risk-based, confirmatory sampling NFA decision based on NFA Criterion 5. The potential release site (PRS) has been characterized in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use.

### 1.3 Local Setting

The acid waste line was installed between 1948 and 1950 and was constructed of 4- to 8-inch diameter vitreous clay pipe. The system extended from three origins in the north central section of TA-I south to an outfall north of the Tijeras Arroyo (Appendix A, Plate 1-1). Lateral lines extended to buildings served by the line. The line remains in place and lies from 4 to 10 ft below ground surface (bgs) within TA-I and at an average of

8 ft bgs south of TA-I. Based on a review of architectural and mechanical drawings of TA-I buildings and interviews with present and retired SNL/NM employees, waste was discharged into the acid line from:

- Building 839, instrument repair and general research laboratory activities.
- Building 840, machine and ceramics shops.
- Building 841, a foundry and plating and coating shop.
- Building 860, environmental testing.
- Building 863, motion picture film processing.
- Building 892, weapons production.

## 2.0 HISTORY OF THE SWMU

This section provides a summary of the historical information that has been obtained at the site.

### 2.1 Sources of Supporting Information

Detailed information regarding the site is provided in the following documents.

- *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico [DRAFT] (DOE, 1987).*
- *Final RCRA Facilities Assessment Report of Solid Waste Management Units at Sandia National Laboratories, Albuquerque, New Mexico (EPA, 1987).*
- *Program Implementation Plan for Albuquerque Potential Release Sites [Draft] (SNL/NM, 1994a).*
- *Technical Area I (ADS 1302) RCRA Facility Investigation Work Plan (SNL/NM, 1995).*

### 2.2 Previous Audits, Inspections, and Findings

The site was first listed as a potential SWMU by the *Comprehensive Environmental Assessment and Response Program (CEARP), Phase I: Installation Assessment, Sandia National Laboratories, Albuquerque, New Mexico [DRAFT] (DOE, 1987)*. The listing resulted from information collected during the Phase I interviews in which the line was reported to have received about 130,000 gal/day of discharge comprised primarily of cooling water blowdown but also containing chromates, ferric chloride, and liquids from etching, plating, and photographic film developing processes. An estimated 200 gal/day of spent chromic acid was discharged to the line.

### 2.3 Historical Operations

The acid waste line was in continuous operation from 1948 through approximately 1967. In the mid- to late-1960s, use of the acid waste line for its original purpose was discontinued. Discharge from the line is evident in aerial photographs taken from 1964 to 1967; the actual date that discharges

ceased is unknown. Around this time (actual date unknown) the line was separated at the intersection of I and 9th Streets. The southern portion was capped at that intersection and was abandoned in place; all discharges to the line south of the intersection were discontinued. The portion of the line north of I Street was connected to the sanitary sewer system near the intersection and remains active. When the northern portion of the line was rerouted to the sanitary sewer system, the acid effluent was then discharged to the sanitary sewer or the waste was collected at the point of generation as chemical waste for off-site disposal.

### **3.0 EVALUATION OF RELEVANT EVIDENCE**

The section summarizes the data collected and evaluated from operational practices, previous investigations, and the RFI investigation.

#### **3.1 Unit Characteristics**

The acid waste line is either a part of the sanitary sewer system or abandoned in place (Section 2.3). All operational safeguards are overseen by TA-I facility personnel.

#### **3.2 Operating Practices**

Hazardous wastes were not managed or contained at the site. However, hazardous wastes were transferred through the line that may have been released to the surrounding soils from breaks within the line.

#### **3.3 Presence or Absence of Visual Evidence**

No visual evidence of hazardous waste constituents were seen on the surface or in soil samples collected for chemical and radionuclide analyses during the ER Site 226 RFI field investigation.

#### **3.4 Results of Previous Sampling Surveys**

Several previous investigations have been conducted in and around the old acid waste line. These investigations have included a radiation screening of the acid waste line outfall area (SNL/NM, 1994b); sediment sampling at two manhole locations in the south end of the system (IT Corp., 1994a); sediment and soil sampling at two branch segments of the system that served Building 839 prior to demolition of the building (IT Corp., 1994a, b); and soil sampling during an excavation trench that crossed the acid waste line (IT Corp., 1992a; Burton, 1992). Soil sampling was also performed during a voluntary corrective measure (VCM) that removed those portions of the acid waste line that served former Building 839 (IT Corp., 1995).

All sample results and documentation associated with the investigations that had previously been conducted were summarized in the TA-I RFI Work Plan (SNL/NM, 1995) and the VCM Report for the Building 839 acid waste line removal (IT Corp., 1995). In summary, the information gathered prior to the TA-I RFI indicated that there were no elevated depleted uranium or gamma radiation anomalies at the acid waste line outfall; elevated lead and total

chromium were detected in sediments collected from two manholes located at the south end of the system; and sediments from within the sections of line exiting Building 839 were contaminated with PCBs, metals (beryllium and lead), and radionuclides (tritium, uranium-238, radium-224, and bismuth-214).

A VCM was proposed to the EPA to remove the contaminated sections of the Building 839 acid waste line, associated uncontaminated sewer system lines, and possible contaminated soils associated with the acid waste lines. In April 1995 authorization was granted by the EPA to conduct the VCM and this action was completed by May 1995 (IT Corp., 1995). Verification samples were collected as part of the VCM to ensure that no contaminated soils remained in the area after the removal of the lines. The results of this confirmatory sampling verified that the contaminants were contained within the acid waste line and that all contaminated soil was removed during the VCM (IT Corp., 1995).

### **3.5 Assessment of Gaps in Information**

The RFI field investigation was designed to fully characterize each area of potential concern within the site. The RFI Sampling and Analysis Plan for this site is provided in Appendix B.

### **3.6 Confirmatory Sampling**

The following subsection provides a summary of the RFI field investigation and the evaluation of the data collected and analyzed during the investigation.

#### **3.6.1 Project Summary**

The objectives of the field investigation were to determine the potential vertical and horizontal extent of soil contamination at breaks in the underground lines and to determine potential contamination within the abandoned sections of the line. The potential constituents of concern (COCs) are radioactive materials, metals, VOCs, SVOCs, and PCBs. These COCs were based on known building activities and processes and on historical data.

ER Site 226 field investigation started July 12, 1995 and was completed July 21, 1995. The field activities included conducting an in-line camera survey of the acid waste line, drilling soil boreholes, collecting subsurface soil samples for chemical and radionuclide analysis, collecting sediments from inside abandoned manhole (line) locations for chemical and radionuclide

analysis, collecting waste samples for chemical and radionuclide analysis, handling the waste generated during drilling, and surveying borehole locations.

#### **3.6.1.1 Health and Safety Monitoring**

A photoionization detector (PID) and/or flame ionization detector (FID) was used to monitor the breathing zone around the drilling and the general background for organic vapors during soil borehole activities. In addition, a pancake probe was used to monitor alpha and beta/gamma radiation. The PID and FID readings for the breathing zone and the general area were zero for all soil boreholes except for one reading of 5 ppm at location T1226-GP-022. The high reading was attributed to a fire training exercise taking place next to the drilling activities. The PID and FID were calibrated daily and the readings were documented on the field activity daily logs. The pancake probe readings ranged from 35 to 70 counts per minute and are within normal background levels. These readings were also documented on the field activity daily logs.

#### **3.6.1.2 In-Line Camera Survey**

During the spring of 1993, an in-line camera survey was conducted in the acid waste line, the resulting data were used to identify pipe deficiencies. This was a major tool for the placement of soil boreholes, as discussed in the Work Plan (SNL/NM, 1995). For this field investigation, another in-line camera survey was conducted to reconfirm the exact location of each pipe deficiency for soil borehole placement. The camera crew located the in-line problem and then marked aboveground the location/depth of the pipe deficiency. This survey placement ensured that the location to be sampled was accurately identified.

#### **3.6.1.3 Drilling Program**

The drilling program was conducted using a truck-mounted Geoprobe® drill rig. A total of 24 soil boreholes (T1226-GP-001 through T1226-GP-024 ) were placed along the acid waste line (Appendix A, Plate 1-1). Soil borehole numbers T1226-GP-005 and T1226-GP-023 were used to identify duplicate soil samples collected during the project.

#### **3.6.1.4 Soil Collection**

Soil samples were collected approximately 18 inches below the acid waste line at each borehole using the Geoprobe® rig equipped with a 2.5-inch outside diameter by 24-inch long core sampler which was lined with a

cellulose acetate butyrate (CAB) sleeve. Samples were collected at depths ranging from 6 to 14 feet bgs. Upon removal of the CAB liner from the sampler, one 6-inch section was cut from the liner. This section was sealed with tape and prepared for shipment to an off-site laboratory for VOC analyses. The remaining sample was composited, placed into appropriate containers, and also prepared for shipment to the off-site laboratories for SVOC, PCB, TAL metals, isotopic uranium, plutonium, and tritium, and to the on-site laboratory for gamma spectroscopy analyses. Usually two sampling runs with the Geoprobe® were required to collect enough soil sample for these analyses.

The samples collected and the analyses performed on these samples are listed in Appendix C, Table 1. Twenty-four (includes two duplicates) soil samples were collected and sent to off-site and on-site laboratories.

In addition, three sediment samples (TI226-SD-001 to TI226-SD-003) were collected for the project (Appendix A, Plate 1-1). The work plan proposed sediment sample collection in three manholes (AWMH-11, AWMH-12, and AWMH-15) associated with the acid waste line (SNL/NM, 1995). Manholes AWMH-11 and AWMH-12 could not be located by the camera survey or by visual inspection of the locations as identified from as-built drawings. One sediment sample was collected at Manhole AWMH-15. An additional sediment sample was collected at Manhole AWMH-10 located approximately 70 feet south of Building 8894 (security guard building). This sample location is downgradient of manhole AWMH-15. The third sediment sample was collected near the acid waste line outfall. These samples were sent to the same laboratories and analyzed for the same parameters as the subsurface soil samples (Appendix C, Table 1).

#### **3.6.1.5 Sample Packaging and Shipping**

Soil samples sent to the off-site laboratories for VOC analysis were collected in CAB liners or glass bottles containing 125-ml of soil; for SVOCs, PCBs, and TAL metals analysis samples were collected into 500-ml glass bottles. Soil samples sent to the off-site laboratory for tritium analysis were collected into one liter amber glass bottles and soil samples for isotopic uranium and isotopic plutonium analysis were collected into 500-ml plastic bottles. Soil samples sent to the on-site laboratory for gamma spectroscopy analysis were collected into 500-ml Marenelli beakers. All liner and bottle sets were labeled, sealed with custody tape, and placed in a protective bubble-wrap Ziplock bag. The soil samples were placed on ice in the field and cooled to 4°C.

Samples were delivered to the SNL/NM Sample Management Office (SMO) on a daily basis. SMO personnel performed cross-checking of the information on the sample labels against the data on the Analysis Request and Chain-of-Custody (ARCOC) forms, and prepared samples for shipment. Samples were shipped by overnight delivery to off-site laboratories for chemical and radionuclide analyses. The gamma spectroscopy samples were delivered to the on-site laboratory the same day as delivery to SMO.

#### **3.6.1.6 Survey Soil Borehole Locations**

Soil borehole and sediment locations were surveyed with global positioning system (GPS) equipment. The GPS data included northing and easting coordinates for each borehole. The soil borehole and sediment sample location elevations were determined by topographic maps.

#### **3.6.1.7 Field Quality Control Samples**

Four types of field QC samples were shipped for analysis during the field investigation: field duplicate subsurface soil samples, equipment rinsate blank samples, soil and water trip blank samples, and field soil blank samples. Additional soils were collected for matrix spike/matrix spike duplicate analysis. Sample number, date/time of sample event, location, and analyses performed are presented in Appendix C, Table 1.

Two subsurface soil field duplicate samples were collected and analyzed for the same parameters as their corresponding samples. The subsurface soil samples were collected by splitting the CAB sleeve crosswise in two pieces for VOC analysis. For the remaining analyses, soils were removed from the CAB sleeves into a stainless steel bowl and composited, then transferred into appropriate containers. The sediment samples were collected by scooping up the dirt, compositing, and placing it in the appropriate containers.

Two equipment rinsate blank samples were collected from deionized water poured over the sampling equipment after decontamination of the equipment. The samples were analyzed for all parameters for which soil samples were analyzed.

Two field blank soil samples were exposed (open jar) to atmospheric conditions around the drilling/sampling operation and analyzed for VOCs only. The field blanks, which consisted of glass bottles filled with clean soils, were supplied by the SMO field office.

Trip blank samples were submitted with each shipment which contained samples for VOC analysis. Ten trip blanks (seven soil and three water) accompanied the sample containers to the field and back to the laboratory.

### **3.6.2 Data Management**

Upon sample shipment to the off-site laboratories, sample information was entered into a database to track the status of each sample. Upon completion of the laboratory analyses, SMO received analytical results in a summary data report and laboratory QC report.

The data summary (Certificate of Analysis) reports were reviewed by the SMO for completeness and accuracy as required by SNL/NM TOP 94-03 (SNL/NM, 1994c). Data validation was performed using SNL/NM Data Verification/Validation (DV) Level 1 (DV1) and Level 2 (DV2) checklists. SMO submitted the original ARCOCs, the Certificate of Analysis Reports, and the DV1/DV2 review reports to the Environmental Operations Record Center. In addition, the laboratories submitted analytical data in an electronic format for loading into the ER data management system (ERDMS). All chemical and radionuclide analytical data tables generated for this report except gamma spectroscopy data were downloaded through the ERDMS.

### **3.6.3 Analytical Data Summary**

This section discusses the analytical methods and the analytical results of the subsurface soil and sediment samples.

#### **3.6.3.1 Analytical Methods**

Subsurface soil and sediment samples sent to off-site laboratories were analyzed by the following approved EPA methods: Method 8240/8260 for VOCs, Method 8270 for SVOCs, Method 8080 for PCBs, Method 6010 for TAL metals, and Methods 7471/7470 for mercury. For the radionuclide samples, the off-site laboratory used methods EPIA-011/-011B for isotopic uranium and EPIA-012/-012B for isotopic plutonium and (for a single sample of decontaminated water only) isotopic thorium. The tritium samples were analyzed by the off-site laboratory using method LAL-91-SOP-0067. In addition, the gamma spectroscopy samples were analyzed following SNL/NM-approved analytical procedures by the on-site laboratory.

Analytical results for organic compounds listed "J" values for some compounds. A "J" indicates an estimated value for a compound that was detected at a level less than the reporting limit but greater than the method detection limit. Data results flagged as "J" values are included in the data summary tables used in this report; however, because "J" values may

represent false-positive concentrations, care should be used when evaluating these analytical results.

### **3.6.2.2 Subsurface Soil Sample Results**

A total of 24 subsurface soil samples (includes two field duplicates) were sent to the off-site laboratories for analysis. Table 2 (Appendix C) summarizes the VOC analytical results, Table 3 (Appendix C) summarizes the SVOC analytical results, and Table 4 (Appendix C) summarizes the PCB analytical results. Metal analytical results are provided in Table 5 (Appendix C). Table 6 (Appendix C) summarizes the radionuclide analytical results.

#### **VOC Results**

Soil samples were non-detect or J values for VOCs except acetone, which had six elevated values ranging from 21.1 to 56.7 parts per billion (ppb), and methylene chloride, with seven elevated values ranging from 19.7 to 127 ppb. The J value compounds were acetone, methylene chloride, and toluene.

Trip blanks either yielded non-detect or J values for all VOC analyses except for acetone (two samples) with values at 43.6 and 96.9 ppb and methylene chloride (one sample) with a value at 6.27 (B) ppb.

Equipment rinsate blank samples were non-detect for all VOC analyses.

Field blanks either yielded non-detect or J values for all VOC analyses except for acetone (one sample) at 45.2 ppb and methylene chloride (one sample) at 22.9 ppb.

#### **SVOC Results**

Soil samples were either non-detect or J values for SVOCs.

Equipment rinsate blanks were non-detect for SVOCs.

#### **PCB Results**

All samples were non-detect for PCBs except for one elevated value of Aroclor 1260 at 56 ppb.

Equipment rinsate blanks were non-detect for PCBs.

#### **TAL Metals Results**

A complete discussion of the metal results is provided in Section 3.6.4.1.

Equipment rinsate blank sample for metals were either non-detect or J values except for low elevated values for calcium, iron, sodium, magnesium, and nickel.

### **Radionuclide Results**

Plutonium (Pu)-238, Pu-239/240, uranium (U)-233/234, and U-238 were detected with elevated values above reporting limits. Two samples had elevated values of Pu-238 with the highest value at  $0.371 \pm 0.0875$  pCi/g. One sample had an elevated value of Pu-239/240 of  $0.915 \pm 0.113$  pCi/g. Twenty-two samples had elevated values of U-233/234, with the highest value at  $1.61 \pm 0.197$  pCi/g. Twenty-two samples had elevated values of U-238, with the highest value at  $1.41 \pm 0.191$  pCi/g. U-235 was not detected above the off-site laboratory's reporting limit. Tritium was not detected above the off-site laboratory's minimum detectable activity (MDA).

Equipment rinsate blank for radionuclide compounds were below laboratory reporting limits except one slightly elevated value of U-233/234 at  $1.58 \pm 0.949$  pCi/L and one slightly elevated value of U-238 at  $1.10 \pm 0.803$  pCi/L.

Gamma spectroscopy results were within normal background levels. Gamma spectroscopy analytical reports with results are located in the Environmental Operations Record Center.

### **3.6.3.3 Sediment Sample Results**

Three subsurface soil samples were sent to the off-site laboratories for analysis. Table 2 (Appendix C) summarizes the VOC analytical results, Table 3 (Appendix C) summarizes the SVOC analytical results, and Table 4 (Appendix C) summarizes the PCB analytical results. Metal analytical results are provided in Table 5 (Appendix C). Table 6 (Appendix C) summarizes the radionuclide analytical results.

### **VOC Results**

Sediment, trip, and equipment rinsate blank samples were non-detect or J values for VOCs. The J value compounds were acetone and methylene chloride.

### **SVOC Results**

Sediment and equipment rinsate blank samples were non-detect for SVOCs.

### **PCB Results**

Sediment samples were non-detect for PCBs except for one elevated value of Aroclor 1254 at 44.6 ppb, and one J value for Aroclor 1260. Equipment rinsate blank samples were non-detect for PCBs.

### **TAL Metal Results**

A complete discussion of the metal results is provided in Section 3.6.4.2.

### **Radionuclide Results**

For sediment samples, U-233/234 and U-238 were detected with elevated values above reporting limits in three samples. The highest value of U-233/234 was  $0.913 \pm 0.107$  pCi/g. The highest value of U-238 was  $0.809 \pm 0.0981$  pCi/g. U-235, Pu-238, and Pu-239/240 were not detected above the off-site laboratory's reporting limit. Tritium was not detected above the off-site laboratory's MDA.

Gamma spectroscopy results were within normal background levels. Gamma spectroscopy analytical reports with results are located in the Environmental Operations Record Center.

### **3.6.4 Statistical Analysis/Evaluation of Concentrations**

Statistical analysis of the VOC, SVOC, PCB, isotopic plutonium, and tritium results could not be completed, due to the small number of elevated values from Site 226 data and the lack of positive hits for the above-mentioned compounds from the TA-I background soil investigation (SNL/NM, 1996).

The chemical and radionuclide data evaluation discussion is provided using the following guidelines: comparing the VOC, SVOC, and PCB analytical results to EPA proposed Subpart S action level for soils (EPA, 1990) and comparing the metal and isotopic uranium analytical results to the background soil data collected during the TA-I field investigation, the site-wide background study for SNL/NM (IT Corp., 1996), and EPA Subpart S action levels for soils (metals only). For updated soil action levels, some values (e.g., zinc) were taken from "Report of Generic Action Level Assistance for the Sandia National Laboratories/New Mexico Environmental Restoration Program" (IT Corp., 1994c). The generic values from this report were made current for guidance through June, 1994 according to RCRA proposed Subpart S methods. Any soil action level used from that report will be referred to as "generic action level for soils". For TA-I background metal

and radionuclide analytical results, the UTL/95th percentile values were developed using the software package Statgraphics (SNL/NM, 1996). In addition, the isotopic plutonium results has been compared to the off-site laboratory reporting limit (RL) and the tritium results was been compared to the off-site laboratory minimum detectable activity (MDA).

Based on the soil evaluation (Sections 3.6.4.1 and 3.6.4.2), a risk assessment analysis was completed on certain radionuclide data that indicated detections above background levels. A summary of that analysis is provided in Section 3.7.

#### **3.6.4.1 Subsurface Soil Evaluation**

VOC results were either non-detect or J values except for acetone and methylene chloride for all samples. The elevated values of acetone (21.1 to 56.7 ppb) and the values of methylene chloride (19.7 to 127 ppb) are well below the EPA proposed Subpart S action levels of 8,000,000 ppb and 90,000 ppb, respectively. In addition, acetone and methylene chloride are common laboratory contaminants.

SVOC results were non-detect or J values for all samples. Only one estimated value of pyrene (178 ppb) and one estimated value of fluoranthene (178 ppb) were detected at one sampling location, TI226-GP-009 at 6 feet bgs. Both compounds are well below the EPA proposed Subpart S action levels of 2,000,000 ppb for pyrene and 3,000,000 ppb for fluoranthene.

All PCB results were non-detect except for one elevated value of 56 ppb at TI226-GP-009 at 6 feet bgs. This value is below the EPA proposed Subpart S action level of 90 ppb.

TAL metals were compared first to TA-I background levels, second to SNL/NM site-wide background levels, and third, to EPA proposed Subpart S action levels and/or the generic action level for soils (Appendix C, Table 7). The metals are within TA-I background levels, SNL/NM background levels, and/or proposed Subpart S action levels except for beryllium, calcium, iron, and magnesium. Although calcium, iron, and magnesium were above background levels, these chemicals are considered essential nutrients and should not be considered COCs for this site. In addition, beryllium was detected below background levels, but above the proposed Subpart S action level for soils. But beryllium occurs at naturally high concentrations in the soils within this geologic region and should not be considered a COC for Site 226.

Isotopic uranium (U-235, U-233/234, and U-238) results were compared first to TA-I background levels, and second to SNL/NM site-wide background

levels (Appendix C, Table 8). All U-235 values are below TA-I and/or SNL/NM background levels. U-238 was detected above SNL/NM site-wide background level (1.3 pCi/g) at two locations, TI226-GP-012 at 6 feet bgs ( $1.3 \pm 0.168$  pCi/g) and TI226-GP-013 at 6 feet bgs ( $1.41 \pm 0.191$  pCi/g). U-233/234 was detected above SNL/NM site-wide background level (1.6 pCi/g) at one location, TI226-GP-012 at 6 feet bgs ( $1.61 \pm 0.197$  pCi/g). U-238 and U-233/234 were included in the risk assessment analysis.

Isotopic plutonium (Pu-238 and Pu-239/240) results were compared to the off-site laboratory RL (Appendix C, Table 6).

- All Pu-238 results were below the RL (0.03 pCi/g) except at two sample locations: TI226-GP-018 ( $0.371 \pm 0.0875$  pCi/g), and TI226-GP-011 ( $0.157 \pm 0.0371$  pCi/g).
- All Pu-239/240 results were below the RL (0.03 pCi/g) except at one sample location, TI226-GP-011 with a elevated value of  $0.915 \pm 0.113$  pCi/g.

Based on the data evaluation, isotopic plutonium was included in the risk assessment analysis.

Tritium results (Appendix C, Table 6) were compared to the off-site laboratory MDA (ranging from 250 to 260 pCi/L). All tritium results were below the off-site laboratory's MDA.

#### **3.6.4.2 Sediment Evaluation**

VOC and SVOC results were either non-detect or J values for all samples. Based on this data evaluation,

All PCB results were non-detect except for one elevated value of Aroclor 1254 (44.6 ppb) and one estimated value of Aroclor 1260 (40.5 ppb). These values are below the EPA Subpart S action level of 90 ppb.

TAL metals were compared first to TA-I background levels, second to SNL/NM site-wide background levels, and third to EPA proposed Subpart S action levels and/or the generic action level for soils (Appendix C, Table 7). The metals are within TA-I background levels, SNL/NM background levels, and/or proposed Subpart S action levels except for beryllium. Beryllium was detected below background levels, but above the proposed Subpart S action level for soils. But beryllium occurs at naturally high concentrations in the soils within this geologic region and should not be considered a COC for Site 226.

Isotopic uranium (U-235, U-233/234, and U-238) results were compared first to TA-I background levels, and second to SNL/NM site-wide background levels (Appendix C, Table 8). All isotopic uranium values are below TA-I and/or SNL/NM background levels.

All isotopic plutonium (Pu-238 and Pu-239/240) and tritium results were below the off-site laboratory RL (Appendix C, Table 6).

### **3.7 Risk Analysis**

The following subsections summarize the results of the risk assessment process for both human and ecological risk related factors.

#### **3.7.1 Human Risk Analysis**

ER Site 226 has been recommended for industrial land-use (DOE, 1996). A complete discussion of the risk assessment process, results, and uncertainties is provided in Appendix D. Due to the presence of radionuclides in concentrations greater than background levels, it was necessary to perform a human health risk assessment analysis for the site. Besides radionuclides, any organics and/or inorganics detected above their reporting limits were included in this assessment. The risk assessment process results in 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 land-use and residential land-use setting. The excess cancer risk from nonradioactive COCs and the radioactive COCs is not additive (EPA, 1989).

In summary, the Hazard Index calculated for chemical compounds is 0.09 and the incremental Hazard Index is 0.01 for the industrial land-use scenario, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA, 1989). The excess cancer risk for chemical compounds is  $3 \times 10^{-6}$  in an industrial land-use setting which is at the lower end of the suggested range of acceptable risk of  $10^{-6}$  and  $10^{-4}$  (EPA, 1989). There was no incremental excess cancer risk for the industrial land-use scenario. The excess cancer risk for radionuclides is  $3.0 \times 10^{-7}$  for industrial land-use scenario, which is much less than risk values calculated due to naturally occurring radiation and from intakes considered background concentration values. In addition, the estimated effective dose equivalent for an industrial land-use setting is 0.08 mrem/yr well below the standard dose limit of 15 mrem/yr (40CFR196, 1994).

The residential land-use scenarios for this site are provided only for comparison in the risk assessment report (Appendix D). The report concludes that Site 226 does not have significant potential to affect human health under either an industrial land-use scenario.

### **3.7.2 Ecological Risk Analysis**

It is unlikely that activities or COCs at Site 226 will have much impact on ecological risk. TA-I is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species is unlikely. Much of the relevant ecological information for TA-I can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992).

### **3.8 Rationale For Pursuing a Risk-Based NFA Decision**

Twenty-four soil borehole locations were drilled around the TA-I acid waste line. In addition, three sediment samples were collected. The data evaluation for the subsurface soil and sediment samples shows no VOC, SVOC, TAL metals, or PCB COCs, but some radionuclide compounds were detected above background levels. Based on the field investigation data and the human health risk assessment analysis, an NFA is being recommended for Site 226 for the following reasons:

- No VOCs or radionuclide compounds were detected above background levels during the field screening program.
- Gamma spectroscopy results were within normal background levels.
- VOCs and SVOCs were either non-detect or J values (by the off-site laboratory analysis).
- PCBs results were either non-detect and/or J values except for two samples. All detected PCB values were well below proposed Subpart S action levels for soils.
- All TAL metals were either below TA-I and SNL/NM background levels or below proposed Subpart S action levels for soils.
- U-235 and tritium results were not detected above relevant reporting limits or SNL/NM background levels.

- No COCs (chemical or radionuclide) were present in concentrations considered hazardous to human health for an industrial and/or a residential land-use scenario.

Based on site history and the data evaluated from the field investigation, neither further investigation nor a VCM are recommended for Site 226.

#### **4.0 CONCLUSION**

Based upon the evidence cited above, no potential remains for a release of hazardous and radionuclide waste that pose a threat to human health or the environment. Therefore, ER Site 226 is recommended for an NFA determination based on NFA Criterion 5. The potential release site has been characterized in accordance with current applicable state or federal regulations, and the available data indicated that contaminants pose an acceptable level of risk under current and projected future land use.

## 5.0 REFERENCES

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Appendix A

ER Site 226 Figures



Appendix B

Section 5.12 of the TA-I RFI Work Plan (SNL/NM, 1995)

## 5.12 ER Site 226, Acid Waste Line

### 5.12.1 Site Description and History

The acid waste line was installed between 1948 and 1950 and was constructed of 4- to 8-inch diameter vitreous clay pipe. The system extended from three origins in the north central section of TA-I south to an outfall north of the Tijeras Arroyo (Plates 5-9 to 5-11). Lateral lines extended to buildings served by the line. The line remains in place and lies from 4 to 10 ft bgs within TA-I and at an average of 8 ft bgs south of TA-I. Based on a review of architectural and mechanical drawings of TA-I buildings and interviews with present and retired SNL/NM employees, waste was discharged into the acid line from:

- Building 839, instrument repair and general research laboratory activities.
- Building 840, machine and ceramics shops.
- Building 841, a foundry and plating and coating shop.
- Building 860, environmental testing.
- Building 863, motion picture film processing.
- Building 892, weapons production.

In the mid- to late-1960s, use of the acid waste line for its original purpose was discontinued. At this time the line was separated at the intersection of I and 9th Streets. The southern portion was capped at that intersection and was abandoned in place (8 to 10 ft below grade); all discharges to the line south of the intersection were discontinued. Discharge from the line is evident in aerial photographs taken from 1964 to 1967; the actual date that discharges ceased is unknown. The portion of the line north of I Street was connected to the sanitary sewer system near the intersection and remains active. When the northern portion of the line was rerouted to the sanitary system, the acid effluent was then either discharged to the sanitary sewer or the waste was collected at the point of generation as chemical waste for off-site disposal.

Based on information gathered in employee interviews, the old acid waste line outfall was listed as ER Site 46 during the CEARP Phase I (DOE 1987). The acid waste line was distinguished from the acid waste line outfall and was designated ER Site 226 in October 1992 (Miller 1992). The acid waste line outfall is being investigated under ADS 1309, Tijeras Arroyo; the acid waste line is being investigated under ADS 1302, TA-I. ER Site 226 boundaries are based on whether the line is active (as part of the sanitary sewer system) or inactive and abandoned. Site 226 includes all abandoned line

and soil near the abandoned line where potential COCs have been detected. For the active portion of the line, Site 226 is limited to soil near those portions of the line where breaks have been identified and potential COCs have been detected. The ER Site will be investigated to assess if potential COCs may have been released to the soil surrounding the piping.

Reportedly, the acid waste line received about 130,000 gal/day of discharge comprised primarily of cooling water blowdown but also containing chromates, ferric chloride, and liquids from etching, plating, and photographic film developing processes. An estimated 200 gal/day of spent chromic acid was discharged to the acid waste line. As stated above, the exact duration of system use is unknown but is estimated to be approximately 15 years. Table 5-31 identifies some of the process waste which was discharged to the line from TA-I buildings.

## 5.12.2 Previous Investigations

### 5.12.2.1 *Radiation Screening of Acid Line Outfall Area*

A gamma scan survey was conducted in 1994 for beta/gamma radiation at the acid waste line outfall (ER Site 46, investigated under ADS 1309). It was performed at 6 ft centers over the exterior surface area of the site, providing 100 percent coverage. No visible signs of depleted uranium were noted and no gamma anomalies were detected above background (SNL/NM 1994d).

### 5.12.2.2 *Line Sediment Investigations*

Two investigations of the acid waste line sediment constituents have been conducted to date:

- Sediment samples from inside the line were collected as part of the investigation of surface soil in current and historic storm sewer discharge areas conducted in May 1992 (IT Corp. 1992d); and
- Sediment samples were collected in December 1993, January 1994, and April 1994 from two branches of the line serving Building 839 prior to demolition of that structure (IT Corp. 1994e, f).

Table 5-31. Wastes Discharged to Acid Waste Line From Buildings in TA-I

Building Number	Building Use	Possible Wastes Discharged
839	Instrument repair and general research laboratory	Solvents, metal alloys
840	Machine and ceramic shop	Lead oxide, solvents, coolant oils
841	Foundry; plating and coating shop	Electroplating solutions, lead, ferric chloride, copper solutions, strippers, solvents, paints, chromic acid
860	Environmental Testing	Unknown
863	Motion Picture Film Processing	Photographic solutions, solvents, silver
892	Weapons Production	DU, acetone, toluene, hydrogen sulfide, neutralizing material, sodium hydroxide

#### 5.12.2.2.1. Manholes South of Technical Area I

Sediment samples were collected during May 1992 from within the acid waste line at three manholes west of TA-II from the portion of the acid waste line north of TA-IV, near the East Ordnance Road, and parallel to 9th Street (Figure 5-34). Field screening detected no Vows and measured radiation levels were within 3-sigma of background. Sediment samples were analyzed at an off-site analytical laboratory for TC metals, TCLP metals, VOCs, and SVOCs and for tritium, gross alpha, gross beta, and gamma spectroscopy with five reported isotopes (cesium-137, potassium-40, radium-224, radium-226, and radium-228) by an off-site radiological laboratory. Insufficient sample volume was available to perform VOC, SVOC, and TCLP metals analyses at Manhole No. 1.

Results of sediment analyses (except TCLP metals and radionuclide results) were compared with soil action levels derived in accordance with the methodology presented in proposed Subpart S (EPA 1990b). No VOCs, SVOCs, or metals with the exception of chromium and lead exceeded the derived action levels. The chromium action level derived is for hexavalent chromium because EPA-approved toxicity data for total chromium are not available. The levels of total chromium detected (900 mg/kg and 839 mg/kg from Manholes 1 and 3, respectively) exceeded the hexavalent chromium action level of 400 mg/kg. Lead was detected at concentrations ranging from 434 to 902 mg/kg in the line sediment. No EPA toxicity data are available for lead; the action level for lead in soil currently recommended by the EPA is 500 mg/kg. Leachable metals (by TCLP) are below the regulatory toxicity characteristic levels specified in 40 CFR 261.

Results of the radiological analyses are summarized in Table 5-32. The only non-naturally occurring isotope detected was cesium-137, which reportedly results from global fallout of radionuclides originating from surface nuclear tests (Purtymun *et al.*, 1987). Neither cesium-137 nor radium-226 exceed DOE guidelines (DOE 1983) for any location. There are no guidelines for the other isotopes detected in the sediment. Background data from the SNL/NM sitewide soil background study have been determined for all five radionuclides analyzed (IT Corp. 1994b) and are shown for comparison purposes in Table 5-32. Radium-224 and radium-228 in the sediments slightly exceeded the soil background values at both Manholes No.1 and No.2 (IT Corp. 1992d).

Table 5-32. Radionuclides Detected in Manhole No. 2

Analyte	Range of Results	SNL/NM Background (Range)
Gross alpha	15.2 to 44.9 pCi/g	None available
Gross beta	21.4 to 38.8 pCi/g	None available
<sup>137</sup> Cs	0.226 to 0.664 pCi/g	0.004 - 10.1 pCi/g
<sup>40</sup> K	13.1 to 22.4 pCi/g	0.192 - 31 pCi/g
<sup>224</sup> Ra	0.644 to 1.31 pCi/g	0.43 - 0.97 pCi/g
<sup>226</sup> Ra	0.687 to 1.01 pCi/g	0.5 - 2.09 pCi/g
<sup>228</sup> Ra	0.732 to 1.25 pCi/g	0.45 - 1.05 pCi/g

#### 5.12.2.2. Sediment Sampling of the Building 839 Acid Waste Lines

Prior to the demolition of Building 839, two acid waste line laterals that once served the building were investigated during 1993 and 1994 (Figure 5-34). Sediment from the interior and soil surrounding the lines were sampled. The sediment sampling is described below and the soil sampling is described in Section 5.12.2.3.

Three sediment samples were collected from two acid waste line laterals near Building 839 in December 1993 and January 1994. The samples were analyzed for VOCs, SVOCs, TAL inorganics, and PCBs (north line only) by an off-site analytical laboratory. Gamma-emitting radionuclides were analyzed on site and tritium was analyzed by an off-site radiological laboratory. Based on the gamma spectrum results, the sediment sample from the north acid waste line was subsequently analyzed for isotopic thorium by the off-site radiological laboratory. In April 1994 during an additional investigation, a wipe sample was collected for PCBs from the interior of the north acid waste line from a break near a clean out (CO1) and a sediment sample was collected for PCBs from the interior of the north acid waste line at the same location as the original sediment sample.

Results of the sediment sampling indicated that certain COCs were present in the line interior. Beryllium exceeded the action level of 0.2 mg/kg derived in accordance with the methodology in proposed Subpart S (EPA 1990b) in all three samples, with concentrations ranging from 0.3 to 1.2 mg/kg and it exceeded the SNL/NM background concentration of 0.785 for the sample from the west end of the south acid line. Lead was detected above the SNL/NM soil background level of 15.0 mg/kg in the samples from the east end of the south acid line (19.0 mg/kg) and the north acid line (118 mg/kg). No other metals were detected at concentrations above the action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b). Several VOCs were detected in the sediment, though none were above proposed Subpart S action levels (EPA 1990b). No SVOCs of concern were detected. All three sediment samples were analyzed for pH; values ranged from 6.6 to 8.7 and are considered to be consistent with the natural soil. The PCB Aroclor 1242 was detected in the sample from the north acid waste line at a concentration of 27,000  $\mu\text{g}/\text{kg}$ , which is above the TSCA cleanup level of 10,000  $\mu\text{g}/\text{kg}$  (40 CFR 761, Subpart G) and the risk-based action level of 90  $\mu\text{g}/\text{kg}$  derived in accordance with the methodology in proposed Subpart S (EPA 1990b, IT Corp. 1994e). The sediment collected from the north acid line in May 1994 confirmed the elevated PCB level; a concentration of 37,000  $\mu\text{g}/\text{kg}$  was detected. No PCBs were detected on the wipe sample collected from the location near CO1 (IT Corp. 1994f). Since no constituents were detected above action level except where noted, a baseline risk assessment was considered unnecessary at the time.

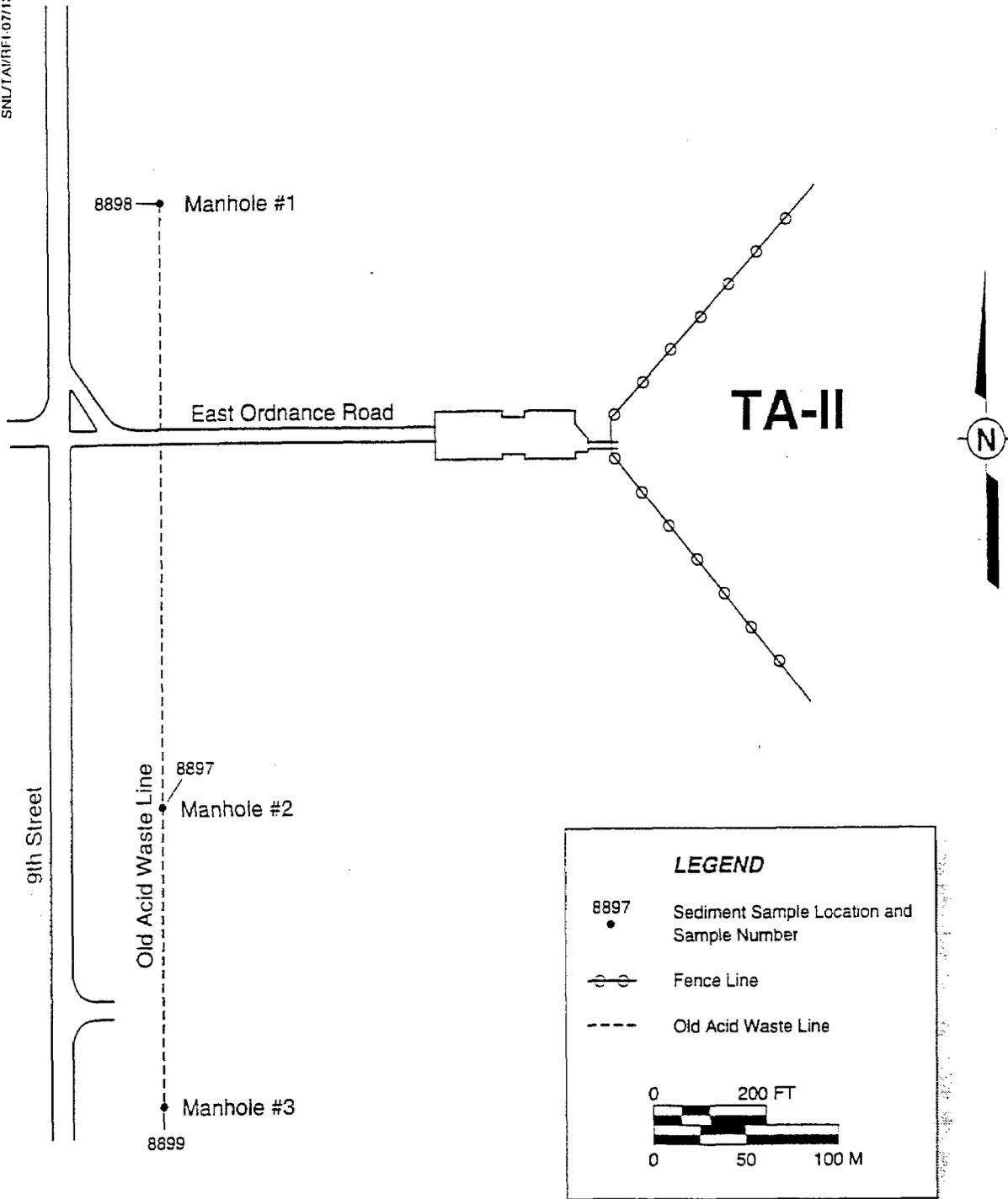


Figure 5-34  
ER Site 226: Old Acid Waste Line,  
Previous Sediment Sample Locations

Two of the three sediment samples collected were analyzed for gamma-emitting radionuclides and tritium. The sample from the east end of the south line was not analyzed for radionuclides because of insufficient sample volume. The sample from the west end of the south line contained radionuclide activities consistent with natural background concentrations. The sample from the north acid line exhibited a tritium concentration of 920 pCi/L and contained radionuclide activities slightly above natural background concentrations that made it suspect for thorium contamination. Subsequent isotopic thorium analysis indicated that the thorium isotope level was within the natural background concentrations found at SNL/NM (IT Corp. 1994f).

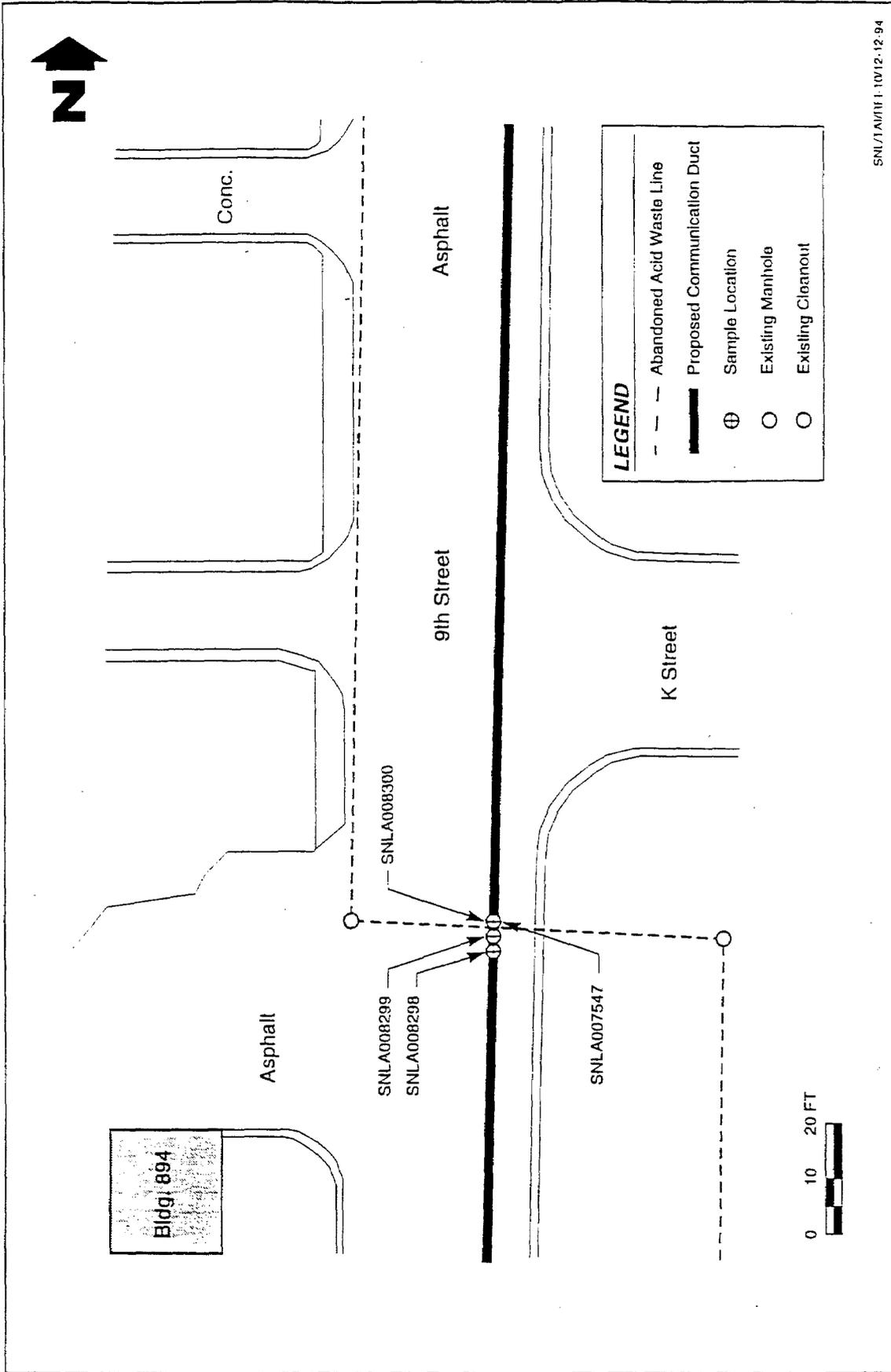
Based on the sediment results, it was determined that additional investigation of the soils surrounding the acid lines was warranted. The additional soil investigation focused on metals, VOCs, and tritium; the results are discussed in Section 5.12.2.3.

#### *5.12.2.3 Previous Soil Sampling and Analysis*

Soil adjacent to several breaks identified in the camera survey has been sampled and analyzed in conjunction with two facilities projects at SNL/NM. These are described below.

##### *5.12.2.3.1. Communications Duct at K and 9th Streets*

In the spring of 1992, prior to excavating a trench across a segment of the acid line for a communication line, 10 soil samples were collected near the intersection of K and 9th Streets (Figure 5-35). The soil was analyzed for total metals, VOCs, SVOCs, tritium, and by gamma spectroscopy. Five samples were collected 3 ft bgs at the approximate depth of the acid waste line, and five samples were collected 8 ft bgs at the depth of the proposed communication lines. Three background and QA/QC samples were also collected. No soil sampled contained constituents in concentrations that exceed RCRA waste characterization thresholds (40 CFR 261), proposed Subpart S risk-based action levels (EPA 1990b), or DOE guidelines (IT Corp. 1992e; Burton 1992). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.



SNL/1A/M/11.10/12.12.94

Figure 5-35  
 ER Site 226: Location of Samples Collected Near Intersection of  
 Communications Duct and Acid Waste Line, 9th and K Streets

#### 5.12.2.3.2. Building 839 Acid Waste Line Soil Sampling

Based on the results of sediment samples collected in December 1993 and January 1994 from the interior of the acid waste line laterals north and south of Building 839 (Subsection 5.12.2.2), additional sampling was conducted in April and May 1994 (IT Corp. 1994f). Soil samples were collected adjacent to the three original acid waste line sampling locations, and, for each of the three, at 4 points approximately 15 ft from the original locations. In addition, samples were collected at two locations that had not previously been sampled adjacent to breaks in the main acid waste line which runs east of Building 839 and at two locations near CO1 in the north acid waste line. At each of the 19 soil sample locations, samples were collected at two depths. The three locations at the original sediment sample locations were sampled 5 ft and 10 ft below the depth of the line (*i.e.*, at 9 ft and 14 ft. bgs). At the other 16 locations, samples were collected at the line depth and 5 ft below line depth (*i.e.*, at approximately 4 ft and 9 ft bgs).

Samples were shipped to an off-site analytical laboratory for TAL inorganics and organic analyses; to the SNL/NM on-site radiological laboratory for gamma spectroscopy; and to an off-site radiological laboratory for tritium analysis. Specific analyses for samples associated with previous sampling were based on the results of the sediment sampling. Samples collected from the east acid waste line were analyzed for metals, VOCs, SVOCs, PCBs, gamma-emitting radionuclides, and tritium.

Near the east acid waste line, no VOCs, SVOCs, PCBs, or metals were detected at levels that exceeded the action levels derived in accordance with the methodology specified in proposed Subpart S (EPA 1990b) and/or SNL/NM soil background levels. Several VOCs and one PCB congener were detected at the line depth but not in the 5-ft sample. This bounds the vertical extent of these constituents at the location and provides useful information about the migration of VOCs and PCBs in TA-I soils. Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time. Gamma-emitting radionuclides detected near the east acid line at values greater than SNL/NM soil background levels were uranium-238, radium-226, bismuth-214, and radium-224. Tritium was detected in three samples at levels ranging from 330 to 420 pCi/L, which exceed the SNL/NM action level of 250 pCi/L (SNL/NM 1994e).

Fifteen of the soil samples (including 1 duplicate) collected near the north acid line were analyzed for VOCs, PCBs, total TAL inorganics, gamma-emitting radionuclides, and tritium. One soil sample collected immediately below the line at an offset cracked joint near CO1 was analyzed for PCBs only. No PCBs were detected in any of the soil samples collected near the north acid waste line. No VOCs

were detected at levels exceeding the risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b). All metals detected except beryllium were below risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b) and/or SNL/NM soil background metals concentrations. Beryllium was detected in all the samples except one at levels exceeding the proposed Subpart S action level of 0.2 mg/kg (EPA 1990b); no level exceeded the SNL/NM soil background level of 0.785 mg/kg. Gamma-emitting radionuclides detected near the north acid waste line at values greater than SNL/NM soil background levels were uranium-238, radium-228, radium-226, bismuth-214, and radium-224. Tritium was detected in ten samples at levels ranging from 290 to 470 pCi/L, which exceed the SNL/NM action level of 250 pCi/L (SNL/NM 1994g). Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

The 10 soil samples collected from five locations near the eastern end of the southern acid waste line were analyzed for total TAL inorganics. All metals detected were below risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b) and/or SNL/NM soil background metals concentrations. Since no constituents were detected above action levels, a baseline risk assessment was considered unnecessary at the time.

The 10 soil samples collected from five locations near the western end of the south acid waste line were analyzed for tritium, gamma-emitting radionuclides, VOCs, and total TAL inorganics. All VOCs and metals detected, except beryllium and barium, were below risk-based action levels derived in accordance with the methodology in proposed Subpart S (EPA 1990b) and/or SNL/NM soil background metals concentrations. Beryllium was detected in all the samples except one at levels exceeding the proposed Subpart S action level of 0.2 mg/kg (EPA 1990b); no level exceeded the SNL/NM soil background level of 0.785 mg/kg. Barium was detected in three samples at levels exceeding the SNL/NM background level of 398 mg/kg but below the proposed Subpart S action level of 4000 mg/kg (EPA 1990b). Gamma-emitting radionuclides detected at values greater than SNL/NM soil background levels were uranium-238, bismuth-214, and radium-224. Tritium was detected in nine samples at levels ranging from 380 to 1100 pCi/L, which exceed the SNL/NM action level of 250 pCi/L (SNL/NM 1994e; IT Corp. 1994f).

The second phase of sampling identified that the contaminated material was confined to within the acid lines. The tritium detected near the western end of the south acid waste line could not be attributed to effluent from the line as it was also detected at the surface at other locations at Building

839. Subsequent calculations have confirmed that the health and safety risk to personnel associated with the levels of tritium detected in the soil are much lower than DOE guidelines (Eidson 1994). A VCM is being proposed to the EPA to remove these sections of contaminated acid waste lines as well as uncontaminated sewer lines. The VCM Plan, Waste Management Plan, and Sampling and Analysis Plan are presently in draft and are anticipated to be ready for regulatory review in the second quarter of fiscal year 1995. The VCM is planned to be conducted at the Building 839 acid waste line and the Building 838 and 839 sewer lines. Verification samples will be collected as part of the VCM to ensure that no contaminated soil remains after the removal of the lines.

#### 5.12.2.4 *Camera Survey*

In the spring of 1993, an in-line camera survey was performed on an estimated 60,000 ft of the sanitary sewer and acid waste line to identify breaks. In the fall of 1993, a second camera survey identified additional breaks in sewer lines serving buildings of potential concern and abandoned lines. These investigations are described in detail in Section 5.10. Several deficiencies were identified and evaluated (Plates 5-9 to 5-11). The following criteria have been used to define pipe deficiencies (Jones 1994):

- A minor crack is a hairline crack which shows no sign of an open void in the pipe material.
- A moderate crack has a visible void in the pipe wall and may have an offset of pipe material at the crack.
- A severe crack was noted in cases where soil was visible through the opening in the pipe.
- A slight offset joint has a deflection of approximately 1/4 inch or less.
- A moderate offset joint has an exposed gasket or a joint deflection greater than 1/4 inch.
- A severe offset joint has soil visible through the offset joint.
- Where there are roots in the lines, particularly in clay pipe, there is the potential for a moderate crack.
- Where not specified, offset joints are slight breaks.
- Where an offset joint is noted to be cracked, the break is moderate.
- Where there is either a joint with offset, a joint with roots, a possible old repair, or a cracked joint, the break is moderate.

- Where there is a broken pipe, a bad joint, an old repair, or a hole in the pipe, the break is severe.

Pipe deficiencies and break locations are shown on the plates. Deficiencies or breaks are shown as slight, moderate, or severe by line weight around, and shading within the keyed note symbol in both the legend and the plate. Keyed notes which do not indicate a pipe deficiency or break are screened back. Keyed notes which pertain to the sanitary sewer system are denoted by an "S".

#### 5.12.3 Nature and Extent of Contamination

There are limited data available on the nature and extent of contamination associated with the acid waste line. Two investigations of sediment from the line interior, a radiation survey of the outfall area, a camera survey of the line interior, an investigation of soil near two lateral lines at a single building, and an investigation of two break locations in the portion of the line incorporated into the sanitary system have been conducted to date. All other information on the nature of possible contamination is based on knowledge of processes producing the waste discharged to the line.

The investigations indicate that chemicals and radioactive materials from industrial processes may remain in the abandoned portions of the line. These chemicals and radioactive materials have been detected near breaks in the line, but at levels much lower than action levels. The constituents detected have been limited in extent to within 15 ft of the breaks.

#### 5.12.4 Conceptual Model

The conceptual model for the acid waste line is based on available information on system usage, the line break locations identified by the camera survey, and the results of previous investigations. Based on known building activities and processes and data collected to date, the waste may have contained radioactive materials as well as metals, VOCs, SVOCs, and PCBs. Deficiencies in lines that have carried industrial or laboratory waste provide a pathway for the waste to the surrounding soil. Because the acid waste line was designed to flow full, breaks located anywhere in the line are assumed to constitute a potential release pathway. However, the line was used for acid discharges for only approximately 15 of the last 45 years. It is unreasonable to assume that each line break identified in 1993 was present when the system was operating 30 years previously. Similarly, every pipe deficiency or line break cannot be assumed to be the source of a release. Many pipe deficiencies may

have occurred during the 25-year period after the system was abandoned (south of I Street) or incorporated into the sanitary sewer system (north of I Street).

Based on available data and knowledge of system use, the potential COCs would not be expected to migrate substantially from the release site, nor be present in concentrations which pose a risk to human health or the environment. There is little potential for lateral contaminant migration. In most cases the lines are buried 4 to 8 ft bgs. There is no grade or local topography, nor surface runoff or overland flow which would contribute to lateral contaminant migration. There is the potential for vertical migration through the vadose zone. If there were breaks in the lines during system use and in the portion converted to sanitary sewer, then the flow in the line may have created an hydraulic head to drive the flow through the vadose zone. The COCs present in the soil could also migrate vertically through the vadose zone with infiltrating precipitation; however, that migration mechanism is limited because of the extensive paving in TA-I.

In order to develop a strategy for investigating releases from the acid waste line, a model of migration of contaminants through the vadose zone was assumed. A crack or other deficiency in the line is considered a point source for release. Because of the low potential for lateral migration, any release is assumed to migrate downward in a conical zone. The release is assumed to spread at approximately a 45 degree angle from the vertical as it migrates vertically.

The potential COCs in the acid waste line are similar to those in the Storm Drain System except that bases have been excluded. Information on the mobility and persistence of the potential COCs is given in the Storm Drain Conceptual Model, Subsection 5.10.4.

A release from the acid waste line would not pose a direct risk to human health and the environment. The affected area lies a minimum of 4 ft bgs and, in many areas, is 8 ft bgs. Unless the line is accessed for construction purposes, there should be no direct contact with the affected soil via inhalation, ingestion, or dermal exposure. If construction is required, proper precautions will be taken to protect site workers. Five hundred feet separate the potential release source and the local aquifer, limiting the potential risk to potable water quality.

Potential corrective measures at the acid waste line are primarily limited to excavation and off-site treatment or disposal. Because of the wide range of contaminants that may be present and the

probable distribution of COCs at break locations, *in situ* and on-site treatment technologies are not considered technically or economically feasible at this time. However, on-site treatment may be feasible if a large soil volume is affected. If data collected indicate that, because of the areal and vertical extent of COCs, the volume of soil to be generated from releases along the lines warrant it, on-site treatment technologies will be evaluated.

#### 5.12.5 Sampling Plan

The sampling strategy selected for the acid waste line is designed to characterize potential releases from the system at the break locations identified by the in-line camera survey and to characterize any material remaining within abandoned portions of the line.

General DQOs for TA-I RFI are given in Section 4.3. Specific DQOs for the acid waste line investigation include:

- Determining if any VOCs, SVOCs, metals, PCBs, and/or radionuclides have been released to the soil within 18 inches of an identified line break or are constituents of any material remaining within abandoned portions of the line.
- Producing data of adequate quality (Level III) for all shallow subsurface samples at each break location under investigation so that risk calculations may be performed for an individual break location.
- Producing data of adequate quality (Level III) for all sediment samples so that risk calculations may be performed for material remaining within the line.
- Characterizing the vertical extent of any COCs detected above action levels near the acid waste lines by collecting samples from deep soil borings for analysis (Level II and Level III).
- Producing data of adequate quality (Level III) for 20 percent of deep borehole samples so that risk calculations may be performed and corrective measures may be evaluated.

The DQOs will be achieved through implementation of the sampling strategy outlined below. If contaminants are detected in the soil samples at concentrations above the action levels, additional samples (*i.e.*, boreholes) will be collected. Analytical Levels II and III will be required for analytical procedures identified under this plan. Data will be collected during sediment and shallow subsurface soil sampling and deep soil boring investigations.

### 5.12.5.1 *Shallow Subsurface Soils Near Lines and Line Sediment*

#### 5.12.5.1.1. Data Collection

Soil samples will be collected adjacent to the breaks identified by the in-line camera survey (Plates 5-9 to 5-11). The sample locations are indicated on the figures using bolded circles around the keyed note symbol on the figure. In many cases, the breaks are clustered around a line segment. Where samples are clustered, a streamlined sampling approach will be taken. Soil will be sampled at one location, selected to be representative of the potential worst case release to surrounding soil. The streamlined approach has been adopted based on the homogenous nature of the effluent. The effluent and any COCs which have entered the system would be the same along a given line or section of line that received discharge from the same source. COCs present would be diluted with discharge from additional lines downstream of each connection and at the confluence of lines. The in-line camera survey identified lines from buildings where radiological and chemical constituents were discharged to the acid waste line and off-set joints or line breaks from which these constituents may have been released to soil. Given the break density and severity designations, the criteria listed below comprise the bases for the selected sample locations.

- Where two or more breaks are located along 100 ft of pipe, the most severe and most upgradient break will be sampled. For example, south of Building 841 there are three line deficiencies within 100 ft of one another (Plate 5-10; Keyed Note Nos. 44, 45, and 46). The sample location chosen is the northern-most of the three (No. 46) because it is the most upgradient and is severe; the other two are moderate deficiencies.
- Where two keyed notes of the same severity were located downgradient of a building connection, the keyed note legend was consulted to select the location having the greatest potential to be the source of a release. For example, east of Building 840, five severe deficiencies were identified (Plate 5-10; Keyed Note Nos. 53 to 57). The northern-most deficiency (No. 57) was chosen as the sample location because it is both the most upgradient (and contaminants are less likely to be diluted) and the pipe is offset on the bottom side, making it the most likely source of a release.
- Where there are two or more slight breaks within 100 ft of pipe, the most upgradient break will be sampled;
- Where five or more severe breaks are clustered along 100 ft of pipe, the most upgradient break and that break nearest a downgradient connection will be sampled (*i.e.*, two breaks will be sampled if more than four severe breaks are located within 100 ft); and
- Where a break is over 100 ft from another break location, the break location will be sampled.

No buildings south of Building 892 were connected to the acid waste line. Sample locations south of that building have been selected based on break location, density, and severity as well as knowledge of the homogeneous flow through the line from Building 892 south to the Tijeras Arroyo. The breaks occur in eight clusters; the distance between clusters ranges from 150 to more than 600 ft. The most upgradient breaks at four of the eight clusters are severe. For example, in Plate 5-11, Keyed Notes Nos. 2 and 13 in Block 10d are the most upgradient and severe breaks in the clusters. These locations were selected to provide the most conservative estimate of the extent of a potential release from a break in the line south of Building 892.

In other clusters, such as Plate 5-11, Keyed Note No. 3 in Block 7d, a severe break is within 75 ft of the most upgradient break in the cluster. This severe break was selected to be representative of a potential release from the line segment for that cluster. There are no severe breaks in the other three clusters. In two clusters, a moderate break is, or is adjacent to, the most upgradient break location. In these clusters, the most upgradient moderate break provides the most conservative sample location (Plate 5-9, Keyed Notes Nos. 4 and 12 in Blocks 4d and 7b).

In the final cluster, there are two slight breaks and slight offset joints lying 3 ft apart, identified as Plate 5-9, Keyed Notes Nos. 1 and 2 in Block 4d. One location will be sampled due to the proximity of these deficiencies to one another and their distance from upgradient (600 ft) and downgradient (150 ft) clusters.

One soil sample will be collected by hand auger within 18 inches directly below or adjacent to the line at the locations shown in Plates 5-9 and 5-11 for field screening, lithologic logging, and laboratory analyses. Soil for laboratory analysis will be transferred from the sampling device to the sample containers immediately upon collection. Additional soil will be collected for screening and logging and then disposed of as IDW. Sediment remaining in the abandoned line (*i.e.*, that portion of the line south of I Street) will be collected from three manholes near Buildings 893, 892, and 819 (Manholes AWMH15, AWMH12, and AWMH11) if sediment volume allows. If sufficient volume is available, the sediment will also be field screened for VOCs. The manholes were chosen based on proximity to buildings contributing substantial effluent to the acid waste sewer; however, the locations may be changed if no sediment remains in the line at these manholes.

#### 5.12.5.1.2. Analytical Parameters

Environmental, QA/QC, and waste management samples are listed in Table 5-33 for the sediment samples and Table 5-34 for the shallow subsurface samples at the end of this subsection. Shallow subsurface samples collected near or below acid waste lines and sediment samples collected from the line interior will be analyzed at an off-site analytical and radiological laboratory (Level III) for VOCs, SVOCs, PCBs, total TAL inorganics, isotopic uranium, isotopic plutonium, isotopic thorium, and tritium, and at the on-site laboratory by gamma spectroscopy (Level II). All sediment and thirty percent of the collected soil samples (chosen on a random basis) will be analyzed for hexavalent chromium. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.

#### 5.12.5.2 Borehole Investigation

##### 5.12.5.2.1. Data Collection

At break locations where the shallow subsurface analytical results exceed risk-based action levels derived in accordance with the methodology presented in proposed Subpart S (EPA 1990b) and SNL/NM background metals and radionuclide concentrations, boreholes will be drilled and additional soil samples will be collected (Section 4.1.2). At those break locations where the shallow subsurface sampling does not indicate the presence of contamination, boreholes will not be drilled. One borehole will initially be drilled approximately 18 inches downgradient from the hot shallow subsurface sample location. The vertical extent of potential contamination will be determined using on-site field laboratory analyses. Three additional boreholes will be located radially around the initial borehole, with one located downgradient from the initial borehole, adjacent to the pipe. The distance of these boreholes from the central borehole will be dependent upon the vertical extent of potential contamination: the distance should equal approximately one-half the vertical extent of the potential contamination as determined using field screening or on-site laboratory analyses, to a maximum of 25 feet. The distance and location of the radial boreholes may be modified based on available screening techniques, site clearance, and access.

At each borehole location, a hollow-stem auger will be used to collect samples for field screening (if available for COCs detected), lithologic logging, and for laboratory analysis (Level II or III).

Borehole sampling will be initiated at the depth of the shallow subsurface sample. Samples will be collected at 5 ft intervals from 0 to 50 ft, at 10 ft intervals from 50 to 100 ft, and at 20 ft intervals at depths greater than 100 ft. The boreholes will be drilled until two samples are determined to be uncontaminated by means of field screening or on-site analysis, as appropriate, or to the depth limits of the drilling method. Sampling will then be terminated.

Split samples will initially be collected at the two shallowest 5 ft intervals. One split from each depth will be sealed, labeled, and set aside for possible off-site laboratory analysis. The other split will be logged for lithology and field screened or analyzed at the on-site analytical laboratory, as appropriate for the COCs under investigation. The samples will also be surveyed for beta/gamma radiation using a Geiger-Mueller pancake probe. If no COCs are detected, then these two 5-ft samples will be considered uncontaminated and sent for confirmatory off-site laboratory analysis. If one of the first two samples is contaminated, then the borehole will be advanced and sampled at the intervals described above until two consecutive intervals are determined to be uncontaminated. To meet the objectives described above, at least 20 percent of the samples will be submitted for off-site verification analysis, including the sample showing the highest screening value (to characterize the nature of the COCs) and one sample from each of the two deepest uncontaminated sample intervals (to characterize the vertical extent of COCs). Other samples may be chosen by the field geologist, using professional judgement, to be representative of the sample set. Core not submitted for laboratory analysis will be disposed of as IDW.

If boreholes are determined to be necessary, they will be located as described above. For planning purposes, borehole depth is estimated to be approximately 100 ft bgs, but the depth may be extended based on the field screening results. Actual depth of vertical sampling may vary according to field conditions and the equipment capabilities. At least three soil samples will be collected for Level III analysis from each borehole as well as additional QA/QC samples.

#### 5.12.5.2.2. Analytical Parameters

Table 5-35 at the end of this subsection is an example table listing the environmental, QA/QC, and waste management samples for a single borehole. Samples collected from the deep borings will be analyzed only for the parameters detected in the shallow subsurface samples. Field screening for VOCs using a PID or FID and for alpha and beta/gamma radiation using alpha scintillation and Geiger-Mueller pancake probes will be conducted as samples are collected.











Table 5-35. (page 2 of 2)

ER SITE 226 : (Acid Waste Line)		SAMPLE ID: (G)		SAMPLE TYPE		SAMPLE METHOD		FIELD SCREENING (a)		ON-SITE LAB ANALYSES (b) (c) (d)		OFF-SITE LAB ANALYSES (e) (f) (g)																	
FIELD NUMBER	Assign Bar-Coded Sample Number in Field	11226-						VOCs	TPH	SOIL PH	PCBS	RADIATION (alpha, beta, gamma)	VOCs (by GC)	METALS (by DCP)	GAMMA SPEC	TPH	VOCs (B240)	TPH (8015)	SVOCs (B270)	PCBS (8080)	TOTAL INORGANICS (h)	ISOTOPIC URANIUM	ISOTOPIC PLUTONIUM	ISOTOPIC THORIUM	TRITIUM (LIQUID SCINT)	TCMP INORGANICS (1311) (i)	TCMP ORGANICS (1311/B270/B240)	HEX CHROMIUM	
				(e.g. Surface Soil, Sediment, Rinsate Blank, Trip Blank, Duplicate, etc.)	(e.g. Geoprobe, Soil Boring, Hand Auger, etc.)																								

Notes:

- (a) Analytical Level I Data - Field screening methods and rationale are discussed in the text.
- (b) Analytical Level II Data - On-site Lab sample container volume/lycso requirements will be determined by the on-site laboratory during mobilization.
- (c) On-site lab analytical methods will be determined at a later date.
- (d) All geochemical laboratory samples will be preserved on ice (at least off-hwys rest area).
- (e) Analytical Level III Data - Correlate or duplicates of 20% of the on-site laboratory analytical samples.
- (f) Off-site Lab sample container volume/type requirements for soil and water will be determined by the Sample Management Office during mobilization.
- (g) The Sample ID correlates information regarding location, matrix, depth, etc.; this sample identification scheme is described in Section 4.4.
- (h) Inorganic analytical methods include 6010 and 7000 series analysis.

Appendix D

ER Site 226: Risk Assessment Analysis Report

## ER SITE 226: RISK ASSESSMENT ANALYSIS

### I. Site Description and History

The acid waste line, Environmental Restoration (ER) Site 226, was installed between 1948 and 1950 and was constructed of 4- and 8-inch diameter vitreous clay pipe. The system extended from three origins in the north central section of Technical Area I (TA-I) south to an outfall north of the Tijeras Arroyo. Lateral lines extended to buildings served by the line. The line remains in place and lies from 4- to 10-feet below ground surface within TA-I and at an average of 8-feet below ground surface south of TA-I.

In the mid- to late-1960s, use of the acid waste line for its original purpose was discontinued. At this time, the line was separated at the intersection of I and 9th Streets. The southern portion was capped at that intersection and was abandoned in place. The portion of the line north of I Street was connected to the sanitary sewer system and remains active. The potential constituents of concern (COCs) are radioactive materials, metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), and polychlorinated biphenyls (PCBs). These COCs were based on known building activities and processes and historical data.

### II. 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 which provide information on the potential COCs, 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 their respective subsequent intake.

<p>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.</p>
<p>Step 6. These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated</p>
<p>Step 7. Discussion of uncertainties in the previous steps.</p>

### 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 226 Data Evaluation Report and the No Further Action Proposal. Chemicals that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (USEPA 1989a). 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. Both radioactive and nonradioactive COCs are evaluated. The nonradioactive COCs evaluated are both metals and organics.

### II.2 Step 2. Pathway Identification

ER Site 226 has been designated with a future land-use scenario of industrial (USDOE, 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. The inhalation pathway for both chemicals and radionuclides is included because of the potential to inhale dust and volatiles. Direct gamma exposure is also included in the radioactive contamination risk assessment. No contamination at depth was detected and therefore no water pathways to the groundwater are considered appropriate. Depth to groundwater at Site 226 is approximately 550 feet. Because of the lack of surface water or other significant mechanisms for

dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

#### PATHWAY IDENTIFICATION

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust and volatiles)	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 226 were evaluated using a tiered approach. First, the maximum concentrations of COCs were compared to TA-I specific background screening levels using 95th upper tolerance limits (UTLs) or percentile values (Sandia National Laboratories/New Mexico [SNL/NM], 1996). If a maximum concentration of a particular COC exceeded the TA-I specific background screening level, then the COC was compared to the SNL/NM background screening level for this area (IT, 1996). 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 uranium isotopes, if a maximum concentration exceeded the SNL/NM background screening level, the isotopic ratios of U-238/U-234 and U-238/U-235 were compared to the range of TA-I specific background ratios.

Maximum concentrations of the COCs were used in order to provide a conservative estimate of the associated risk. If any nonradiological COCs were above both the TA-I and 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 both the TA-I or SNL/NM background screening levels and, as applicable, were above the range of uranium isotopic ratios, background values were subtracted from the individual maximum radionuclide concentrations. Those

that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with USDOE orders. Radioactive COCs that did not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196, 1994) which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

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) (USEPA, 1989a) documentation. If there are 10 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 10 COCs, the Subpart S screening procedure was skipped. For the radioactive COCs, the cumulative dose was calculated and the corresponding excess cancer risk estimated.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989a). The combined effects of the nonradiological COCs at their respective background concentrations in the soils were calculated. The combined effects of all associated nonradiological background constituents in the soils were also calculated. The most conservative background concentration between TA-I specific and SNL/NM concentration (minimum value of the 95th UTL or percentile concentration value, as appropriate) was used in the risk calculation. For toxic compounds, the combined effect was calculated by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended standard 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  $10^{-6}$ . For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using USDOE's RESRAD computer code.

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

Nonradioactive ER Site 226 soil sample COCs are listed in Table 1, radioactive COCs are listed in Table 2. Both tables show the 95th percentile or UTL background levels (SNL/NM 1996; IT, 1996). Table 3 shows the isotopic uranium ratio comparison to background. Background levels for plutonium and tritium are not applicable because these radionuclides do not occur naturally, or, when due to fallout, at levels detectable by common laboratory analytical instrumentation.

The TA-I background levels have not yet been approved by the USEPA or the New Mexico Environment Department (NMED), but are the result of statistical analyses of samples collected from background areas within TA-I. USEPA guidance (USEPA, 1989b; 1992a; and 1992b) were followed to arrive at the background levels. The SNL/NM background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 1 and Table 2 supersede the background values described in an interim background study report (IT, 1994).

The background value for manganese was determined by the USGS as part of the NURE program (USGS, 1994). All inorganics were within background levels. Because organic compounds do not have calculated background values, this screening step was skipped, and all nonradiological COCs (including inorganics) were retained for further analysis with the exception of lead. The maximum concentration value for lead is 7.69 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore no risk parameters can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). 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.

Table 1. Nonradioactive COCs at ER Site 226 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	TA-I 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Aluminum	11,000 B	12,055	Yes		
Antimony	0.33 BJ	0.49	Yes		
Arsenic	3.75	7.7	Yes		
Barium	404 B	654	Yes		
Beryllium	0.53 B	0.57	Yes		
Cadmium	0.737	0.84	Yes		
Chromium, total	12.7 B	11.7	No	17.3	Yes
Chromium VI	1.0	54	Yes		
Cobalt	6.05	6.3	Yes		
Copper	10.5 B	10.0	No	25.5	Yes
Lead	7.69	17.3	Yes		
Manganese	302 B	243	No	831 <sup>+</sup>	Yes
Mercury	0.07 B	0.14	Yes		
Nickel	12.3	10.6	No	25.4	Yes
Selenium	<0.143	0.24	Yes		
Silver	1.27	NC	No	2.0	Yes
Thallium	<0.207	1.2	Yes		
Vanadium	33.2	34.9	Yes		
Zinc	37.9 B	50.8	Yes		

NC - not calculated

+ - regional background value from the USGS NURE program (USGS, 1994).

J - estimated value

B - parameter detected in method blank

Table 2. Radioactive COCs at ER Site 226 and Comparison to the Background Screening Values.

COC name	Maximum concentration (pCi/g)	TA-I 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable TA-I background screening value?	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Pu-239/240	0.915	NC	No	NC	No
Pu-238	0.371	NC	No	NC	No
H-3	ND	NC	NA	NC	NA
U-238	1.41	1.03	No	1.3	No
U-235	0.0835	0.1	Yes	0.18	Yes
U233/234	1.61	0.84	No	1.6	No

NC - not calculated

ND - radionuclide not detected above minimum detectable activity

NA - not applicable

Table 3. Isotopic Uranium Ratio Comparison to Background Range

COC name	U-238 to U-234 Ratio	TA-I Background U-238 to U-234 Ratio Range	U-238 to U-235 Ratio	TA-I Background U-238 to U-235 Ratio Range	Are isotopic ratios within the range of TA-I background ratios
U-238	1.04	0.804 - 1.253	27.43	8.277 - 23.947	No
U-233/234	0.807	0.804 - 1.253	15.57	8.277 - 23.947	Yes

Because organic nonradiological COCs do not have a background screening level, the site fails the background screening criteria and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. However, since there were more than 10 COCs, the proposed Subpart S screening procedure was skipped. Radioactive contamination does not have pre-determined action levels analogous to proposed Subpart S and therefore this step in the screening process is not performed for radionuclides.

### II.3.2 Identification of Toxicological Parameters

Tables 4 and 5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the incremental TEDE values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).
- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).
- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil* (Health Physics 28:193-205) (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993a).

### 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; industrial and residential land-uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs; 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 on RAGS (USEPA, 1989a). The parameter values are based on information from RAGS (USEPA, 1989a) as well as other EPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989a). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess dose and cancer risk for the individual exposure pathways. Further discussion of this

Table 4. Nonradioactive Toxicological Parameter Values for ER Site 226 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 ^
Aluminum	1	--	Est.	--	--	--
Antimony	0.0004	--	L	--	--	D
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*	1	0.00000057 1	L	--	--	D
Chromium VI	0.005	--	L	--	42	A
Cobalt	0.06	--	--	--	--	--
Copper	0.04	--	Est.	--	--	D
Manganese	0.005	0.0000143	--	--	--	D
Mercury	0.0003	0.0000857	--	--	--	D
Nickel	0.02	--	--	--	--	D
Selenium	0.005	--	H	--	--	D
Silver	0.005	--	--	--	--	D
Thallium	--	--	--	--	--	D
Vanadium	0.007	--	Heast	--	--	D
Zinc	0.3	--	M	--	--	D
Fluoranthene	0.04	--	L	--	--	D
Pyrene	0.03	--	L	--	--	D
Toluene	0.2	0.14	M	--	--	D
PCBs (total aroclor)	--	--	--	7.7	--	B2

\* total chromium assumed to be chromium III because chromium VI is calculated separately

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, Est. = estimated

Heast - Heast Table from USEPA 1996b

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>

^ 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

Table 5. Radiological Toxicological Parameter Values for ER Site 226 COCs

COC name	SF <sub>ev</sub> (g/pCi-yr)	SF <sub>o</sub> (1/pCi)	SF <sub>inh</sub> (1/pCi)	Cancer Class <sup>^</sup>
Pu-239/240	1.3E-11	3.2E-10	2.8E-08	A
Pu-238	1.9E-11	3.0E-10	2.7E-08	A
U-238	5.7E-08	6.2E-11	1.2E-08	A

SF<sub>ev</sub> - external volume exposure slope factor (risk/yr per pCi/g)

SF<sub>o</sub> - oral (Ingestion) slope factor (risk/pCi)

SF<sub>inh</sub> - inhalation slope factor (risk/pCi)

<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

process is provided in Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993).

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

### II.3.3.2 Risk Characterization

Table 6 shows that for the nonradioactive COCs, the Hazard Index value is 0.09 and the excess cancer risk is  $3 \times 10^{-6}$  for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust and volatile inhalation for the nonradioactive COCs. Table 7 shows that for the ER Site 226 associated nonradiological background

Table 6. Nonradioactive Risk Assessment Values for ER Site 226 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	11,000 B	0.01	--	0.04	--
Antimony	0.33 JB	0.00	--	0.02	--
Arsenic	3.75	0.01	2E-6	0.21	4E-5
Barium	404 B	0.01	--	0.06	--
Beryllium	0.53 B	0.00	1E-6	0.00	4E-6
Cadmium	0.737	0.00	3E-10	0.60	4E-10
Chromium, total*	12.7 B	0.00	--	0.00	--
Chromium VI	1.0	0.00	3E-9	0.00	4E-9
Cobalt	6.05	0.00	--	0.00	--
Copper	10.5 B	0.00	--	0.05	--
Manganese	302 B	0.06	--	2.67	--
Mercury	0.07 B	0.00	--	0.12	--
Nickel	12.3	0.00	--	0.00	--
Selenium	<0.143	0.00	--	0.05	--
Silver	1.27	0.00	--	0.05	--
Thallium	<0.207	--	--	--	--
Vanadium	33.2	0.00	--	0.03	--
Zinc	37.9 B	0.00	--	0.07	--
Fluoranthene	0.178 J	0.00	--	0.00	--
Pyrene	0.178 J	0.00	--	0.00	--
Toluene	0.00868 J	0.00	--	0.00	--
PCBs (total aroclors)**	0.056	0.00	2E-7	0.00	7E-7
<b>TOTAL</b>		<b>0.09</b>	<b>3E-6</b>	<b>4</b>	<b>4E-5</b>

\* total chromium assumed to be chromium III because chromium VI is calculated separately

\*\* PCBs are combined maximum concentrations of all aroclors

J - estimated value

B - parameter detected in method blank

-- information not available

Table 7. Nonradioactive Risk Assessment Values for ER Site 226  
Background Constituents.

Constituent Name	Background concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Aluminum	12,055	0.01	--	0.05	--
Antimony	0.49	0.00	--	0.02	--
Arsenic	5.6	0.02	4E-06	0.32	6E-05
Barium	200	0.00	--	0.03	--
Beryllium	0.57	0.00	1E-06	0.00	5E-06
Cadmium	0.84	0.00	3E-10	0.69	5E-10
Chromium, total*	11.7	0.00	--	0.00	--
Chromium VI**	11.7	0.00	3E-8	0.01	4E-8
Cobalt	6.3	0.00	--	0.00	--
Copper	10.0	0.00	--	0.04	--
Manganese	243	0.05	--	2.15	--
Mercury	0.14	0.00	--	0.24	--
Nickel	10.6	0.00	--	0.00	--
Selenium	0.24	0.00	--	0.08	--
Silver	2.0	0.00	--	0.08	--
Thallium	<1.1	--	--	--	--
Vanadium	34.9	0.00	--	0.03	--
Zinc	50.8	0.00	--	0.09	--
<b>TOTAL</b>		<b>0.08</b>	<b>5E-6</b>	<b>4</b>	<b>7E-5</b>

-- information not available

\* total chromium assumed to be chromium III because chromium VI is calculated separately

\*\* chromium VI background concentration assumed to be chromium III (most conservative - lowest UTL), risk calculated in terms of chromium VI (consistent with Table 4)

constituents, the Hazard Index is 0.08 and the excess cancer risk is  $5 \times 10^{-6}$  for the designated industrial land-use scenario.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The TEDE for industrial land-use is 0.08 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an excess TEDE of 15 mrem/yr (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated dose values for ER Site 226 for the industrial land-use is well below this standard.

For the residential land-use scenario, the Hazard Index value increases to 4 and the excess cancer risk is  $4 \times 10^{-5}$ . The number presented included exposure from soil ingestion, dust and volatile inhalation and plant uptake. Although USEPA (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, NM, 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 7 shows that for the ER Site 226 associated nonradiological background constituents, the Hazard Index increases to 4 and the excess cancer risk is  $7 \times 10^{-5}$ .

For the radioactive COCs, the TEDE for residential land-use is 0.37 mrem/yr. In accordance with proposed USEPA guidance, the standard being utilized is an excess TEDE of 75 mrem/yr (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated dose values for ER Site 226 for the residential land-use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196, 1994), ER Site 226 should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/yr.

The excess cancer risk from the nonradioactive COCs and the radioactive COCs is not additive, as noted in RAGS (USEPA, 1989a).

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

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 also a residential land-use scenario.

For the industrial land-use scenario, the Hazard Index calculated is 0.09; this is much less than the numerical standard suggested in RAGS (USEPA,

1989a) of 1. The excess cancer risk is estimated at  $3 \times 10^{-6}$ . In RAGS, the USEPA suggests that a range of values ( $10^{-6}$  to  $10^{-4}$ ) be used as the numerical standard; the value calculated for this site is in the low end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the low end of the 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 0.08. The excess cancer risk is estimated at  $5 \times 10^{-6}$ . 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 is 0.01 and there was no incremental cancer risk for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 0.08 mrem/yr, which is significantly less than the numerical standard of 15 mrem/yr suggested in the draft EPA guidance. The incremental cancer risk estimate is  $3 \times 10^{-7}$ .

For the residential land-use scenario, the calculated Hazard Index is 4, which is above the numerical guidance. The excess cancer risk is estimated at  $4 \times 10^{-5}$ ; this value is in the middle of the suggested acceptable risk range. For the residential land-use scenario, the Hazard Index is 4 for the associated background concentrations. The excess cancer risk is estimated at  $7 \times 10^{-5}$ . The incremental Hazard Index is 0.14 and there was no incremental cancer risk for the industrial land-use scenario. The potential pathways considered for this calculation includes both soil ingestion, dust inhalation and plant uptake.

The incremental TEDE from the radioactive components is 0.37 mrem/yr, which is significantly less than the numerical standard of 75 mrem/yr suggested in the draft USEPA guidance. The associated incremental cancer risk is  $1 \times 10^{-6}$ .

## II.5 Step 7 Uncertainty Discussion

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 standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate small

contribution of risk from nonradiological COCs when considering the industrial land-use scenario.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the industrial land-use scenario, are well within proposed standards (40 CFR Part 196, 1994) and are a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

The potential effects on human health, for the nonradiological COCs, are greater when considering the residential land-use scenario. However, there was not incremental risk between potential nonradiological COCs and associated background. The potential 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 TA-I is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely as is the likelihood that this site will be residential in the near future (USDOE, 1996). The uncertainty in this conclusion is also considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within proposed standards (40 CFR Part 196, 1994) and is a small fraction of the estimated 290 mrem/yr received due to natural background (NCRP, 1987).

Because of the location, history of the site and the future land-use (USDOE, 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 subsurface soils and because of the location and physical characteristics of the site, the exposure pathways relevant to the analysis are conservative. For example, considering the industrial land-use scenario, the soil ingestion pathway results are very conservative as a worker contacting the soil at depth would be likely involved in construction and would contact the soil for only a short time instead of 30 years.

This is particularly applicable in application to the radiological COCs. Although the acid waste line is buried 4 to 10 feet below ground surface, it was assumed that the radiological COCs were uniformly distributed from ground surface to 6 feet below ground surface, thus, not accounting for the 4 feet of clean cover over the acid waste line.

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 and minimum value of the 95th UTL or percentile background concentration value, as applicable, of background concentrations associated with 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) (USEPA, 1996b) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) databases. Where values are not provided, information is not available from HEAST, IRIS, or USEPA regions. The constituents without toxicological parameters have low concentrations and are judged to be insignificant contributors to the overall risk. 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 low for the industrial land-use scenario compared to the established numerical standards. Though the residential land-use Hazard Index is above the numerical standard, there was no incremental risk between the potential COCs and background, and it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The overall uncertainty in all of the steps in the risk assessment process is therefore considered to be insignificant with respect to the conclusion reached.

### III. Summary

The TA-I Acid Waste Line, ER Site 226, had relatively minor contamination consisting of some inorganic and organic nonradioactive and radioactive compounds. Because of the location of the site on KAFB, the designated industrial land-use scenario (USDOE, 1996) and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust and volatile inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. These exposure pathways are very conservative as a worker contacting the soil at depth would likely be

involved in construction and would contact the soil for only a short time instead of 30 years.

The residential land-use scenario includes the soil ingestion, inhalation, and plant uptake exposure pathways. Because the small amount of contamination present is below ground surface, the potential for exposure from soil ingestion and inhalation of surface dust is not significant. Likewise, plant uptake will generally occur near surface. Because the site is designated as industrial (USDOE, 1996) and the residential land-use scenario is presented to only provide perspective, the stated exposure pathways were included but provide a conservative risk assessment.

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 (0.09) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk ( $3 \times 10^{-6}$ ) is in the low end of the suggested acceptable risk range. The incremental Hazard Index is 0.01 and there was no incremental cancer risk for the industrial land-use scenario. Incremental risk calculations indicate that insignificant contribution to risk from the nonradiological COCs considering an industrial land-use scenario.

The incremental TEDE corresponding estimated cancer risk from the radioactive components are much less than EPA guidance values; the estimated incremental TEDE is 0.08 the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/yr, in draft EPA guidance. The corresponding estimated cancer risk value is  $3 \times 10^{-7}$  for the industrial land-use scenario.

The calculations for the nonradiological COCs show that for the residential land-use scenario the Hazard Index (4) is above the accepted numerical guidance from the USEPA. The estimated cancer risk ( $4 \times 10^{-5}$ ) is in the middle of the suggested acceptable risk range. The majority of the risk is associated with the inclusion of the plant uptake exposure pathway. Nonradiological 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 TA-I is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely. Also, the contamination occurs at depth, below typical plant root zones. The incremental Hazard Index is 0.14 and there was no incremental cancer risk for the industrial land-use scenario. Incremental risk calculations indicate that insignificant contribution to risk from the nonradiological COCs considering a residential land-use scenario.

The incremental TEDE corresponding estimated cancer risk from the radioactive components are much less than EPA guidance values; the estimated incremental TEDE is 0.37 mrem/yr for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/yr, in draft EPA guidance. The corresponding estimated cancer risk value is  $1 \times 10^{-6}$  for the residential land-use scenario.

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

#### Ecological Risk Assessment

It is unlikely that activities or COCs at ER Site 226 have or will have significant impact to ecological risk. TA-1 is an industrial complex and has been heavily disturbed by humans for over 50 years. Given the amount of known and potential human intrusion, a great diversity or abundance of nonhuman species has not occurred and is unlikely. Much of the relevant ecological information for TA-1 can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM, 1992).

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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, 1989) 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>a</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, 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.

References

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