7-1-2004

Justification for Class III Permit Modification July 2004 DSS Site 1077 Operable Unit 1295 Building 6920 Septic System

Sandia National Laboratories/NM

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Sandia National Laboratories

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July 2004

DSS Site 1077
Operable Unit 1295
Building 6920 Septic System

NFA (SWMU Assessment Report) Submitted September 2003

Environmental Restoration Project

United States Department of Energy
Albuquerque Operations Office
Sandia National Laboratories

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Building 6920 Septic System

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Environmental Restoration Project

United States Department of Energy
Albuquerque Operations Office
CERTIFIED MAIL-RETURN RECEIPT REQUESTED

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

Dear Mr. Kieling,

On behalf of the Department of Energy (DOE) and Sandia Corporation, DOE is submitting the enclosed SWMU Assessment Reports and Proposals for No Further Action (NFA) for Drain and Septic Systems (DSS) Sites 1001, 1014, 1030, 1032, 1073, 1077, 1089, 1096, and 1111, at Sandia National Laboratories, New Mexico, EPA ID No. NM5890110518. Per our verbal agreement, the second NMED set is being sent directly to the Albuquerque Group Manager.

This submittal includes descriptions of the site characterization work, soil characterization data, and risk assessments for DSS Sites 1001, 1014, 1030, 1032, 1073, 1077, 1089, 1096, and 1111. The risk assessments conclude that, for these nine sites, (1) there is no significant risk to human health under both the industrial and residential land-use scenarios, and (2) that there are no ecological risks associated with these sites.

DOE and Sandia are requesting a determination that these DSS sites are acceptable for No Further Action.

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

Sincerely,

Karen L. Boardman
Manager

Enclosure
cc w/enclosure:
L. King, EPA, Region 6 (2 copies Via Certified Mail)
W. Moats, NMED-HWB (Via Certified Mail)
K. Thomas, EPA, Region 6
M. Gardipe, SC/ERD
C. Voorhees, NMED-OB
Program Manager, NMED-OB

cc w/o enclosure:
J. Estrada, SSO/AIP, MS 0184
S. Martin, NMED-HWB
F. Nimick, SNL, MS 1089
D. Stockham, SNL, MS 1087
P. Freshour, SNL, MS 1087
M. Sanders, SNL, MS 1087
Sandia National Laboratories/New Mexico Environmental Restoration Project

SWMU ASSESSMENT REPORT AND PROPOSAL FOR NO FURTHER ACTION BUILDING 6920 SEPTIC SYSTEM, DRAIN AND SEPTIC SYSTEMS SITE 1077

September 2003

United States Department of Energy
Sandia Site Office
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1.0 PROJECT BACKGROUND

Environmental characterization of Sandia National Laboratories/New Mexico (SNL/NM) Drain and Septic Systems (DSS) started in the early 1990s. These units consist of either septic systems (one or more septic tanks plumbed to either drainfields or seepage pits), or other types of miscellaneous drain units without septic tanks (including drywells or french drains, seepage pits, and surface outfalls). Initially, 23 of these sites were designated as Solid Waste Management Units (SWMUs) under Operable Unit (OU) 1295, Septic Tanks and Drainfields. Characterization work at 22 of these 23 SWMUs has taken place since 1994 as part of the SNL/NM Environmental Restoration (ER) Project activities. The twenty-third site did not require any characterization, and an administrative proposal for no further action (NFA) was granted in July 1995.

Numerous other DSS sites that were not designated as SWMUs were present throughout SNL/NM. An initial list of these non-SWMU sites was compiled and summarized in an SNL/NM document dated July 8, 1996; the list included a total of 101 sites, facilities, or systems (Bleakly July 1996). For tracking purposes, each of these 101 individual DSS sites was designated with a unique four-digit site identification number starting with 1001. This numbering scheme was devised to clearly differentiate these non-SWMU sites from existing SNL/NM SWMUs, which have been designated by one to three-digit numbers. As work progressed on the site evaluation project, it became apparent that the original 1996 list was in need of field verification and updating. This process included researching SNL/NM’s extensive library of facilities engineering drawings and conducting field-verification inspections jointly with SNL/NM ER personnel and New Mexico Environment Department (NMED)/Hazardous Waste Bureau (HWB) regulatory staff from July 1999 through January 2000. The goals of this additional work included:

- Determine to the degree possible whether each of the 101 systems included on the 1996 list was still in existence, or had ever existed.
- For systems confirmed or believed to exist, determine the exact or apparent locations and components of those systems (septic tanks, drainfields, seepage pits, etc.).
- Identify which systems would, or would not, need initial shallow investigation work as required by NMED.
- For systems requiring characterization, determine the specific types of shallow characterization work (including passive soil-vapor sampling and/or shallow soil borings) that would be required by NMED.

A number of additional drain systems were identified from the engineering drawing and field inspection work. It was also determined that some of the sites on the 1996 list actually contained more than one individual drain or septic system that had been combined under one four-digit site number. In order to reduce confusion, a decision was made to assign each individual system its own unique four-digit number. A new site list containing a total of 121 individual DSS sites was generated in 2000. Of these 121 sites, NMED required environmental assessment work at a total of 61; no evaluation of the remaining 60 systems
was necessary. Subsequent backhoe excavation at DSS Site 1091 confirmed that the system did not exist, which decreased the number of DSS sites requiring characterization to 60.

Concurrent with the field inspection and site identification work, NMED/HWB and SNL/NM ER Project technical personnel worked together to reach consensus on a staged approach and specific procedures that would be used to characterize the DSS sites, as well as the remaining OU 1295 Septic Tanks and Drainfield SWMUs that had not been approved for NFA. These procedures are described in detail in the "Sampling and Analysis Plan [SAP] for Characterizing and Assessing Potential Releases to the Environment From Septic and Other Miscellaneous Drain Systems at Sandia National Laboratories/New Mexico" (OU 1295 SAP) (SNL/NM October 1999), which was approved by the NMED/HWB on January 28, 2000 (Bearzi January 2000). A follow-on document, "Field Implementation Plan [FIP], Characterization of Non-Environmental Restoration Drain and Septic Systems," (OU 1295 FIP) (SNL/NM November 2001) was then written to formally document the updated DSS site list and the specific site characterization work required by NMED for each of the 60 DSS sites. The FIP was approved by the NMED in February 2002 (Moats February 2002). Both the SAP and the FIP were written after the investigation of DSS Site 1077 was completed. However, the investigation procedures utilized at this site were in accordance with investigation procedures that had been utilized at numerous other SNL/NM DSS sites prior to this site investigation.
2.0 DSS SITE 1077, THE BUILDING 6920 SEPTIC SYSTEM

2.1 Summary

The SNL/NM ER Project conducted an assessment of the Building 6920 septic system, DSS Site 1077. There are no known or specific environmental concerns at this DSS site. The assessment was conducted to determine whether contamination was released to the environment via the septic system present at the site. This report presents the results of the assessment and, based upon the findings, recommends a risk-based proposal for NFA for the Building 6920 septic system. The NFA proposal provides documentation that the site was sufficiently characterized and that no significant releases of contaminants to the environment occurred via the Building 6920 septic system, and that the site does not pose a threat to human health or the environment under either industrial or residential land use scenarios.

Review and analysis of all relevant data for the Building 6920 septic system site indicate that concentrations of constituents of concern (COCs) at this site are below applicable risk assessment action levels. Thus, the Building 6920 septic system, DSS Site 1077, is proposed for an NFA decision based upon sampling data demonstrating that COCs released from the site into the environment pose an acceptable level of risk under current and projected future land uses as set forth by Criterion 5, which states: “The SWMU/AOC [Area of Concern] has been characterized or remediated in accordance with current applicable state or federal regulations, and the available data indicate that contaminants pose an acceptable level of risk under current and projected future land use” (NMED March 1998).

2.2 Site Description and Operational History

2.2.1 Site Description

The Building 6920 septic system is located in SNL/NM Technical Area (TA)-III on federally owned land controlled by Kirtland Air Force Base (KAFB) and permitted to the U.S. Department of Energy (DOE) (Figure 2.2.1-1). DSS Site 1077 is located approximately 1,300 feet west-northwest of the southeast corner of TA-III (Figure 2.2.1-2). The SNL/NM Radioactive and Mixed Waste Management Facility (RMWMF) is currently located in Building 6920 and other nearby buildings, and DSS Site 1077 is located in the northwest part of RMWMF facility. As shown on Figure 2.2.1-2, the abandoned septic system consists of a 1,000-gallon septic tank and distribution box that emptied to three 24-foot-long parallel drainlines installed in 3.5-foot-deep, aggregate-filled drainline trenches. Septic system construction details and drainline trench depths are based upon engineering drawings (SNL/NM October 1991, SNL/NM November 1994). The location of the septic system, as indicated on the engineering drawings, was covered with pavement when the site was inspected in May 1998. However, a comparison of other observable features at the site that are also shown on the map containing the septic system were determined to be accurate when the site was inspected in May 1998. It was
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Figure 2.2.1-1
Location Map of the Bldg. 6920 Septic System, TA-III Drain and Septic System (DSS) Site Number 1077

Legend
- DSS Site 1077
- Major Road
- KAFB Boundary
- SNL Technical Area

Sandia National Laboratories, New Mexico
Environmental Geographic Information System
Building 6926 addition added in 1998 after soil sampling was completed, covering former drainfield location.

Figure 2.2.1-2
Site Map of the Bldg. 6920
Septic System, TA-III,
Drain and Septic Systems (DSS)
Site Number 1077

Legend

- Soil Boring Location
- Septic Tank
- Drain Line
- Fence
- Building / Structure
- Approximate Former Eastern Extent of Bldg. 9626

Sandia National Laboratories, New Mexico
Environmental Geographic Information System
therefore concluded that the drawing also accurately showed the location of the drainfield drain lines, and could be used as a basis for locating sampling boreholes at the site. A backhoe was not used to confirm the locations, number, and lengths of the drain lines at this asphalt-paved site.

The surface geology at DSS Site 1077 is characterized by a veneer of aeolian sediments underlain by Upper Santa Fe Group alluvial fan deposits that interfinger with sediments of the ancestral Rio Grande west of the site. These deposits extend to, and probably far below, the water table at this site. The alluvial fan materials originated in the Manzanita Mountains east of DSS Site 1077, typically consist of a mixture of silts, sands, and gravels that are poorly sorted, and exhibit moderately connected lenticular bedding. Individual beds range from 1 to 5 feet in thickness with a preferred east-west orientation, and have moderate to low hydraulic conductivities (SNL/NM March 1996). Vegetation primarily consists of desert grasses, shrubs, and cacti.

The ground surface in the vicinity of the site is flat to very slightly inclined to the west. The area around DSS Site 1077 is paved and surface drainages are used to direct surface water away from the site to a run-off retention basin located southwest of the site. No perennial surface-water bodies are present in the vicinity of the site. Average annual rainfall in the SNL/NM and KAFB area, as measured at Albuquerque International Sunport, is 8.1 inches (NOAA 1990). Infiltration of precipitation is almost nonexistent as virtually all of the moisture undergoes evapotranspiration. The estimates of evapotranspiration rates for the KAFB area range from 95 to 99 percent of the annual rainfall (Thompson and Smith 1985, SNL/NM March 1996). The site lies at an average elevation of approximately 5,405 feet above mean sea level. Depth to groundwater is approximately 475 feet below ground surface (bgs) at the site. Groundwater flow direction is thought to be generally to the west in this area (SNL/NM March 2002). The nearest production wells to DSS Site 1077 are north/northwest of the site, and include KAFB-4 and KAFB-11, which are approximately 4.6 and 4.8 miles away, respectively. The nearest groundwater monitoring wells are those installed on the west side of the Chemical Waste Landfill, which are located approximately 500 feet east of the site.

2.2.2 Operational History

Available information indicates that Building 6920 was constructed in 1990 (SNL/NM March 2003), and it is assumed the septic system was constructed at that time. Because operational records are not available, the investigation of the site was planned to be consistent with other DSS site investigations and to sample for COCs most commonly found at similar test facilities. In June 1991, Building 6920 was connected to an extension of the City of Albuquerque sanitary sewer system (Jones June 1991), and it is assumed that the septic system was abandoned concurrent with this change. Conversations with RMWMF personnel in May 1998 indicated that Building 6920 was not occupied from the time it was constructed until approximately 1992. Therefore, although the septic system was operational for a period of less than two years, it appears that it was never used. In addition, one of the engineering drawings (SNL/NM November 1994) contains a note that states "septic tank and drainfield for Bldg. 6920 abandoned in place in 1991 and the line from the Building 6920 tied to the sanitary sewer system. The septic tank has been filled with dirt. Septic tank was abandoned before any hazardous or mixed wastes were brought to Bldg. 6920."
2.3 Land Use

2.3.1 Current Land Use

The current land use for DSS Site 1077 is industrial.

2.3.2 Future/Proposed Land Use

The projected future land use for DSS Site 1077 is industrial (DOE et al. September 1995).
3.0 INVESTIGATORY ACTIVITIES

3.1 Summary

One assessment investigation has been conducted at the Building 6920 septic system. SNL/NM ER project personnel were notified by DOE Kirtland Area Office personnel in mid-April 1998 that an addition to the existing Building 6926 was planned, and that this addition would cover the area of the abandoned Building 6920 septic system drainfield. As discussed in Section 2.2.2, it was considered highly unlikely that hazardous or radioactive COCs would be found beneath the drainfield drain lines, as it was apparent that the system had never been used. However, as a conservative measure in May 1998, soil samples were collected from beneath the drainfield while it was still accessible (Investigation 1). Results of this sampling were expected to conclusively determine if COCs had been released to the environment via the septic system at this site. The investigation procedures utilized at this site were similar to those that had been used at other previously characterized DSS sites at the time. The procedures were also in accordance with procedures that were being developed in the OU 1295 SAP (SNL/NM October 1999) and OU 1295 FIP (SNL/NM November 2001) described in Chapter 1.0, neither of which had been finalized when this investigation was conducted. This investigation is discussed below.

3.2 Investigation 1—Soil Sampling

On May 5, 1998, soil samples were collected from two drainfield boreholes. Soil samples were collected from the borehole locations shown on Figure 2.2.1-2. A summary of the boreholes, sample depths, sample analyses, and sample dates are presented in Table 3.2-1.

3.2.1 Soil Sampling Methodology

An auger drill rig was used to sample all boreholes at two depth intervals. The top of the shallow interval started at the bottom of the drainline trenches, as shown on the SNL/NM engineering drawing (SNL/NM November 1994); the lower (deep) interval started at 5 feet below the top sample interval. Once the auger rig had reached the top of the sampling interval, a 1.5-inch inside diameter by 3-foot-long Geoprobe™ sampling tube lined with a butyl acetate (BA) sampling sleeve was inserted into the borehole and hydraulically driven downward 3 feet to fill the tube with soil.

Once the sample tube was retrieved from the borehole, the sample for volatile organic compound (VOC) analysis was immediately collected by slicing off a 3- to 4-inch section from the lower end of the BA sleeve and capping the section ends first with Teflon film, then a rubber end cap, and finally sealing with tape.

For the non-VOC analyses, the soil remaining in the BA liner was emptied into a decontaminated mixing bowl, and aliquots of soil were transferred to appropriate sample containers for analysis. Soil samples were submitted to the SNL/NM ER Chemistry Laboratory (ERCL) for VOC, high explosive (HE) compounds, and Resource Conservation and Recovery
Table 3.2-1
Summary of Soil Samples Collected at Building 6920 Septic System (DSS Site 1077)

<table>
<thead>
<tr>
<th>Sampling Area</th>
<th>Analytical Parameters</th>
<th>Number of Borehole Locations</th>
<th>Top of Sampling Intervals in Each Borehole (ft bgs)</th>
<th>Total Number of Soil Samples</th>
<th>Total Number of Duplicate Samples</th>
<th>Date Samples Collected</th>
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<tr>
<td>Drainfield</td>
<td>VOCs</td>
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<td>3, 8</td>
<td>4</td>
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<tr>
<td></td>
<td>HE</td>
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<td>3,8</td>
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<td>3,8</td>
<td>4</td>
<td>0</td>
<td>05-05-98</td>
</tr>
</tbody>
</table>

bgs = below ground surface.
DSS = Drain and Septic Systems.
ft = Foot (feet).
HE = High explosive(s).
VOC = Volatile organic compound.

Act (RCRA) metals analyses, and to the SNL/NM Radiation Protection and Sample Diagnostics (RPSD) Laboratory for gamma spectroscopy analyses. All samples were documented and handled in accordance with applicable SNL/NM Operating Procedures and transported to on- and off-site laboratories for analysis.

Samples were analyzed for VOCs by U.S. Environmental Protection Agency (EPA) Method 8260, HE compounds by EPA Method 8095 (EPA 8330 equivalent at the on-site ERCL), RCRA metals by EPA Method 6010/7471A and 7196A, and gamma spectroscopy by the EPA Method 901.1 equivalent at the on-site RPSD Laboratory (EPA November 1986).

3.2.2 Soil Sampling Results and Conclusions

Analytical results for the soil samples collected at DSS Site 1077 are presented and discussed in this section. Sample locations are shown on Figure 2.2.1-2.

VOCs

VOC analytical results for the four soil samples collected from the two drainfield boreholes are presented in Table 3.2.2-1. Method Detection Limits (MDLs) for the VOC analyses are presented in Table 3.2.2-2. As shown in Table 3.2.2-1, trace levels of two VOCs (benzene and toluene) were detected in samples from both boreholes. These compounds are typical constituents in petroleum hydrocarbons, and most likely reflect contamination from the asphalt paving at the two boring locations which may have been incorporated into the VOC samples.
Table 3.2.2-1
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling, VOC Analytical Results
May 1998
(On-Site Laboratory)

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<th>Record Number</th>
<th>ER Sample ID</th>
<th>Sample Depth (ft)</th>
<th>2-Butanone</th>
<th>Benzene</th>
<th>Toluene</th>
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<td>600250</td>
<td>6920-DF1-BH1-3-S</td>
<td>3</td>
<td>ND (5.4)</td>
<td>1.1 J (4.4)</td>
<td>1.5 J (4.4)</td>
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<tr>
<td>600250</td>
<td>6920-DF1-BH1-8-S</td>
<td>8</td>
<td>ND (5.5 J)</td>
<td>ND (1.1)</td>
<td>ND (1.1)</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH2-3-S</td>
<td>3</td>
<td>ND (5.6 J)</td>
<td>ND (1.1)</td>
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<tr>
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<td>6920-DF1-BH2-8-S</td>
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<td>ND (5.4 J)</td>
<td>ND (1.1)</td>
<td>ND (1.1)</td>
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</table>

QA/QC Samples (µg/L)

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<th>ER Sample ID</th>
<th>Sample Depth (ft)</th>
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<th>Benzene</th>
<th>Toluene</th>
</tr>
</thead>
<tbody>
<tr>
<td>600250</td>
<td>6920-DF1-EB</td>
<td>NA</td>
<td>ND (5)</td>
<td>ND (0.5)</td>
<td>ND (0.5)</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-TB</td>
<td>NA</td>
<td>9.1 J (20)</td>
<td>ND (0.5)</td>
<td>ND (0.5)</td>
</tr>
</tbody>
</table>

Note: Values in **bold** represent detected analytes.

EPA November 1986.

Analysis request/chain-of-custody record.

BH = Borehole.
DF = Drainfield.
DSS = Drain and Septic Systems.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J = Analytical result was qualified as an estimated value during data validation, see data validation report.
J () = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
J (#) = Not detected above the MDL, shown in parentheses.
J (# J) = Not detected. Uncertainty in the MDL, shown in parentheses.
QA = Quality assurance.
QC = Quality control.
S = Soil sample.
TB = Trip blank.
VOC = Volatile organic compound.
Table 3.2.2-2
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling, VOC Analytical MDLs
May 1998
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>EPA Method 8260&lt;sup&gt;a&lt;/sup&gt; Detection Limit (µg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>5.4–5.6</td>
</tr>
<tr>
<td>Benzene</td>
<td>1.1</td>
</tr>
<tr>
<td>Bromodichloromethane</td>
<td>1.1</td>
</tr>
<tr>
<td>Bromoform</td>
<td>1.1</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>1.1</td>
</tr>
<tr>
<td>2-Butanone</td>
<td>5.4–5.6</td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>1.1</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>1.1</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>1.1</td>
</tr>
<tr>
<td>Chloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1.1</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>1.1</td>
</tr>
<tr>
<td>Dibromochloromethane</td>
<td>1.1</td>
</tr>
<tr>
<td>1,1-Dichloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>1,2-Dichloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>1,1-Dichloroethene</td>
<td>1.1</td>
</tr>
<tr>
<td>cis-1,2-Dichloroethene</td>
<td>1.1</td>
</tr>
<tr>
<td>trans-1,2-Dichloroethene</td>
<td>1.1</td>
</tr>
<tr>
<td>1,2-Dichloropropane</td>
<td>1.1</td>
</tr>
<tr>
<td>cis-1,3-Dichloropropene</td>
<td>0.54–0.56</td>
</tr>
<tr>
<td>trans-1,3-Dichloropropene</td>
<td>1.1</td>
</tr>
<tr>
<td>Ethyl benzene</td>
<td>2.1–2.2</td>
</tr>
<tr>
<td>2-Hexanone</td>
<td>5.4–5.6</td>
</tr>
<tr>
<td>4-Methyl-2-pentanone</td>
<td>5.4–5.6</td>
</tr>
<tr>
<td>Methylene chloride</td>
<td>1.1</td>
</tr>
<tr>
<td>Styrene</td>
<td>1.1</td>
</tr>
<tr>
<td>1,1,2,2-Tetrachloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>Tetrachloroethene</td>
<td>2.1–2.2</td>
</tr>
<tr>
<td>Toluene</td>
<td>1.1</td>
</tr>
<tr>
<td>1,1,1-Trichloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>1,1,2-Trichloroethane</td>
<td>1.1</td>
</tr>
<tr>
<td>Trichloroethene</td>
<td>1.1</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>1.1</td>
</tr>
<tr>
<td>p-, xylene, m-Xylene</td>
<td>3.2–3.3</td>
</tr>
<tr>
<td>o-Xylene</td>
<td>2.1–2.2</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA November 1986.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
µg/kg = Microgram(s) per kilogram.
VOC = Volatile organic compound.
HE

HE analytical results for the four soil samples collected from the drainfield boreholes are presented in Table 3.2.2-3. MDLs for the HE analyses are presented in Table 3.2.2-4. No HE compounds were detected in any of the soil samples.

RCRA Metals

RCRA metals analytical results for the four soil samples collected from the drainfield boreholes are presented in Table 3.2.2-5. MDLs for the metals analyses are presented in Table 3.2.2-6. As shown in Table 3.2.2-5, chromium was detected above the NMED-approved background concentration only in the sample collected at a depth of 3 feet from the borehole 6920-DF1-BH2-3. All other metal detections were below their NMED-approved background activities.

Radionuclides

Gamma spectroscopy analytical results for the four soil samples collected from the drainfield boreholes are presented in Table 3.2.2-7. As shown in Table 3.2.2-7, no readings above NMED-approved background activities were detected in any sample analyzed. However, although they were not detected, minimum detectable activities (MDAs) for uranium-235 and uranium-238 exceeded the background activities for those two radionuclides due to an insufficient gamma spectroscopy count time.

3.2.3 Soil Sampling Quality Assurance/Quality Control Samples and Data Validation Results

Quality assurance/quality control samples were collected at an approximate frequency of 1 per 20 field samples. These typically included sample duplicates and matrix spike/matrix spike duplicates. Samples were shipped to the laboratory in batches of 20, so that any one shipment might contain samples from several sites. Aqueous equipment blanks (EBs) were collected at an approximate frequency of 1 per 20 samples and sent to the laboratory. EBs were analyzed for the same analytical suite as the soil samples in that shipment. Aqueous trip blanks (TBs) were used for VOC analysis only, and were included in every sample cooler containing VOC soil samples. The analytical results for the EB and TB samples appear on the data tables for this site, and were used in the data validation process for samples from DSS Site 1077.

An aqueous TB was included in the sample cooler containing the VOC soil samples collected from the Building 6920 drainfield in May 1998. As shown in Table 3.2.2-1, 9.1 J micrograms per liter of 2-butanone was detected in the sample.

A set of aqueous EB samples was collected and analyzed for VOCs, HE compounds, and RCRA metals following completion of soil sampling in the Building 6920 drainfield in May 1998. As shown in Tables 3.2.2-1, 3.2.2-3, and 3.2.2-5, no VOCs, HE compounds, or RCRA metals were detected in any of the EB samples.

No duplicate soil samples were collected at this site.
## Table 3.2.2-3
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling, HE Analytical Results
May 1998
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Record Number</th>
<th>ER Sample ID</th>
<th>Sample Depth (ft)</th>
<th>HE (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600250</td>
<td>6920-DF1-BH1-3-S</td>
<td>3</td>
<td>ND</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH1-8-S</td>
<td>8</td>
<td>ND</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH2-3-S</td>
<td>3</td>
<td>ND</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH2-8-S</td>
<td>8</td>
<td>ND</td>
</tr>
</tbody>
</table>

**QA/QC Samples (all in µg/L)**

<table>
<thead>
<tr>
<th>Record Number</th>
<th>ER Sample ID</th>
<th>Sample Depth (ft)</th>
<th>HE (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>600250</td>
<td>6920-DF1-EB</td>
<td>NA</td>
<td>ND</td>
</tr>
</tbody>
</table>

---

*aEPA November 1986.

*bAnalysis request/chain-of-custody record.

BH = Borehole.
DF = Drainfield.
DSS = Drain and Septic Systems.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
HE = High explosive(s).
ID = Identification.
µg/L = Microgram(s) per liter.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
ND = Not detected above the method detection limit.
QA = Quality assurance.
QC = Quality control.
S = Soil sample.
Table 3.2.2-4  
Summary of Building 6920 Septic System (DSS Site 1077)  
Confirmatory Soil Sampling, HE Analytical MDLs  
May 1998  
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>EPA Method 8330(^a) Detection Limit (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Amino-4,6-dinitrotoluene</td>
<td>0.12–0.13</td>
</tr>
<tr>
<td>4-Amino-2,6-dinitrotoluene</td>
<td>0.1–0.11</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene</td>
<td>0.072–0.076</td>
</tr>
<tr>
<td>2,4-Dinitrotoluene</td>
<td>0.24–0.25</td>
</tr>
<tr>
<td>2,6-Dinitrotoluene</td>
<td>0.28–0.29</td>
</tr>
<tr>
<td>HMX</td>
<td>0.12–0.13</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>0.16–0.17</td>
</tr>
<tr>
<td>2-Nitrotoluene</td>
<td>0.14–0.15</td>
</tr>
<tr>
<td>3-Nitrotoluene</td>
<td>0.14–0.15</td>
</tr>
<tr>
<td>4-Nitrotoluene</td>
<td>0.12–0.13</td>
</tr>
<tr>
<td>Pentaerythritol tetranitrate</td>
<td>0.33–0.35</td>
</tr>
<tr>
<td>RDX</td>
<td>0.17–0.18</td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene</td>
<td>0.1–0.11</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene</td>
<td>0.28–0.29</td>
</tr>
</tbody>
</table>

\(^a\)EPA November 1986.

DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
HE = High explosive(s).
HMX = 1,3,5,7-tetranitro-1,3,5,7-tetrazacyclooctane.
mg/kg = Milligram(s) per kilogram.
RDX = 1,3,5-trinitro-1,3,5-triazacyclohexane.
### Table 3.2.2-5
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling Metals Analytical Results
May 1998
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Sample Attributes</th>
<th>Metals (EPA Method 6020&lt;sup&gt;a&lt;/sup&gt;) (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Record Number&lt;sup&gt;b&lt;/sup&gt;</td>
<td>ER Sample ID</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH1-3-S</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH1-8-S</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH2-3-S</td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-BH2-8-S</td>
</tr>
<tr>
<td>Background Concentration (Southwest Area Supergroup)&lt;sup&gt;c&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>QA/QC Samples (µg/L)</td>
<td></td>
</tr>
<tr>
<td>600250</td>
<td>6920-DF1-EB</td>
</tr>
</tbody>
</table>

Note: Values in **bold** represent analytes detected above their respective background concentration.

<sup>a</sup>EPA November 1986.

<sup>b</sup>Analysis request/chain-of-custody record.

<sup>c</sup>Dinwiddie September 1997.

BH = Borehole.
DF = Drainfield.
DSS = Drain and Septic Systems.
EB = Equipment blank.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
J () = The reported value is greater than or equal to the MDL but is less than the practical quantitation limit, shown in parentheses.
MDL = Method detection limit.
µg/L = Microgram(s) per liter.
mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
ND ( ) = Not detected above the MDL, shown in parentheses.
ND (# J) = Not detected. Uncertainty in the MDL, shown in parentheses.
QA = Quality assurance.
QC = Quality control.
S = Soil sample.
Table 3.2.2-6
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling, Metals Analytical MDLs
May 1998
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Analyte</th>
<th>EPA Method 6020/7196A&lt;sup&gt;a&lt;/sup&gt; Detection Limit (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>0.61–0.68</td>
</tr>
<tr>
<td>Barium</td>
<td>0.51–0.57</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.04–0.045</td>
</tr>
<tr>
<td>Chromium</td>
<td>0.71–0.79</td>
</tr>
<tr>
<td>Lead</td>
<td>0.3–0.34</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.04–0.045</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.3–0.34</td>
</tr>
<tr>
<td>Silver</td>
<td>0.04–0.045</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA November 1986.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
MDL = Method detection limit.
mg/kg = Milligram(s) per kilogram.
Table 3.2.2-7
Summary of Building 6920 Septic System (DSS Site 1077)
Confirmatory Soil Sampling, Gamma Spectroscopy Analytical Results
May 1998
(On-Site Laboratory)

<table>
<thead>
<tr>
<th>Record Number</th>
<th>ER Sample ID</th>
<th>Depth (ft)</th>
<th>Sample</th>
<th>Cesium-137 Result</th>
<th>Error</th>
<th>Thorium-232 Result</th>
<th>Error</th>
<th>Uranium-235 Result</th>
<th>Error</th>
<th>Uranium-238 Result</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>600251</td>
<td>6920-DF1-BH1-3-S</td>
<td>3</td>
<td>ND</td>
<td>0.0342</td>
<td>--</td>
<td>0.723</td>
<td>0.393</td>
<td>ND (0.184)</td>
<td>--</td>
<td>ND (1.23)</td>
<td>--</td>
</tr>
<tr>
<td>600251</td>
<td>6920-DF1-BH1-8-S</td>
<td>8</td>
<td>ND</td>
<td>0.0351</td>
<td>--</td>
<td>0.621</td>
<td>0.336</td>
<td>ND (0.187)</td>
<td>--</td>
<td>ND (1.22)</td>
<td>--</td>
</tr>
<tr>
<td>600251</td>
<td>6920-DF1-BH2-3-S</td>
<td>3</td>
<td>ND</td>
<td>0.0314</td>
<td>--</td>
<td>0.744</td>
<td>0.399</td>
<td>ND (0.187)</td>
<td>--</td>
<td>ND (1.68)</td>
<td>--</td>
</tr>
<tr>
<td>600251</td>
<td>6920-DF1-BH2-8-S</td>
<td>8</td>
<td>ND</td>
<td>0.0242</td>
<td>--</td>
<td>0.553</td>
<td>0.281</td>
<td>ND (0.166)</td>
<td>--</td>
<td>ND (1.45)</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Error</td>
<td></td>
<td></td>
<td>Error</td>
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<td>Error</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>0.393</td>
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<td></td>
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<td></td>
<td></td>
<td>0.336</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.399</td>
<td></td>
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<td></td>
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<td></td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.281</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Background Concentration—Southwest Area:

- Cesium-137: 0.079
- Thorium-232: 1.01
- Uranium-235: 0.16
- Uranium-238: 1.4

aEPA November 1986.
bAnalysis request/chain-of-custody record.
cTwo standard deviations about the mean detected activity.
dDinwiddie September 1997.

BH = Borehole.
DF = Drainfield.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
ER = Environmental Restoration.
ft = Foot (feet).
ID = Identification.
MDA = Minimum detectable activity.
NA = Not applicable.
ND ( ) = Not detected above the MDA, shown in parentheses.
ND ( ) = Not detected, but the MDA (shown in parentheses) exceeds background activity.
pCi/g = Picocurie(s) per gram.
S = Soil sample.
-- = Error not calculated for nondetectable results.
All laboratory data were reviewed and verified/validated according to Data Verification/Validation Level 3 (SNL/NM July 1994) or SNL/NM ER Project Data Validation Procedure for Chemical and Radiochemical Data, AOP [Administrative Operating Procedure] 00-03, Rev. 0 (SNL/NM December 1999). In addition, SNL/NM Department 7713 (RPSD Laboratory) reviewed all gamma spectroscopy results according to "Laboratory Data Review Guidelines," Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). Annex A contains the data validation reports for the samples collected at DSS Site 1077. The data are acceptable for use in the DSS Site 1077 NFA proposal.

3.3 Site Sampling Data Gaps

Analytical data from the site assessment are sufficient for characterizing the nature and extent of possible COC releases. There are no further data gaps regarding characterization of the Building 6920 septic system, DSS Site 1077.
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4.0 CONCEPTUAL SITE MODEL

The conceptual site model for the Building 6920 septic system, DSS Site 1077, is based upon the COCs identified in the soil samples collected from beneath the drainfield at this site. This chapter summarizes the nature and extent of contamination and the environmental fate of the COCs.

4.1 Nature and Extent of Contamination

Potential COCs at DSS Site 1077 are VOCs, HE compounds, RCRA metals, and radionuclides. Trace levels of two VOCs were detected in three of the four VOC samples collected from the site, and may reflect residual contamination that was incorporated in the samples due to asphalt paving at both borehole locations. No HE compounds were detected in any of the soil samples collected at this site. Only one RCRA metals detection exceeded the NMED-approved background concentration for SNL/NM Southwest Area Supergroup soils (Dinwiddie September 1997); therefore that analyte was carried forward in the risk assessment process. None of the four representative gamma spectroscopy radionuclides were detected, but the MDAs for all of the uranium-235 and some of the uranium-238 analyses exceed their respective background activities.

4.2 Environmental Fate

Assuming that the Building 6920 septic system was used, potential COCs may have been released into the vadose zone via aqueous effluent discharged from the septic system drainfield. Possible secondary release mechanisms include the uptake of COCs that may have been released to the soil beneath the drainfield (Figure 4.2-1). The depth to groundwater at the site (approximately 475 feet bgs) most likely precludes migration of potential COCs into the groundwater system. The potential pathways to receptors include soil ingestion, dermal contact, and inhalation, which could occur as a result of receptor exposure to contaminated subsurface soil at the site. No intake routes through plant, meat, or milk ingestion are considered appropriate for either the industrial or residential land use scenarios. Annex B provides additional discussion on the fate and transport of COCs at DSS Site 1077.

Table 4.2-1 summarizes the potential COCs for DSS Site 1077. All potential COCs were retained in the conceptual site model and were evaluated in both the human health and ecological risk assessments. The current and future land use for DSS Site 1077 is industrial (DOE et al. September 1995).

The potential human receptors at the site are considered to be an industrial worker and resident. The exposure routes for the receptors are dermal contact and ingestion/inhalation, but these are realistic possibilities only if contaminated soil is excavated at the site. The major exposure route modeled in the human health risk assessment is soil ingestion for the COCs. The inhalation pathway is included because of the potential to inhale dust; the dermal pathway is included because of the potential for receptors to be exposed to the contaminated soil.
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Figure 4.2-1
Conceptual Site Model Flow Diagram for Building 6920 Septic System, DSS Site 1077
Table 4.2-1
Summary of Potential COCs for Building 6920 Septic System (DSS Site 1077)

<table>
<thead>
<tr>
<th>COC Type</th>
<th>Number of Samples&lt;sup&gt;a&lt;/sup&gt;</th>
<th>COCs Greater than Background</th>
<th>Maximum Background Limit/Southwest Area Super Group&lt;sup&gt;b&lt;/sup&gt; (mg/kg)</th>
<th>Maximum Concentration&lt;sup&gt;c&lt;/sup&gt; (mg/kg)</th>
<th>Average Concentration&lt;sup&gt;c&lt;/sup&gt; (mg/kg)</th>
<th>Number of Samples Where Background Concentration Exceeded&lt;sup&gt;e&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOCs</td>
<td>4</td>
<td>NA</td>
<td>NA</td>
<td>0.0011 J</td>
<td>0.0007</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Benzene</td>
<td>NA</td>
<td>0.0064</td>
<td>0.0024</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Toluene</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>None</td>
</tr>
<tr>
<td>HE</td>
<td>4</td>
<td>None</td>
<td>15.9</td>
<td>NA</td>
<td>NA</td>
<td>None</td>
</tr>
<tr>
<td>RCRA, Metals</td>
<td>4</td>
<td>Chromium</td>
<td>0.16</td>
<td>ND (0.187)</td>
<td>ND (1.68)</td>
<td>4</td>
</tr>
<tr>
<td>Gamma</td>
<td>4</td>
<td>U-235</td>
<td>1.4</td>
<td>ND (0.187)</td>
<td>ND (1.68)</td>
<td>2</td>
</tr>
<tr>
<td>Spectroscopy</td>
<td>4</td>
<td>U-238</td>
<td>1.4</td>
<td>ND (0.187)</td>
<td>ND (1.68)</td>
<td>2</td>
</tr>
<tr>
<td>Radionuclides</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> Number of samples includes duplicates and splits.
<sup>b</sup> Dinwiddie September 1997.
<sup>c</sup> Maximum concentration is either the maximum amount detected, or the maximum MDL or MDA, if nothing was detected.
<sup>d</sup> Average concentration includes all samples except blanks. The average is calculated as the sum of detected amounts and one-half of the MDLs for nondetected results, divided by the number of samples.
<sup>e</sup> See appropriate data table for sample locations.

- VOC = Constituent of concern.
- DSS = Drain and Septic Systems.
- HE = High explosive(s).
- J = Analytical result was qualified as an estimated value during data validation, see data validation report.
- MDA = Minimum detectable activity.
- MDL = Method detection limit.
- mg/kg = Milligram(s) per kilogram.
- NA = Not applicable.
- NC = Not calculated.
- ND ( ) = Not detected above the MDA, shown in parentheses.
- pCi/g = Picocurie(s) per gram.
- VOC = Volatile organic compound.
Potential biota receptors include flora and fauna at the site. Major exposure routes for biota include direct soil ingestion, ingestion of COCs through food chain transfers, and direct contact with COCs in soil. Annex B provides additional discussion of the exposure routes and receptors at the Building 6920 Septic System Site.

4.3 Site Assessments

Site assessment at DSS Site 1077 included risk assessments for both human health and ecological risk. This section briefly summarizes the risk assessment results, and Annex B presents the risk assessment performed for DSS Site 1077 in more detail.

4.3.1 Summary

The site assessment concluded that DSS Site 1077 poses no significant threat to human health under either the industrial or residential land use scenario. After considering the uncertainties associated with the available data and modeling assumptions, ecological risks associated with DSS Site 1077 were found to be very low.

4.3.2 Risk Assessments

Risk assessments were performed for both human health and ecological risks at DSS Site 1077. This section summarizes the results.

4.3.2.1 Human Health

DSS Site 1077 has been recommended for an industrial land use scenario (DOE et al. September 1995). Because metals, organic compounds, and possibly radionuclides are present, it was necessary to perform a human health risk assessment analysis for the site, which included all detected COCs. Annex B provides a complete discussion of the risk assessment process, results, and uncertainties. The risk assessment process provides a quantitative evaluation of the potential adverse human health effects from constituents in the site’s soil by calculating the hazard index (HI) and excess cancer risk for both industrial and residential land use scenarios.

In summary, the HI calculated for the COCs is 0.06 at DSS Site 1077 under the industrial land use scenario, which is lower than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). Incremental HI risk, determined by subtracting risk associated with background from potential nonradiological COC risk (without rounding), is 0.06. The estimated excess cancer risk for DSS Site 1077 COCs is 8E-7 for an industrial land use setting. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is below the suggested acceptable risk value. The incremental excess cancer risk is 8.40E-7. Both the incremental HI and excess cancer risk are below NMED guidelines.

In summary, the HI calculated for the COCs at DSS Site 1077 is 0.25 under the residential land use scenario, which is lower than the numerical standard of 1.0 suggested by risk assessment.
guidance (EPA 1989). Incremental HI risk, determined by subtracting risk associated with background from potential nonradiological COC risk (without rounding), is 0.25. The excess cancer risk for DSS Site 1077 COCs is 2E-6 for a residential land use setting. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001); thus, the excess cancer risk for this site is below the suggested acceptable risk value. The incremental excess cancer risk is 2.09E-6. Both the incremental HI and excess cancer risk are below NMED guidelines.

The incremental total effective dose equivalent (TEDE) and corresponding estimated cancer risk from radiological COCs are much lower than EPA guidance values. The estimated TEDE is 1.2E-2 millirem (mrem)/year (yr) for the industrial land use scenario, which is much lower than the EPA's numerical guidance of 15 mrem/yr (EPA 1997). The corresponding incremental estimated excess cancer risk value is 1.2E-7 for the industrial land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional controls is 3.0E-2 mrem/yr with an associated risk of 3.5E-7. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore DSS Site 1077 is eligible for unrestricted radiological release.

The summation of the nonradiological and radiological carcinogenic risks is tabulated in Table 4.3.2-1.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Nonradiological Risk</th>
<th>Radiological Risk</th>
<th>Total Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial</td>
<td>8.4E-7</td>
<td>1.2E-7</td>
<td>9.6E-7</td>
</tr>
<tr>
<td>Residential</td>
<td>2.1E-6</td>
<td>3.5E-7</td>
<td>2.4E-6</td>
</tr>
</tbody>
</table>

Uncertainties associated with the calculations are considered small relative to the conservatism of risk assessment analysis. It is therefore concluded that this site poses insignificant risk to human health under both the industrial and residential land use scenarios.

4.3.2.2 Ecological

An ecological assessment that corresponds with the procedures in the EPA's Ecological Risk Assessment Guidance for Superfund (EPA 1997) also was performed as set forth by the NMED Risk-Based Decision Tree description in the "RPMP Document Requirement Guide" (NMED March 1998). An early step in the evaluation compared COC concentrations and identified potentially bioaccumulative constituents (see Annex B, Sections IV and VII). This methodology also required developing a site conceptual model and a food web model, as well as selecting ecological receptors, as presented in the "Predictive Ecological Risk Assessment Methodology for SNL/NM ER Program, Sandia National Laboratories/New Mexico" (IT July 1998). The risk assessment also includes the estimation of exposure and ecological risk.

Annex B presents the results of the ecological risk assessment. Site-specific information was incorporated into the risk assessment when such data were available. No hazard quotients greater than 1 were originally predicted, with the exception of total chromium. Initial predictions of potential risk to plants from exposure to total chromium were based upon highly conservative plant toxicity benchmarks and assumptions of high bioavailability and maximum exposure point.
concentration. Actual risk to this receptor is expected to be near or within the range of background risk. Therefore ecological risks associated with this site are expected to be very low.

Annex B also summarizes the internal and external dose-rate model results for the deer mouse and burrowing owl, respectively. The total radiation dose rate is predicted to be 2.8E-4 rad/day for the deer mouse and 2.7E-4 rad/day for the burrowing owl. The dose rates for the deer mouse and the burrowing owl are less than the benchmark of 0.1 rad/day.

4.4 Baseline Risk Assessments

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

4.4.1 Human Health

Because the results of the human health risk assessment summarized in Section 4.3.2.1 indicate that DSS Site 1077 poses insignificant risk to human health under both industrial and residential land use scenarios, a baseline human health risk assessment is not required for this site.

4.4.2 Ecological

Because results of the ecological risk assessment summarized in Section 4.3.2.2 indicate that ecological risks at DSS Site 1077 are expected to be very low, a baseline ecological risk assessment is not required for the site.
5.0 NFA PROPOSAL

5.1 Rationale

Based upon field investigation data and the human health and ecological risk assessment analyses, an NFA decision is recommended for DSS Site 1077 for the following reasons:

- The soil has been sampled for all potential COCs.
- No COCs are present in soil at levels considered hazardous to human health for an industrial or residential land use scenario.
- None of the COCs warrant ecological concern after conservative exposure assumptions are analyzed.

5.2 Criterion

Based upon the evidence provided above, DSS Site 1077 is proposed for an NFA decision according to Criterion 5, which states, "the SWMU/AOC has been characterized or remediated 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" (NMED March 1998).
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6.0 REFERENCES


DOE, see U.S. Department of Energy.

EPA, see U.S. Environmental Protection Agency.

IT, see IT Corporation.


Jones, J. (Sandia National Laboratories/New Mexico), June 1991. Internal Memorandum to D. Dionne listing the septic tanks that were removed from service with the construction of the Area III sanitary sewer system. June 21, 1991.


NOAA, see National Oceanic and Atmospheric Administration.


NMED, see New Mexico Environment Department.

Sandia National Laboratories/New Mexico (SNL/NM), October 1991. SNL/NM Facilities Engineering Drawing #101881-M1 (showing the Building 6920 septic system), Sandia National Laboratories, Albuquerque, New Mexico.


Sandia National Laboratories (SNL/NM), November 1994. SNL/NM Facilities Engineering Drawing #101882-M1 (showing the Building 6920 septic system), Sandia National Laboratories, Albuquerque, New Mexico.


Sandia National Laboratories/New Mexico (SNL/NM), December 1999. "Data Validation Procedure for Chemical and Radiochemical Data, Sandia National Laboratories/New Mexico Environmental Restoration Project, AOP 00-03," Rev. 0, Sandia National Laboratories, Albuquerque, New Mexico.


Sandia National Laboratories/New Mexico (SNL/NM), March 2003. Database printout provided by SNL/NM Facilities Engineering showing the year that numerous SNL/NM buildings were constructed, Sandia National Laboratories, Albuquerque, New Mexico.

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


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**DOCUMENTATION COMPLETENESS CHECKLIST**

(Data Verification/Validation Level 1 - DV1)

---

**Project Leader:** Tony Raybal  
**Project Name:** Non ER Septic System  
**AR/COC No.:** 660250  
**Analytical Lab:** ERL  
**Case No.:** 7223.230  
**SDG No.:** NA

---

In the tables below, mark any information that is missing or incorrect and give an explanation.

**1.0 Analysis Request and Chain of Custody Record**

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Item</th>
<th>Complete?</th>
<th>If no, explain</th>
<th>Resolved?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>All items on COC complete - data entry clerk initiated and dated</td>
<td>NA</td>
<td>Not applicable</td>
<td>NA</td>
</tr>
<tr>
<td>1.2</td>
<td>Container type(s) correct for analyses requested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Sample volume adequate for # and types of analyses requested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Preservative correct for analyses requested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Custody records continuous and complete</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Lab sample number(s) provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.7</td>
<td>Condition upon receipt information provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>Tritium Screen data provided (Rad labs)</td>
<td>NA</td>
<td>Not applicable, non EMMA location</td>
<td>NA</td>
</tr>
</tbody>
</table>

**2.0 Analytical Laboratory Report**

<table>
<thead>
<tr>
<th>Line No.</th>
<th>Item</th>
<th>Complete?</th>
<th>If no, explain</th>
<th>Resolved?</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Data reviewed, signature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Date samples received</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Method reference number(s) complete and correct</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Quality control data provided (MB, LCS, LCD, Detection Limit)</td>
<td></td>
<td>LCD not analyzed with submitted samples</td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Matrix spike/matrix spike duplicate data provided (if requested)</td>
<td></td>
<td>Note: not requested</td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Narrative provided</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7</td>
<td>TAT met</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.8</td>
<td>Hold times met</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.9</td>
<td>All requested result data provided</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Based on the review, this data package is complete  

- [ ] Yes  
- [ ] No

If no, provide: correction request tracking #  
and date correction request was submitted: ____________

Reviewed by: Jeff A. Raizada  
Date: 1/17/98  
Closed by:_________  
Date: __________
DATA QUALITY INDICATOR CHECKLIST
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

Project Name: Non ER Septic System
Case Number: 7223.220
Sample Numbers: 6920—DFI—

<table>
<thead>
<tr>
<th>AR/COC No.</th>
<th>Analytical laboratory</th>
<th>SDG No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>600250</td>
<td>ERLC</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>600250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600250</td>
<td></td>
<td></td>
</tr>
<tr>
<td>600250</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1.0 EVALUATION

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
<th>If no. Sample ID No./Fraction(s) and Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Sample volume, container, and preservation correct?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Holding times met for all samples?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Reporting units appropriate for the matrix and meet project-specific requirements?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) Quantitation limit met for all samples?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) Accuracy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) Laboratory control sample accuracy reported and met for all samples?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Surrogate data reported and met for all organic samples analyzed by a gas chromatography technique?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reviewed by: [Signature]
Date: 7/12/08

Succ-024 = Acohol MEK, Carbon Tetrachloride, Tetrachloroethylene
Succ-08 = Ag, HE-023, no results
## DATA QUALITY INDICATOR CHECKLIST (DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

### 2.0 COMMENTS:
All items marked "No" above must be explained in this section. For each item, give SNL/NM ID No. and the analysis, if appropriate, of all samples affected by the finding.

1. The percent recoveries for acetone, MEK, carbon tetrachloride and Tetrachloroethylene were biased low in US 5001-024. There is an uncertainty associated with the MOLs of the above listed.

Reviewed by: [Signature]
Date: 7/17/98

---

### Table

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>No</th>
<th>If no, Sample ID No./Fraction(s) and Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>c) Matrix spike recovery data reported and met for all samples for which it was requested?</td>
<td></td>
<td></td>
<td>$198-69 \Rightarrow Ag$</td>
</tr>
<tr>
<td>6) Precision</td>
<td></td>
<td></td>
<td>LCD was not analyzed with submitted samples</td>
</tr>
<tr>
<td>a) Laboratory control sample precision reported and met for all samples?</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Matrix spike duplicate RPD data reported and met for all samples for which it was requested?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7) Blank data</td>
<td></td>
<td></td>
<td>Trip blank 6920-DF1-T8 $\Rightarrow 5'$ value reported for MEK</td>
</tr>
<tr>
<td>a) Method or reagent blank data reported and met for all samples?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b) Sampling blank (e.g., field, trip, and equipment) data reported and met?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8) Narrative included, correct, and complete?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2.0 COMMENTS CONTINUATION SHEET

- The percent recovery for silver was also biased low in LCS 5/198-09. The LCS and LCD for explosives (GC Batch HE-023) were not reported.

- The percent recovery for Ag was biased low in the MS and MiD samples.

- MEK was detected in the trip blank but was not detected in the submitted samples.

Reviewed by: [Signature]
Date: 7/17/88

AL2-04/SNL:SOP3044B.R1
**DATA QUALITY INDICATOR CHECKLIST**
(DATA VERIFICATION/VALIDATION LEVEL 2—DV2)

### 3.0 SUMMARY:
Summarize the findings in the table below. List only samples/fractions for which deficiencies have been noted. Use the qualifiers given at the end of the table if possible. Explain any other qualifiers in the comments column.

<table>
<thead>
<tr>
<th>Sample/Fraction No.</th>
<th>Analysis</th>
<th>Qualifiers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### QUALIFIERS:
- **J** = Estimated quantity (provide reason)
- **B** = Contamination in blank (indicate which blank)
- **P** = Laboratory precision does not meet criteria
- **R** = Reporting units inappropriate
- **N** = There is presumptive evidence of the presence of the material
- **UJ** = The material was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
- **Q** = Quantitation limit does not meet criteria
- **A** = Laboratory accuracy does not meet criteria
- **U** = Analyte is undetected (indicate which analyte and reason for qualification)
- **NJ** = There is presumptive evidence of the presence of the material at an estimated quantity.

Reviewed by: [Signature]
Date: 7/17/98
## SAMPLE FINDINGS SUMMARY

**Site:** Non ER Septic System

**AR SOC:** 600 250  
**Data Classification:** DV-2

<table>
<thead>
<tr>
<th>Sample Fraction No.</th>
<th>Analysis</th>
<th>Qualifiers</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>6920 - DF1 - BH 1-3-S</td>
<td>7440-22-4</td>
<td>J A, A2</td>
<td></td>
</tr>
<tr>
<td>- BH 1 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 3-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6920 - DF1 - BH 1-3-S</td>
<td>67-64-1</td>
<td>US A</td>
<td></td>
</tr>
<tr>
<td>- BH 1 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 3-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6920 - DF1 - BH 1-3-S</td>
<td>56-203-5</td>
<td>US A</td>
<td>Insufficient quality control</td>
</tr>
<tr>
<td>- BH 1 - 8-S</td>
<td></td>
<td></td>
<td>data to determine laboratory</td>
</tr>
<tr>
<td>- BH 2 - 3-S</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- BH 2 - 8-S</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sample No. Fraction No.** - This value is located on the Chain of Custody in the ER Sample Id field.

**Analysis** - Use valid test methods provided below or if the result applies to an individual analyte within a test method, use the CAS number from the analytical data sheet.

**DV Qualifiers** - The entry will be taken from the list of valid qualifiers and associated comments. If other qualifiers not on the list are needed, contact Tina Sanchez to coordinate adding them to the list.

**Comments** - This is only to be used if a comment associated with the qualifier is not appropriate, needs modification because of an unusual circumstance, or additional clarification is warranted.

**Test Methods** - Anions_CE, EPA6010, EPA6020, EPA-4701, EPA8015B, EPA8081, EPA8260, EPA8260-M5, EPA8270, HACH_ALK, HACH_NO2, HACH_NO3, MEKC.HE, PCBRISC

Reviewed by: [Signature]  
*Date:* 7/17/98
List of Data Qualifiers used in Data Validation and Associated Comment Responses

<table>
<thead>
<tr>
<th>Qualifier</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Laboratory accuracy and/or bias measurements for the associated Laboratory Control Sample (LCS) do not meet acceptance criteria.</td>
</tr>
<tr>
<td>A1</td>
<td>Laboratory accuracy and/or bias measurements for the associated Surrogate Spike do not meet acceptance criteria.</td>
</tr>
<tr>
<td>A2</td>
<td>Laboratory accuracy and/or bias measurements for the associated Matrix Spike (MS) do not meet acceptance criteria.</td>
</tr>
<tr>
<td>B</td>
<td>Analyte present in laboratory method blank</td>
</tr>
<tr>
<td>B1</td>
<td>Analyte present in trip blank.</td>
</tr>
<tr>
<td>B2</td>
<td>Analyte present in equipment blank.</td>
</tr>
<tr>
<td>B3</td>
<td>Analyte present in continuing calibration blank.</td>
</tr>
<tr>
<td>J</td>
<td>The associated value is an estimated quantity. (Note: this qualifier may be used in conjunction with other qualifiers (i.e., A,J))</td>
</tr>
<tr>
<td>J1</td>
<td>The method requirements for sample preservation/temperature were not met for the sample analysis. The associated value is an estimated quantity.</td>
</tr>
<tr>
<td>J2</td>
<td>The holding time was exceeded for the associated sample analysis. The associated value is an estimated quantity.</td>
</tr>
<tr>
<td>P</td>
<td>Laboratory precision measurements for the Laboratory Control Sample and duplicate (LCS/LCSD) do not meet acceptance criteria.</td>
</tr>
<tr>
<td>P1</td>
<td>Laboratory precision measurements for the Matrix Spike Sample and associated duplicate (MS/MSD) do not meet acceptance criteria.</td>
</tr>
<tr>
<td>P2</td>
<td>Insufficient quality control data to determine laboratory precision.</td>
</tr>
<tr>
<td>Q</td>
<td>Quantitation limit reported does not meet Data Quality Objective (DQO) requirements.</td>
</tr>
<tr>
<td>R</td>
<td>The data are unusable for their intended purpose (Note: Analyte may or may not be present.)</td>
</tr>
<tr>
<td>U</td>
<td>The analyte is a common laboratory contaminant. The associated result is less than ten times the concentration in any blank.</td>
</tr>
<tr>
<td>U1</td>
<td>The analyte was also detected in a blank. The associated result is less than five times the concentration in any blank.</td>
</tr>
<tr>
<td>UJ</td>
<td>The analyte was analyzed for but was not detected. The associated value is an estimate and may be inaccurate or imprecise.</td>
</tr>
</tbody>
</table>

Qualifiers are potentially available, see TOP 94-03. Notify Tina.
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<tr>
<th>Figure</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Conceptual Site Model Flow Diagram for Building 6920 Septic System, DSS Site 1077</td>
</tr>
</tbody>
</table>
DSS SITE 1077: RISK ASSESSMENT REPORT

I. Site Description and History

Drain and Septic Systems (DSS) Site 1077, the Building 6920 Septic System, Operable Unit 1295, at Sandia National Laboratories/New Mexico (SNL/NM), consists of a 1,000 gallon septic tank connected to a drainfield consisting of three 24-foot-long drain lines. The septic system was located approximately 60 feet northwest of Building 6920. The site is located in the southeast portion of SNL/NM Technical Area (TA)-III on federally owned land controlled by Kirtland Air Force Base (KAFB) and leased to the U.S. Department of Energy (DOE). Available information indicates that Building 6920 was constructed in 1990 (SNL/NM March 2003) and it is assumed that the septic system was constructed at this time. As of June 1991, Building 6920 was connected to an extension of the City of Albuquerque (COA) sanitary sewer system (Jones June 1991). The septic tank and drainfield were abandoned in place, the septic tank was filled with dirt, and in 1998 Building 6926 was expanded to the east over the area of the former drainfield.

Environmental concerns about DSS Site 1077 are based upon the potential for the release of constituents of concern (COCs) in effluent discharged to the environment via the septic system at the site. The investigation was conducted in accordance with established procedures that had and were being used to investigate numerous other SNL/NM drain and septic system-type sites at that time.

No springs or perennial surface-water bodies are located within two miles of the site. Average annual rainfall in the SNL/NM and KAFB area, as measured at Albuquerque International Sunport, is 8.1 inches (NOAA 1990). The area around DSS Site 1077 is paved and surface drainages are used to direct surface water away from the site and to a run-off retention basin located southwest of the site. However, virtually all of the moisture undergoes evapotranspiration. The estimates of evapotranspiration for the KAFB area range from 95 to 99 percent of the annual rainfall (SNL/NM March 1996).

DSS Site 1077 lies at an average elevation of approximately 5,405 feet above mean sea level. Depth to groundwater is approximately 475 feet below ground surface (bgs). The nearest groundwater monitoring wells are those installed along the west side of the Chemical Waste Landfill in TA-III and are located approximately 500 feet east of the site. The nearest production wells are north/northwest of the site and include KAFB-4 and KAFB-11, which are approximately 4.6 and 4.8 miles away, respectively.

II. Data Quality Objectives

Investigation procedures utilized at DSS Site 1077 were in accordance with, and were essentially the same as, investigation procedures that have been utilized at numerous other SNL/NM DSS sites prior to this site investigation. These established DSS characterizations serve as a basis for identifying the site-specific sample locations, sample depths, sampling procedures, analytical requirements, and Data Quality Objectives (DQOs) for this DSS site. The DQOs outlined the Quality Assurance (QA)/Quality Control (QC) requirements necessary
for producing defensible analytical data suitable for risk assessment purposes. The baseline sampling conducted at DSS Site 1077 was designed to:

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

Table 1 summarizes the rationale for determining the sampling locations at this site.

<table>
<thead>
<tr>
<th>DSS Site 1077 Sampling Areas</th>
<th>Potential COC Source</th>
<th>Number of Sampling Locations</th>
<th>Sample Density (samples/acre)</th>
<th>Sampling Location Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil beneath the septic system drainfield</td>
<td>Effluent discharged to the environment from the drainfield</td>
<td>2</td>
<td>NA</td>
<td>Evaluate potential COC releases to the environment from effluent discharged from the drainfield</td>
</tr>
</tbody>
</table>

COC = Constituent of concern.
DQO = Data Quality Objective.
DSS = Drain and Septic Systems.
NA = Not applicable.

Baseline soil samples were collected from two locations at DSS Site 1077. The samples were collected with a Geoprobe™ from two 3-foot-long sampling intervals at each boring location. Drainfield sampling intervals started at 3 and 8 feet bgs in each drainfield boring. The soil samples were collected in accordance with established procedures that were being used to investigate SNL/NM DSS sites at that time. Table 2 summarizes the types of confirmatory and QA/QC samples collected at the site and the laboratories that performed the analyses.

The DSS Site 1077 baseline soil samples were analyzed for volatile organic compounds (VOCs), high explosives (HE), Resource Conservation and Recovery Act (RCRA) metals, and radionuclide activity. The samples were analyzed by an on-site laboratory (Environmental Restoration [ER] Chemistry Laboratory [ERCL]) and the SNL/NM Radiation Protection Sample Diagnostic (RPSD) Laboratory. Table 3 summarizes the analytical methods and the data quality requirements for DSS Site 1077.

QA/QC samples were collected during the baseline sampling effort according to the ER Project Quality Assurance Project Plan. The QA/QC samples consisted of one trip blank (for VOCs only) and one set of equipment blanks (for VOCs, HE, and RCRA metals). No significant QA/QC problems were identified in the QA/QC samples.
Table 2
Number of Confirmatory Soil Samples Collected From DSS Site 1077

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>VOCs</th>
<th>HE</th>
<th>RCRA Metals</th>
<th>Gamma Spectroscopy Radionuclides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmatory</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Duplicates</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EBs and TBs (VOCs only)</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total Samples</td>
<td>6</td>
<td>5</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

Analytical Laboratory

<table>
<thead>
<tr>
<th>DSS</th>
<th>EB</th>
<th>ERCL</th>
<th>HE</th>
<th>RCRA</th>
<th>RPSD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DSS = Drain and Septic Systems.
EB = Equipment blank.
ERCL = Environmental Restoration Chemistry Laboratory.
HE = High explosive(s).
RCRA = Resource Conversation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics Laboratory.
TB = Trip blank.
VOC = Volatile organic compound.

Table 3
Summary of Data Quality Requirements

<table>
<thead>
<tr>
<th>Analytical Method</th>
<th>Data Quality Level</th>
<th>ERCL</th>
<th>RPSD</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOCs</td>
<td>Defensible</td>
<td>4 samples</td>
<td>None</td>
</tr>
<tr>
<td>EPA Method 8260</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HE</td>
<td>Defensible</td>
<td>4 samples</td>
<td>None</td>
</tr>
<tr>
<td>EPA Method 8330</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RCRA metals</td>
<td>Defensible</td>
<td>4 samples</td>
<td>None</td>
</tr>
<tr>
<td>EPA Method 6020/7000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma Spectroscopy Radionuclides</td>
<td>Defensible</td>
<td>None</td>
<td>4 samples</td>
</tr>
</tbody>
</table>

Note: The number of samples does not include QA/QC samples such as duplicates, trip blanks, and equipment blanks.

EPA = U.S. Environmental Protection Agency.
ERCL = Environmental Restoration Chemistry Laboratory.
HE = High explosive(s).
QA = Quality assurance.
QC = Quality control.
RCRA = Resource Conversation and Recovery Act.
RPSD = Radiation Protection Sample Diagnostics Laboratory.
VOC = Volatile organic compound.
All of the baseline soil sample results were verified/validated by SNL/NM. The on-site laboratory results from ERCL were reviewed and are in compliance with the “Environmental Restoration Chemistry Laboratory (ERCL) Quality Assurance Project Plan, QAPP-97-01” (SNL/NM March 1997). The data validation reports are presented in the associated DSS Site 1077 proposal for no further action (NFA). The gamma spectroscopy data from the RPSD Laboratory were reviewed according to “Laboratory Data Review Guidelines,” Procedure No. RPSD-02-11, Issue No. 02 (SNL/NM July 1996). The gamma-spectroscopy results are presented in the NFA proposal. The reviews confirmed that the analytical data are defensible and therefore acceptable for use in the NFA proposal; therefore, the DQOs have been fulfilled.

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

III.1 Introduction

The determination of the nature, migration rate, and extent of contamination at DSS Site 1077 was based upon an initial conceptual site model validated with confirmatory sampling at the site. The initial conceptual site model was developed from archival site research, site inspections, and soil sampling. The sample data were subsequently used to develop the final conceptual site model for DSS Site 1077, which is presented in Section 4.0 of the associated NFA proposal. The quality of the data specifically used to determine the nature, migration rate, and extent of contamination are described below.

III.2 Nature of Contamination

Both the nature of contamination and the potential for the degradation of COCs at DSS Site 1077 were evaluated using laboratory analyses of the soil samples. The analytical requirements included analyses for VOCs, HEs, RCRA metals, and radionuclides by gamma spectroscopy. The analytes and methods listed in Tables 2 and 3 are appropriate to characterize the COCs and any potential degradation products at DSS Site 1077.

III.3 Rate of Contaminant Migration

The septic system at DSS Site 1077 has not been in service since 1991, when Building 6920 was connected to an extension of the COA sanitary sewer system, and may have never been used at all. The migration rate of COCs that may have been introduced into the subsurface via the septic system at this site was dependent upon the volume of aqueous effluent that may or may not have been discharged to the environment from this system when it was operational. Any migration of COCs from this site after use of the septic system was discontinued has been dependent predominantly on precipitation, although it is highly unlikely that sufficient precipitation has fallen on the site to reach the depth at which COCs may have been discharged to the subsurface from this system. Analytical data generated from the soil sampling conducted at the site are adequate to characterize the rate of COC migration at DSS Site 1077.
III.4 Extent of Contamination

Subsurface baseline soil samples were collected from boreholes drilled at two locations beneath the effluent release points and areas (drainfield) at the site to assess whether releases of effluent (if any) from the septic system caused any environmental contamination.

The baseline soil samples were collected at sampling depths starting at 3 and 8 feet beneath the drainfield lines. Sampling intervals started at the depths at which effluent discharged from the septic system would have entered the subsurface environment at the site. The baseline soil samples are considered to be representative of the soil potentially contaminated with the COCs at this site, and are sufficient to determine any vertical extent of COCs.

IV. Comparison of COCs to Background Screening Levels

Site history and characterization activities are used to identify potential COCs. The DSS Site 1077 NFA proposal describes the identification of COCs and the sampling that was conducted in order to determine the concentration levels of those COCs across the site. Generally, COCs that were evaluated in this risk assessment included all detected organic compounds and all inorganic and radiological COCs for which samples were analyzed. If the detection limit of an organic compound was too high (i.e., could possibly cause an adverse effect to human health or the environment), the compound was retained. Nondetected organic compounds not included in this assessment were determined to have detection limits low enough to ensure protection of human health and the environment. In order to provide conservatism in this risk assessment, the calculation used only the maximum concentration value of each COC found for the entire site. The SNL/NM maximum background concentration (Dinwiddie September 1997) was selected to provide the background screen listed in Tables 4 through 7.

Nonradiological inorganic constituents that are essential nutrients such as iron, magnesium, calcium, potassium, and sodium were not included in this risk assessment (EPA 1989). Both radiological and nonradiological COCs were evaluated. The nonradiological COCs evaluated in the risk assessment consist of inorganic and organic compounds.

Tables 4 and 5 list the nonradiological COCs for the human health and the ecological risk assessments at DSS Site 1077, respectively. Tables 6 and 7 list radiological COCs for the human health and ecological risk assessments, respectively. All tables show the associated SNL/NM maximum background concentration values (Dinwiddie September 1997). Section VI.4 provides discussion of Tables 4 and 6 while Sections VII.2 and VII.3 provide discussion of Tables 5 and 7.

V. Fate and Transport

The primary releases of COCs at DSS Site 1077 were to the subsurface soil resulting from discharges of effluents from Building 6920 to the septic tank and drainfield. Wind, water, and biota are natural mechanisms of COC transport from the primary release point. Because the discharges were to the subsurface, wind and surface water are considered to be of low significance as transport mechanisms at this site.
Table 4  
Nonradiological COCs for Human Health Risk Assessment at DSS Site 1077 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

<table>
<thead>
<tr>
<th>COC</th>
<th>Maximum Concentration (mg/kg)</th>
<th>SNL/NM Background Concentration (mg/kg)$^a$</th>
<th>Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?</th>
<th>BCF (maximum aquatic)</th>
<th>Log $K_{ow}$ (for organic COCs)</th>
<th>Bioaccumulator?$^b$ (BCF&gt;40, Log $K_{ow}$&gt;4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inorganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arsenic</td>
<td>3.8</td>
<td>4.4</td>
<td>Yes</td>
<td>44$^c$</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Barium</td>
<td>150</td>
<td>214</td>
<td>Yes</td>
<td>170$^d$</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.14 J</td>
<td>0.9</td>
<td>Yes</td>
<td>64$^c$</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium, total</td>
<td>20</td>
<td>15.9</td>
<td>No</td>
<td>18$^c$</td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>Lead</td>
<td>7.2</td>
<td>11.8</td>
<td>Yes</td>
<td>49$^e$</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.0225$^e$</td>
<td>&lt;0.1</td>
<td>Unknown</td>
<td>5,500$^c$</td>
<td>-</td>
<td>Yes</td>
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<tr>
<td>Selenium</td>
<td>0.45 J</td>
<td>&lt;1</td>
<td>Unknown</td>
<td>800$^f$</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver</td>
<td>0.0225$^e$</td>
<td>&lt;1</td>
<td>Unknown</td>
<td>0.5$^e$</td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>0.0011 J</td>
<td>NA</td>
<td>NA</td>
<td>5.2$^c$</td>
<td>2.13$^c$</td>
<td>No</td>
</tr>
<tr>
<td>Toluene</td>
<td>0.0064</td>
<td>NA</td>
<td>NA</td>
<td>10.7$^c$</td>
<td>2.69$^c$</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Bold indicates the COCs that exceed background screening values and/or are bioaccumulators.

$^a$Dinwiddie September 1997, Southwest Supergroup.

$^b$NMED March 1998.

$^c$Yanicak March 1997.

$^d$Neumann 1976.

$^e$Parameter was not detected. Concentration is one-half the detection limit.

$^f$Callahan et al. 1979.

BCF = Bioconcentration factor.

COC = Constituent of concern.

DSS = Drain and Septic Systems.

J = Estimated concentration.

$K_{ow}$ = Octanol-water partition coefficient.

Log = Logarithm (base 10).

mg/kg = Milligram(s) per kilogram.

NA = Not applicable.

NMED = New Mexico Environment Department.

SNL/NM = Sandia National Laboratories/New Mexico.

= Information not available.
Table 5
Nonradiological COCs for Ecological Risk Assessment at DSS Site 1077 with Comparison to the Associated SNL/NM Background Screening Value, BCF, and Log $K_{ow}$

<table>
<thead>
<tr>
<th>COC</th>
<th>Maximum Concentration (mg/kg)</th>
<th>SNL/NM Background Concentration (mg/kg)*</th>
<th>Is Maximum COC Concentration Less Than or Equal to the Applicable SNL/NM Background Screening Value?</th>
<th>BCF (maximum aquatic)</th>
<th>Log $K_{ow}$ (for organic COCs)</th>
<th>Bioaccumulator?(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>3.8</td>
<td>4.4</td>
<td>Yes</td>
<td>44(^c)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Barium</td>
<td>140</td>
<td>214</td>
<td>Yes</td>
<td>170(^d)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.14 J</td>
<td>0.9</td>
<td>Yes</td>
<td>64(^e)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Chromium, total</td>
<td>20</td>
<td>15.9</td>
<td>No</td>
<td>16(^f)</td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>Lead</td>
<td>7.2</td>
<td>11.8</td>
<td>Yes</td>
<td>49(^g)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.0225(^e)</td>
<td>&lt;0.1</td>
<td>Unknown</td>
<td>5,500(^c)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.40 J</td>
<td>&lt;1</td>
<td>Unknown</td>
<td>800(^i)</td>
<td>-</td>
<td>Yes</td>
</tr>
<tr>
<td>Silver</td>
<td>0.0225(^e)</td>
<td>&lt;1</td>
<td>Unknown</td>
<td>0.5(^j)</td>
<td>-</td>
<td>No</td>
</tr>
<tr>
<td>Benzene</td>
<td>0.0011 J</td>
<td>NA</td>
<td>NA</td>
<td>5.2(^c)</td>
<td>2.13(^c)</td>
<td>No</td>
</tr>
<tr>
<td>Toluene</td>
<td>0.0064</td>
<td>NA</td>
<td>NA</td>
<td>10.7(^c)</td>
<td>2.69(^a)</td>
<td>No</td>
</tr>
</tbody>
</table>

Note: Bold indicates the COCs that exceed background screening values and/or are bioaccumulators.

\(^a\)Dinwiddie September 1997, Southwest Supergroup.
\(^b\)NMED March 1998.
\(^c\)Yanicak March 1997.
\(^d\)Neumann 1976.
\(^e\)Parameter was not detected. Concentration is one-half the detection limit.
\(^f\)Callahan et al. 1979.

BCF = Bioconcentration factor.
COC = Constituent of concern.
DSS = Drain and Septic Systems.
J = Estimated concentration.
$K_{ow}$ = Octanol-water partition coefficient.
Log = Logarithm (base 10).

mg/kg = Milligram(s) per kilogram.
NA = Not applicable.
NMED = New Mexico Environment Department.
SNL/NM = Sandia National Laboratories/New Mexico.
- = Information not available.
Table 6
Radiological COCs for Human Health Risk Assessment at DSS Site 1077 with Comparison to the Associated SNL/NM Background Screening Value and BCF

<table>
<thead>
<tr>
<th>COC</th>
<th>Maximum Activity (pCi/g)</th>
<th>SNL/NM Background Activity (pCi/g)</th>
<th>Is Maximum COC Activity Less Than or Equal to the Applicable SNL/NM Background Screening Value?</th>
<th>BCF (maximum aquatic)</th>
<th>Is COC a Bioaccumulator? (BCF &gt;40)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>ND (0.035)</td>
<td>0.079</td>
<td>Yes</td>
<td>3,000&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Yes</td>
</tr>
<tr>
<td>Th-232</td>
<td>0.744</td>
<td>1.01</td>
<td>Yes</td>
<td>3,000&lt;sup&gt;c&lt;/sup&gt;</td>
<td>No</td>
</tr>
<tr>
<td>U-235</td>
<td>ND (0.187)</td>
<td>0.16</td>
<td>No</td>
<td>900&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Yes</td>
</tr>
<tr>
<td>U-238</td>
<td>ND (1.68)</td>
<td>1.4</td>
<td>No</td>
<td>900&lt;sup&gt;c&lt;/sup&gt;</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.

<sup>a</sup>Dinwiddie September 1997, Southwest Supergroup.
<sup>b</sup>NMED March 1998.
<sup>c</sup>Baker and Soldati 1992.

BCF = Bioconcentration factor.
COC = Constituent of concern.
DSS = Drain and Septic Systems.
MDA = Minimum detectable activity.
ND ( ) = Not detected above the MDA, shown in parentheses.
NMED = New Mexico Environment Department.
pCi/g = Picocurie(s) per gram.
SNL/NM = Sandia National Laboratories/New Mexico.
### Table 7
Radiological COCs for Ecological Risk Assessment at DSS Site 1077 with Comparison to the Associated SNL/NM Background Screening Value and BCF

<table>
<thead>
<tr>
<th>COC</th>
<th>Maximum Activity (pCi/g)</th>
<th>SNL/NM Background Activity (pCi/g)</th>
<th>Is Maximum COC Activity Less Than or Equal to the Applicable SNL/NM Background Screening Value?</th>
<th>BCF (maximum aquatic)</th>
<th>Is COC a Bioaccumulator?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cs-137</td>
<td>ND (0.035)</td>
<td>0.079</td>
<td>Yes</td>
<td>3,000</td>
<td>Yes</td>
</tr>
<tr>
<td>Th-232</td>
<td>0.744</td>
<td>1.01</td>
<td>Yes</td>
<td>3,000</td>
<td>No</td>
</tr>
<tr>
<td>U-235</td>
<td>ND (0.187)</td>
<td>0.16</td>
<td>No</td>
<td>900</td>
<td>Yes</td>
</tr>
<tr>
<td>U-238</td>
<td>ND (1.68)</td>
<td>1.4</td>
<td>No</td>
<td>900</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Note: **Bold** indicates COCs that exceed background screening values and/or are bioaccumulators.

aDinwiddie September 1997, Southwest Supergoup.

bNMED March 1998.


BCF = Bioconcentration factor.

COC = Constituent of concern.

DSS = Drain and Septic Systems.

MDA = Minimum detectable activity.

ND ( ) = Not detected above the MDA, shown in parentheses.

NMED = New Mexico Environment Department.

pCi/g = Picocurie(s) per gram.

SNL/NM = Sandia National Laboratories/New Mexico.

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Water at DSS Site 1077 is received as precipitation (approximately 8.1 inches annually [NOAA 1990]). Precipitation will either evaporate at or near the point of contact, infiltrate into the soil, or form runoff. Infiltration at the site is enhanced by the sandy texture of the soil. However, because it is estimated that 95 to 99 percent of the annual precipitation in this area is lost through evapotranspiration, the depth of percolation of this water into the soil is limited and the potential for further downward movement of COCs through leaching is low. Because groundwater at the site is approximately 475 feet bgs, the potential for COCs to reach groundwater through the unsaturated zone above the water table is extremely low.

COCs can enter the food chain through uptake by plant roots. COCs taken up by plant roots can be transported to aboveground tissues where they can be consumed by herbivores, which can in turn be eaten by predators. Once in the food web, COCs can be transported from the site by the movements of the organisms that contain them or other surficial transport mechanisms. However, because DSS Site 1077 occupies only a very small area (less than 1 acre) with limited vegetative cover, food chain transport is expected to be of low significance at this site.

COCs at DSS Site 1077 include both inorganic and organic constituents. The inorganic constituents include both radiological and nonradiological analytes. The nonradiological inorganic COCs are elemental in form and are not considered to be degradable. Transformations of these inorganic constituents could include changes in valence (oxidation/reduction reactions) or incorporation into organic forms (e.g., the conversion of selenite or selenate from soil to seleno-amino acids in plants). Radiological COCs will undergo...
decay to stable isotopes or radioactive daughter elements. However, because of the long half-lives of the radiological COCs, the aridity of the environment at this site, and the lack of potential contact with biota, none of these mechanisms is expected to result in significant losses or transformations of the inorganic COCs.

The organic COCs at DSS Site 1077 may be degraded through photolysis, hydrolysis, and biotransformation. Photolysis requires light, and therefore takes place in the air, at the ground surface, or in surface water. Hydrolysis includes chemical transformations in water, and may occur in the soil solution. Biotransformation (i.e., transformation due to plants, animals, and microorganisms) may occur; however, biological activity may be limited by the aridity of the environment at this site. The two organic COCs (benzene and toluene) may be lost through volatilization, with subsequent degradation in the air.

Table 8 summarizes the fate and transport processes that can occur at DSS Site 1077. COCs at this site include radiological and nonradiological inorganic analytes and organic analytes. For the reasons detailed above, wind, surface water, and biota are considered to be of low significance as potential transport mechanisms at this site. Significant leaching in the subsurface soil is unlikely and leaching into the groundwater at this site is highly unlikely. The potential for transformation of inorganic constituents is low and loss through decay of the radiological COCs is insignificant because of their long half-life. For the organic COCs, loss through volatilization and eventual degradation may be of moderate significance.

Table 8
Summary of Fate and Transport at DSS Site 1077

<table>
<thead>
<tr>
<th>Transport and Fate Mechanism</th>
<th>Existence at Site</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind</td>
<td>Yes</td>
<td>Low</td>
</tr>
<tr>
<td>Surface runoff</td>
<td>Yes</td>
<td>Low</td>
</tr>
<tr>
<td>Migration to groundwater</td>
<td>No</td>
<td>None</td>
</tr>
<tr>
<td>Food chain uptake</td>
<td>Yes</td>
<td>Low</td>
</tr>
<tr>
<td>Transformation/degradation</td>
<td>Yes</td>
<td>Low to moderate</td>
</tr>
</tbody>
</table>

DSS = Drain and Septic Systems.

VI. Human Health Risk Assessment

VI.1 Introduction

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

Step 1. Site data are described that provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.

Step 2. Potential pathways are identified by which a representative population might be exposed to the COCs.
Step 3. The potential intake of these COCs by the representative population is calculated using a tiered approach. The first component of the tiered approach is a screening procedure that compares the maximum concentration of the COC to an SNL/NM maximum background screening value. COCs that are not eliminated during the first screening procedure are carried forward in the risk assessment process.

Step 4. Toxicological parameters are identified and referenced for COCs that were not eliminated during the screening procedure.

Step 5. Potential toxicity effects (specified as a hazard index [HI]) and estimated excess cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction applies only when a radiological COC occurs as contamination and exists as a natural background radionuclide.

Step 6. These values are compared with guidelines established by the U.S. Environmental Protection Agency (EPA), New Mexico Environmental Department (NMED), and DOE to determine whether further evaluation and potential site cleanup are required. Nonradiological COC risk values also are compared to background risk so that an incremental risk can be calculated.

Step 7. Uncertainties of the above steps are addressed.

VI.2 Step 1. Site Data

Section I of this risk assessment provides the site description and history for DSS Site 1077. Section II presents a comparison of results to DQOs. Section III discusses the nature, rate, and extent of contamination.

VI.3 Step 2. Pathway Identification

DSS Site 1077 has been designated with a future land use scenario of industrial (DOE et al. September 1995) (see Appendix 1 for default exposure pathways and parameters). However, the residential land use scenario is also considered within the pathway analysis. Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure is considered to be soil ingestion for the nonradiological COCs and direct gamma exposure for the radiological COCs. The inhalation pathway for both nonradiological and radiological COCs is included because the potential exists to inhale dust and volatiles. Soil ingestion is included for the radiological COCs as well. The dermal pathway is included for the nonradiological COCs because of the potential for the receptor to be exposed to contaminated soil. No water pathways to groundwater are considered. Depth to groundwater at DSS Site 1077 is approximately 475 feet bgs. No intake routes through plant, meat, or milk ingestion are considered appropriate for either the industrial or residential land use scenarios. Figure 1 shows the conceptual site model flow diagram for DSS Site 1077.

### Pathway Identification

<table>
<thead>
<tr>
<th>Nonradiological Constituents</th>
<th>Radiological Constituents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil ingestion</td>
<td>Soil ingestion</td>
</tr>
<tr>
<td>Inhalation (dust and volatiles)</td>
<td>Inhalation (dust)</td>
</tr>
<tr>
<td>Dermal contact</td>
<td>Direct gamma</td>
</tr>
</tbody>
</table>
Figure 1
Conceptual Site Model Flow Diagram for Building 6920 Septic System, DSS Site 1077
VI.4 Step 3. Background Screening Procedure

This section discusses Step 3, the background screening procedure, which compares the maximum COC concentration to the background screening level. The methodology and results are described below.

VI.4.1 Methodology

Maximum concentrations of nonradiological COCs were compared to the approved SNL/NM maximum screening level for this area (Dinwiddie September 1997). The SNL/NM maximum background concentration was selected to provide the background screen in Table 4 and was used to calculate risk attributable to background in Sections VI.6.2 and VI.7. Only the COCs that were detected above their respective SNL/NM maximum background screening levels or did not have either a quantifiable or a calculated background screening level were considered in further risk assessment analyses.

For radiological COCs that exceeded the SNL/NM background screening levels, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1993). Radiological COCs that do not have a background value and were detected above the analytical minimum detectable activity (MDA) were carried through the risk assessment at their maximum levels. The resultant radiological COCs remaining after this step are referred to as background-adjusted radiological COCs.

VI.4.2 Results

Tables 4 and 6 show DSS Site 1077 maximum COC concentrations that were compared to the SNL/NM maximum background values (Dinwiddie September 1997) for the human health risk assessment. For the nonradiological COCs, one constituent was measured at a concentration greater than its respective background screening value. Three constituents did not have quantified background screening concentrations; therefore it is unknown if these COCs exceeded background. Two nonradiological COCs were organic compounds and did not have corresponding background values.

For the radiological COCs, two constituents had MDA values greater than their respective backgrounds (U-235 and U-238). These values were conservatively used in the risk assessment.

VI.5 Step 4. Identification of Toxicological Parameters

Tables 9 and 10 list the COCs retained in the risk assessment and the values for the available toxicological information. The toxicological values used for nonradiological COCs in Table 9 were obtained from the Integrated Risk Information System (IRIS) (EPA 2003), the Health Effects Assessment Summary Tables (HEAST) (EPA 1997a), the EPA Region 6 electronic database (EPA 2002a), and the Technical Background Document for Development of Soil Screening Levels (NMED December 2000). Dose conversion factors (DCF) used in
Table 9
Toxicological Parameter Values for DSS Site 1077 Nonradiological COCs

<table>
<thead>
<tr>
<th>COC</th>
<th>RID&lt;sub&gt;O&lt;/sub&gt; (mg/kg-d)</th>
<th>Confidence&lt;sup&gt;a&lt;/sup&gt;</th>
<th>RfD&lt;sub&gt;lnh&lt;/sub&gt; (mg/kg-d)</th>
<th>Confidence&lt;sup&gt;a&lt;/sup&gt;</th>
<th>SF&lt;sub&gt;O&lt;/sub&gt; (mg/kg-day)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>SF&lt;sub&gt;lnh&lt;/sub&gt; (mg/kg-day)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Cancer Class&lt;sup&gt;b&lt;/sup&gt;</th>
<th>ABS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium III</td>
<td>1.5E+0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chromium VI</td>
<td>3E-3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>L</td>
<td>2.3E-6&lt;sup&gt;d&lt;/sup&gt;</td>
<td>L</td>
<td></td>
<td>4.2E+1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>A</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercury</td>
<td>3E-4&lt;sup&gt;f&lt;/sup&gt;</td>
<td>-</td>
<td>8.6E-5&lt;sup&gt;d&lt;/sup&gt;</td>
<td>M</td>
<td></td>
<td></td>
<td>D</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Selenium</td>
<td>5E-3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Silver</td>
<td>5E-3&lt;sup&gt;d&lt;/sup&gt;</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>D</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>3E-3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
<td>1.7E-3&lt;sup&gt;c&lt;/sup&gt;</td>
<td>-</td>
<td>5.5E-2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.7E-2&lt;sup&gt;d&lt;/sup&gt;</td>
<td>A</td>
<td>0.01&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Toluene</td>
<td>2E-1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>M</td>
<td>1.1E-1&lt;sup&gt;d&lt;/sup&gt;</td>
<td>M</td>
<td></td>
<td></td>
<td>D</td>
<td>0.1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Confidence associated with IRIS (EPA 2003) database values. Confidence: L = low, M = medium, H = high.
<sup>b</sup>EPA weight-of-evidence classification system for carcinogenicity (EPA 1989) taken from IRIS (EPA 2003):

- A = Human carcinogen.
- D = Not classifiable as to human carcinogenicity.
- Cancer Class values from HEAST (EPA 1997a).
- Toxicological parameter values from EPA Region 6 (EPA 2002a).
- Toxicological parameter values from IRIS electronic database (EPA 2003).
- Toxicological parameter values from NMED December 2000.
- Toxicological parameter values from HEAST (EPA 1997a).

ABS = Gastrointestinal adsorption coefficient.
COC = Constituent of concern.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
HEAST = Health Effects Assessment Summary Tables.
IRIS = Integrated Risk Information System.
mg/kg-d = Milligram(s) per kilogram per day.
(mg/kg-day)<sup>†</sup> = Per milligram per kilogram per day.
NMED = New Mexico Environmental Department.
RfD<sub>lnh</sub> = Inhalation chronic reference dose.
RfD<sub>O</sub> = Oral chronic reference dose.
SF<sub>lnh</sub> = Inhalation slope factor.
SF<sub>O</sub> = Oral slope factor.
- = Information not available.
Table 10
Radiological Toxicological Parameter Values for DSS Site 1077 COCs Obtained from RESRAD Risk Coefficients

<table>
<thead>
<tr>
<th>COC</th>
<th>(SF_o) (1/pCi)</th>
<th>(SF_{inh}) (1/pCi)</th>
<th>(SF_{ev}) (g/pCi-yr)</th>
<th>Cancer Class (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-235</td>
<td>4.70E-11</td>
<td>1.30E-08</td>
<td>2.70E-07</td>
<td>A</td>
</tr>
<tr>
<td>U-238</td>
<td>6.20E-11</td>
<td>1.20E-08</td>
<td>6.60E-08</td>
<td>A</td>
</tr>
</tbody>
</table>

\(^a\)Yu et al. 1993a.

\(^b\)EPA weight-of-evidence classification system for carcinogenicity (EPA 1989): A = Human carcinogen for high dose and high dose rate (i.e., greater than 50 rem per year). For low-level environmental exposures, the carcinogenic effect has not been observed and documented.

1/pCi = One per picocurie.
COC = Constituent of concern.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
g/pCi-yr = Gram(s) per picocurie per year.
\(SF_{ev}\) = External volume exposure slope factor.
\(SF_{inh}\) = Inhalation slope factor.
\(SF_o\) = Oral (ingestion) slope factor.

determining the excess TEDE values for radiological COCs for the individual pathways were the default values provided in the RESRAD computer code (Yu et al. 1993a) as developed in the following documents:

- DCFs for ingestion and inhalation were taken from “Federal Guidance Report No. 11, Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion” (EPA 1988).
- DCFs for surface contamination were taken from DOE/EH-0070, “External Dose-Rate Conversion Factors for Calculation of Dose to the Public” (DOE 1988).
- DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in “Dose-Rate Conversion Factors for External Exposure to Photon Emitters in Soil” (Kocher 1983) and in ANL/EAIS-8, “Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil” (Yu et al. 1993b).

VI.6 Step 5. Exposure Assessment and Risk Characterization

Section VI.6.1 describes the exposure assessment for this risk assessment. Section VI.6.2 provides the risk characterization, including the HI and excess cancer risk for both the potential nonradiological COCs and associated background for industrial and residential land use scenarios. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs for both industrial and residential land use scenarios.
Appendix 1 provides the equations and parameter input values used in calculating intake values and subsequent HI and excess cancer risk values for the individual exposure pathways. The appendix shows parameters for both industrial and residential land use scenarios. The equations for nonradiological COCs are based upon the Risk Assessment Guidance for Superfund (RAGS) (EPA 1989). Parameters are based upon information from the RAGS (EPA 1989), the Technical Background Document for Development of Soil Screening Levels (NMED December 2000), and other EPA and NMED guidance documents and reflect the reasonable maximum exposure (RME) approach advocated by the RAGS (EPA 1989). For radiological COCs, the coded equations provided in RESRAD computer code are used to estimate the incremental TEDE and cancer risk for individual exposure pathways. Further discussion of this process is provided in the "Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD" (Yu et al. 1993a).

Although the designated land use scenario for this site is industrial, risk and TEDE values for a residential land use scenario are also presented.

Table 11 shows an HI of 0.06 for the DSS Site 1077 nonradiological COCs and an estimated excess cancer risk of 8E-7 for the designated industrial land use scenario. The numbers presented included exposure from soil ingestion, dermal contact, and dust and volatile inhalation for nonradiological COCs. Table 12 shows an HI of 0.00 and no quantifiable estimated excess cancer risk for the designated industrial land use scenario.

For the radiological COCs, contribution from the direct gamma exposure pathway is included. For the industrial land use scenario, a TEDE was calculated for an individual on the site, which resulted in an incremental TEDE of 1.2E-2 millirem (mrem)/year (yr). In accordance with EPA guidance found in Office of Solid Waste and Emergency Response (OSWER) Directive No. 9200.4-18 (EPA 1997b), an incremental TEDE of 15 mrem/yr is used for the probable land use scenario (industrial in this case); the calculated dose value for DSS Site 1077 for the industrial land use is well below this guideline. The estimated excess cancer risk is 1.2E-7.

For the residential land use scenario nonradiological COCs, the HI is 0.25 and the excess cancer risk is 2E-6 (Table 11). The numbers in the table include exposure from soil ingestion, dermal contact, and dust and volatile inhalation. Although the EPA (1991) generally recommends that inhalation not be included in a residential land use scenario, this pathway is included because of the potential for soil in Albuquerque, New Mexico, to be eroded and, subsequently, for dust to be present in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Appendix 1). Table 12 shows that for the DSS Site 1077 associated background constituents, the HI is 0.00 and there is no quantifiable estimated excess cancer risk.

For the radiological COCs, the incremental TEDE for the residential land use scenario is 3.0E-2 mrem/yr. The guideline being used is an excess TEDE of 75 mrem/yr (SNL/NM February 1998) for a complete loss of institutional controls (residential land use in this case); the calculated dose value for DSS Site 1077 for the residential land use scenario is well below this guideline. Consequently, DSS Site 1077 is eligible for unrestricted radiological release as
### Table 11
Risk Assessment Values for DSS Site 1077 Nonradiological COCs

<table>
<thead>
<tr>
<th>COC</th>
<th>Maximum Concentration (mg/kg)</th>
<th>Industrial Land Use Scenario&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Residential Land Use Scenario&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hazard Index</td>
<td>Cancer Risk</td>
</tr>
<tr>
<td><strong>Inorganic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium, total&lt;sup&gt;b&lt;/sup&gt;</td>
<td>20</td>
<td>0.01</td>
<td>4E-8</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.0225&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.00</td>
<td>–</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.45</td>
<td>0.00</td>
<td>–</td>
</tr>
<tr>
<td>Silver</td>
<td>0.0225&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.00</td>
<td>–</td>
</tr>
<tr>
<td><strong>Organic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>1.1 J</td>
<td>0.05</td>
<td>8E-7</td>
</tr>
<tr>
<td>Toluene</td>
<td>6.4</td>
<td>0.00</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.06</td>
<td>8E-7</td>
</tr>
</tbody>
</table>

<sup>a</sup>EPA 1989.
<sup>b</sup>Chromium, total assumed to be chromium VI (most conservative).
<sup>c</sup>Maximum concentration was one-half the detection limit.

COC = Constituent of concern.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
J = Concentration is an estimate.
mg/kg = Milligram(s) per kilogram.
- = Information not available.

### Table 12
Risk Assessment Values for DSS Site 1077 Nonradiological Background Constituents

<table>
<thead>
<tr>
<th>COC</th>
<th>Background Concentration&lt;sup&gt;a&lt;/sup&gt; (mg/kg)</th>
<th>Industrial Land Use Scenario&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Residential Land Use Scenario&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Hazard Index</td>
<td>Cancer Risk</td>
</tr>
<tr>
<td>Chromium, total&lt;sup&gt;c&lt;/sup&gt;</td>
<td>15.9</td>
<td>0.00</td>
<td>–</td>
</tr>
<tr>
<td>Mercury</td>
<td>&lt;0.1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Selenium</td>
<td>&lt;1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Silver</td>
<td>&lt;1</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.00</td>
<td>–</td>
</tr>
</tbody>
</table>

<sup>a</sup>Dinwiddie September 1997, Southwest Supergroup.
<sup>b</sup>EPA 1989.
<sup>c</sup>Chromium, total assumed to be chromium III (most conservative).
COC = Constituent of concern.
DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
mg/kg = Milligram(s) per kilogram.
- = Information not available.
the residential land use scenario resulted in an incremental TEDE of less than 75 mrem/yr to the on-site receptor. The estimated excess cancer risk is 3.5E-7. The excess cancer risk from the nonradiological COCs and the radiological COCs should be summed to provide risk estimates for persons exposed to both types of carcinogenic contaminants, as noted in OSWER Directive No. 9200-4-18 “Establishment of Cleanup Levels for CERCLA [Comprehensive Environmental Response, Compensation, and Liability Act] Sites with Radioactive Contamination” (EPA 1997b). This summation is tabulated in Section VI.9, “Summary.”

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

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

For the nonradiological COCs under the industrial land use scenario, the HI is 0.06, which is lower than the numerical guideline of 1 suggested in the RAGS (EPA 1989). The estimated excess cancer risk is 8E-7. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is below the suggested acceptable risk value. This assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and the residential land use scenarios. Assuming the industrial land use scenario, for nonradiological COCs the HI is 0.00 and there is no quantifiable excess cancer risk. Incremental risk is determined by subtracting risk associated with background from potential COC risk. These numbers are not rounded before the difference is determined and, therefore, may appear to be inconsistent with numbers presented in tables and within the text. For conservatism, the background constituents that do not have quantified background screening concentrations are assumed to have a hazard quotient (HQ) of 0.00. Incremental HI is 0.06, and the estimated incremental cancer risk is 8.40E-7 for the industrial land use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs under an industrial land use scenario.

For radiological COCs under the industrial land use scenario, incremental TEDE is 1.2E-2 mrem/yr, which is significantly lower than the EPA’s numerical guideline of 15 mrem/yr. Incremental estimated excess cancer risk is 1.2E-7.

The calculated HI for the nonradiological COCs under the residential land use scenario is 0.25, which is below numerical guidance. The estimated excess cancer risk is 2E-6. NMED guidance states that cumulative excess lifetime cancer risk must be less than 1E-5 (Bearzi January 2001), thus the excess cancer risk for this site is below the suggested acceptable risk value. For background concentrations of the nonradiological COCs, the HI is 0.00 and there is no quantifiable excess cancer risk. The incremental HI is 0.25 and the estimated incremental cancer risk is 2.09E-6 for the residential land use scenario. These incremental risk calculations indicate insignificant risk to human health from nonradiological COCs considering a residential land use scenario.

The incremental TEDE for a residential land use scenario from the radiological components is 3.0E-2 mrem/yr, which is significantly lower than the numerical guideline of 75 mrem/yr.
suggested in the SNL/NM RESRAD Input Parameter Assumptions and Justification (SNL/NM February 1998). The estimated excess cancer risk is 3.5E-7.

VI.8 Step 7. Uncertainty Discussion

The determination of the nature, rate, and extent of contamination at DSS Site 1077 was based upon an initial conceptual site model that was validated with baseline sampling conducted at the site. The baseline sampling was conducted in accordance with established procedures that were being used to investigate SNL/NM DSS sites at that time. The data from soil samples collected at effluent release point are representative of potential COC releases to the site. The analytical requirements and results satisfy the DQOs, and data quality was verified/validated in accordance with SNL/NM procedures. Therefore, there is no uncertainty associated with the data quality used to perform the risk screening assessment at DSS Site 1077.

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

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

Table 9 shows the uncertainties in nonradiological toxicological parameter values. There is a mixture of estimated values and values from the IRIS (EPA 2003), HEAST (EPA 1997a), EPA Region 6 (EPA 2002a), and Technical Background Document for Development of Soil Screening Levels (NMED December 2000). Where values are not provided, information is not available from the HEAST (EPA 1997a), IRIS (EPA 2003), Technical Background Document for Development of Soil Screening Levels (NMED December 2000), Risk Assessment Information System (ORNL 2003), or EPA regions (EPA 2002a, EPA 2002b, EPA 2002c). Because of the conservative nature of the RME approach, uncertainties in toxicological values are not expected to change the conclusion from the risk assessment analysis.

Risk assessment values for nonradiological COCs are within the acceptable range for human health under both the industrial and residential land use scenarios in established numerical guidance.

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

The overall uncertainty in all of the steps in the risk assessment process is not considered to be significant with respect to the conclusion reached.
VI.9 Summary

DSS Site 1077 contains identified COCs consisting of some inorganic, organic, and radiological compounds. Because of the location of the site, the designated industrial land use scenario, and the nature of contamination, potential exposure pathways identified for this site included soil ingestion, dermal contact, and dust and volatile inhalation for chemical COCs and soil ingestion, dust inhalation, and direct gamma exposure for radionuclides. The same exposure pathways were applied to the residential land use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs show that for the industrial land use scenario the HI (0.06) is significantly lower than the accepted numerical guidance from the EPA. The estimated excess cancer risk is 8E-7; thus, excess cancer risk is also below the acceptable risk value provided by the NMED for an industrial land use scenario (Bearzi January 2001). The incremental HI is 0.06, and the estimated incremental excess cancer risk is 8.40E-7 for the industrial land use scenario. Incremental risk calculations indicate insignificant risk to human health for the industrial land use scenario.

Using conservative assumptions and an RME approach to risk assessment, calculations for nonradiological COCs show that for the residential land use scenario the HI (0.25) is also below the accepted numerical guidance from the EPA. The estimated excess cancer risk is 2E-6. Thus, excess cancer risk is also below the acceptable risk value provided by the NMED for a residential land use scenario (Bearzi January 2001). The incremental HI is 0.25, and the estimated incremental excess cancer risk is 2.09E-6 for the residential land use scenario. Incremental risk calculations indicate insignificant risk to human health for the residential land use scenario.

Incremental TEDE and corresponding estimated cancer risk from radiological COCs are much lower than EPA guidance values; the estimated TEDE is 1.2E-2 mrem/yr for the industrial land use scenario. This value is much lower than the EPA’s numerical guidance of 15 mrem/yr (EPA 1997b). The corresponding incremental estimated cancer risk value is 1.2E-7 for the industrial land use scenario. Furthermore, the incremental TEDE for the residential land use scenario that results from a complete loss of institutional control is 3.0E-2 mrem/yr with an associated risk of 3.5E-7. The guideline for this scenario is 75 mrem/yr (SNL/NM February 1998). Therefore, DSS Site 1077 is eligible for unrestricted radiological release.

The summation of the nonradiological and radiological carcinogenic risks are tabulated in Table 13.

<table>
<thead>
<tr>
<th>Table 13</th>
<th>Summation of Radiological and Nonradiological Risks from Site Carcinogens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenario</td>
<td>Nonradiological Risk</td>
</tr>
<tr>
<td>Industrial</td>
<td>8.4E-7</td>
</tr>
<tr>
<td>Residential</td>
<td>2.1E-6</td>
</tr>
</tbody>
</table>
Uncertainties associated with the calculations are considered small relative to the conservatism of risk assessment analysis. Therefore, it is concluded that this site poses insignificant risk to human health under both the industrial and residential land use scenarios.

VII. Ecological Risk Assessment

VII.1 Introduction

This section addresses the ecological risks associated with exposure to constituents of potential ecological concern (COPECs) in soils at DSS Site 1077. A component of the NMED Risk-Based Decision Tree (NMED March 1998) is to conduct an ecological assessment that corresponds with that presented in the EPA’s Ecological RAGS (EPA 1997c). The current methodology is tiered and contains an initial scoping assessment followed by a more detailed risk assessment. Initial components of the NMED’s decision tree (a discussion of DQOs, data assessment, and evaluations of bioaccumulation as well as fate and transport potential) are addressed in previous sections of this report. Following the completion of the scoping assessment, a determination is made as to whether a more detailed examination of potential ecological risk is necessary. If deemed necessary, the scoping assessment proceeds to a risk assessment whereby a more quantitative estimate of ecological risk is conducted. Although this assessment incorporates conservatisms in the estimation of ecological risks, ecological relevance and professional judgment are also used as recommended by the EPA (1998) to ensure that predicted exposures of selected ecological receptors reflect those reasonably expected to occur at the site.

VII.2 Scoping Assessment

The scoping assessment focuses primarily on the likelihood of exposure of biota at or adjacent to the site to constituents associated with site activities. Included in this section are an evaluation of existing data and a comparison of maximum detected concentrations to background concentrations, examination of bioaccumulation potential, and fate and transport potential. A scoping risk management decision (Section VII.2.4) involves summarizing the scoping results and determining whether further examination of potential ecological impacts is necessary.

VII.2.1 Data Assessment

As indicated in Section IV (Tables 5 and 7), inorganic constituents in soil within the 0- to 5-foot depth interval that exceeded background concentrations were as follows:

- Total chromium
- Mercury
- Selenium
- Silver
- U-235
- U-238
Organic analytes detected in soil were as follows:

- Benzene
- Toluene

VII.2.2 Bioaccumulation

Among the COPECs listed in Section VII.2.1, the following were considered to have bioaccumulation potential in aquatic environments (Section IV, Tables 5 and 7):

- Mercury
- Selenium
- Silver
- U-235
- U-238

It should be noted, however, that as directed by the NMED (NMED March 1998), bioaccumulation for inorganic compounds is assessed exclusively based upon maximum reported bioconcentration factors (BCF) for aquatic species. Because only aquatic BCFs are used to evaluate the bioaccumulation potential for metals, bioaccumulation in terrestrial species is likely to be overpredicted.

VII.2.3 Fate and Transport Potential

The potential for the COPECs to move from the source of contamination to other media or biota is discussed in Section V. As noted in Table 8 (Section V), wind, surface water, and biota are expected to be of low significance as transport mechanisms for COPECs at this site. Migration to groundwater is not anticipated. Degradation (decay) and transformation for the inorganic COPECs and radionuclides is expected to be of low significance, but may be of moderate significance for the organic COPECs.

VII.2.4 Scoping Risk-Management Decision

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

VII.3 Risk Assessment

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

- Problem Formulation—sets the stage for the evaluation of potential exposure and risk.
- Exposure Estimation—provides a quantitative estimate of potential exposure.
- Ecological Effects Evaluation—presents benchmarks used to gauge the toxicity of COPECs to specific receptors.
- Risk Characterization—characterizes the ecological risk associated with exposure of the receptors to environmental media at the site.
- Uncertainty Assessment—discusses uncertainties associated with the estimation of exposure and risk.
- Risk Interpretation—evaluates ecological risk in terms of HQs and ecological significance.
- Risk Assessment Scientific/Management Decision Point—presents the decision to risk managers based upon the results of the ecological risk assessment.

VII.3.1 Problem Formulation

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

VII.3.1.1 Ecological Pathways and Setting

DSS Site 1077 is less than 1 acre in size. The site is located in an area dominated by grassland habitat; however, the original vegetation has been highly disturbed by site use. The site is open to use by wildlife. No threatened or endangered species are known to occur at this site (IT February 1995) and no surface-water bodies, seeps, or springs are associated with the site.

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

VII.3.1.2 COPECs

Discharges of waste water from Building 6920 to the septic system and drainfield were the primary sources of COPECs at DSS Site 1077. Inorganic and organic COPECs identified for this site are listed in Section VII.2.1. The inorganic COPECs include both radiological and nonradiological analytes. The inorganic analytes were screened against background concentrations, and those that exceeded the approved SNL/NM background screening levels (Dinwiddie September 1997) for the area were considered to be COPECs. Nonradiological inorganic constituents that are essential nutrients, such as iron, magnesium, calcium, potassium, and sodium, were not included in this risk assessment as set forth by the EPA (1989). All organic analytes detected within the upper 5 feet of soil were considered to be COPECs for the site. In order to provide conservatism, this ecological risk assessment was based upon the maximum soil concentrations of the COPECs measured in the upper 5 feet of soil at this site. Tables 5 and 7 present maximum concentrations for the COPECs.

VII.3.1.3 Ecological Receptors

As described in detail in "Predictive Ecological Risk Assessment Methodology, Environmental Restoration Program, Sandia National Laboratories, New Mexico" (IT July 1998), a nonspecific perennial plant was selected as the receptor to represent plant species at the site. Vascular plants are the principal primary producers at the site and are key to the diversity and productivity of the wildlife community associated with the site. The deer mouse (Peromyscus maniculatus) and the burrowing owl (Speotyto cunicularia) were used to represent wildlife use. Because of its opportunistic food habits, the deer mouse was used to represent a mammalian herbivore, omnivore, and insectivore. The burrowing owl was selected to represent a top predator at this site. The burrowing owl is present at SNL/NM and is designated a species of management concern by the U.S. Fish and Wildlife Service in Region 2, which includes the state of New Mexico (USFWS September 1995).

VII.3.2 Exposure Estimation

For nonradiological COPECs, direct uptake from the soil was considered the only significant route of exposure for terrestrial plants. Exposure modeling for the wildlife receptors was limited to food and soil ingestion pathways. Inhalation and dermal contact were considered insignificant pathways with respect to ingestion (Sample and Suter 1994). Drinking water was also considered an insignificant pathway because of the lack of surface water at this site. The deer mouse was modeled under three dietary regimes: as an herbivore (100 percent of its diet as plant material), as an omnivore (50 percent of its diet as plants and 50 percent as soil invertebrates), and as an insectivore (100 percent of its diet as soil invertebrates). The burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Because the exposure in the burrowing owl from a diet consisting of equal parts of herbivorous, omnivorous, and insectivorous mice would be equivalent to the exposure consisting of only omnivorous mice, the diet of the burrowing owl was modeled with intake of omnivorous mice only. Both species were modeled with soil ingestion comprising 2 percent of
total dietary intake. Table 14 presents the species-specific factors used in modeling exposures in the wildlife receptors. Justification for use of the factors presented in this table is described in the ecological risk assessment methodology document (IT July 1998).

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

For the radiological dose rate calculations, the deer mouse was modeled as an herbivore (100 percent of its diet as plants), and the burrowing owl was modeled as a strict predator on small mammals (100 percent of its diet as deer mice). Both were modeled with soil ingestion comprising 2 percent of total dietary intake. Receptors are exposed to radiation both internally and externally from U-235 and U-238. Internal and external dose rates to the deer mouse and the burrowing owl are approximated using modified dose-rate models from the DOE (1995) as presented in the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998). Radionuclide-dependent data for the dose-rate calculations were obtained from Baker and Soldat (1992). The external dose-rate model examines the total body dose rate to a receptor residing in soil exposed to radionuclides. The soil surrounding the receptor is assumed to be an infinite medium uniformly contaminated with gamma-emitting radionuclides. The external dose-rate model is the same for both the deer mouse and the burrowing owl. The internal total body dose-rate model assumes that a fraction of the radionuclide concentration ingested by a receptor is absorbed by the body and concentrated at the center of a spherical body shape. This provides for a conservative estimate for absorbed dose. This concentrated radiation source at the center of the body of the receptor is assumed to be a “point” source. Radiation emitted from this point source is absorbed by the body tissues to contribute to the absorbed dose. Alpha and beta emitters are assumed to transfer 100 percent of their energy to the receptor as they pass through tissues. Gamma-emitting radionuclides only transfer a fraction of their energy to the tissues because gamma rays interact less with matter than alpha or beta emitters. The external and internal dose-rate results are summed to calculate a total dose rate from exposure to U-235 and U-238 in soil.

Table 15 presents the transfer factors used in modeling the concentrations of COPECs through the food chain. Table 16 presents maximum concentrations in soil and derived concentrations in tissues of the various food chain elements that are used to model dietary exposures for each of the wildlife receptors.

VII.3.3 Ecological Effects Evaluation

Table 17 shows benchmark toxicity values for the plant and wildlife receptors. For plants, the benchmark soil concentrations are based upon the lowest-observed-adverse-effect level (LOAEL). For wildlife, the toxicity benchmarks are based upon the no-observed-adverse-effect level (NOAEL) for chronic oral exposure in a taxonomically similar test species. Insufficient toxicity information was found to estimate the LOAELs or NOAELs for some COPECs.

The benchmark used for exposure of terrestrial receptors to radiation was 0.1 rad/day. This value has been recommended by the International Atomic Energy Agency (IAEA 1992) for the protection of terrestrial populations. Because plants and insects are less sensitive to radiation
Table 14
Exposure Factors for Ecological Receptors at DSS Site 1077

<table>
<thead>
<tr>
<th>Receptor Species</th>
<th>Class/Order</th>
<th>Trophic Level</th>
<th>Body Weight (kg)</th>
<th>Food Intake Rate (kg/day)</th>
<th>Dietary Composition</th>
<th>Home Range (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deer Mouse (Peromyscus maniculatus)</td>
<td>Mammalia/</td>
<td>Herbivore</td>
<td>2.39E-2d</td>
<td>3.72E-3</td>
<td>Plants: 100%</td>
<td>2.7E-1e</td>
</tr>
<tr>
<td></td>
<td>Rodentia</td>
<td></td>
<td></td>
<td></td>
<td>(+ Soil at 2% of intake)</td>
<td></td>
</tr>
<tr>
<td>Deer Mouse (Peromyscus maniculatus)</td>
<td>Mammalia/</td>
<td>Omnivore</td>
<td>2.39E-2d</td>
<td>3.72E-3</td>
<td>Plants: 50%</td>
<td>2.7E-1e</td>
</tr>
<tr>
<td></td>
<td>Rodentia</td>
<td></td>
<td></td>
<td></td>
<td>Invertebrates: 50%</td>
<td>(+ Soil at 2% of intake)</td>
</tr>
<tr>
<td>Deer Mouse (Peromyscus maniculatus)</td>
<td>Mammalia/</td>
<td>Insectivore</td>
<td>2.39E-2d</td>
<td>3.72E-3</td>
<td>Invertebrates: 100%</td>
<td>2.7E-1e</td>
</tr>
<tr>
<td></td>
<td>Rodentia</td>
<td></td>
<td></td>
<td></td>
<td>(+ Soil at 2% of intake)</td>
<td></td>
</tr>
<tr>
<td>Burrowing owl (Speotyto cunicularia)</td>
<td>Aves/</td>
<td>Carnivore</td>
<td>1.55E-1f</td>
<td>1.73E-2</td>
<td>Rodents: 100%</td>
<td>3.5E+1g</td>
</tr>
<tr>
<td></td>
<td>Strigiformes</td>
<td></td>
<td></td>
<td></td>
<td>(+ Soil at 2% of intake)</td>
<td></td>
</tr>
</tbody>
</table>

- Body weights are in kg wet weight.
- Food intake rates are estimated from the allometric equations presented in Nagy (1987). Units are kg dry weight per day.
- Dietary compositions are generalized for modeling purposes. Default soil intake value of 2% of food intake.
- Silva and Downing 1995.
- EPA 1993, based upon the average home range measured in semiarid shrubland in Idaho.
- Dunning 1993.

DSS = Drain and Septic Systems.
EPA = U.S. Environmental Protection Agency.
kg = Kilogram(s).
Table 15
Transfer Factors Used in Exposure Models for COPECs at DSS Site 1077

<table>
<thead>
<tr>
<th>COPEC</th>
<th>Soil-to-Plant Transfer Factor</th>
<th>Soil-to-Invertebrate Transfer Factor</th>
<th>Food-to-Muscle Transfer Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chromium, total</td>
<td>4.0E-2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.3E-1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.0E-2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mercury, total</td>
<td>1.0E+0&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.0E+0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.5E-1&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Selenium</td>
<td>5.0E-1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.0E+0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.0E-1&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Silver</td>
<td>1.0E+0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.5E-1&lt;sup&gt;e&lt;/sup&gt;</td>
<td>5.0E-3&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Organic&lt;sup&gt;f&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>2.3E+0</td>
<td>1.7E+1</td>
<td>2.9E-6</td>
</tr>
<tr>
<td>Toluene</td>
<td>1.0E+0</td>
<td>1.8E+1</td>
<td>1.3E-5</td>
</tr>
</tbody>
</table>

<sup>a</sup>NCRP January 1989.
<sup>b</sup>Ma 1982.
<sup>c</sup>Default value.
<sup>d</sup>Baes et al. 1984.
<sup>e</sup>Stafford et al. 1991.
<sup>f</sup>Soil-to-plant and food-to-muscle transfer factors from equations developed in Travis and Arms (1988).
Soil-to-invertebrate transfer factors from equations developed in Cornell and Markwell (1990). All three equations based upon relationship of the transfer factor to the Log K<sub>ow</sub> value of compound.

COPEC = Constituents of potential ecological concern.
DSS = Drain and Septic Systems.
K<sub>ow</sub> = Octanol-water partition coefficient.
Log = Logarithm (base 10).
NCRP = National Council on Radiation Protection and Measurements.
Table 16
Media Concentrations\(^a\) for COPECs at DSS Site 1077

<table>
<thead>
<tr>
<th>COPEC</th>
<th>Soil (maximum)(^a)</th>
<th>Plant Foliage(^b)</th>
<th>Soil Invertebrate(^b)</th>
<th>Deer Mouse Tissues(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium, total</td>
<td>2.0E+1</td>
<td>8.0E-1</td>
<td>2.6E+0</td>
<td>2.0E-1</td>
</tr>
<tr>
<td>Mercury</td>
<td>2.3E-2(^d)</td>
<td>2.3E-2</td>
<td>2.3E-2</td>
<td>1.8E-2</td>
</tr>
<tr>
<td>Selenium</td>
<td>4.0E-1(^e)</td>
<td>2.0E-1</td>
<td>4.0E-1</td>
<td>9.6E-2</td>
</tr>
<tr>
<td>Silver</td>
<td>2.3E-2(^d)</td>
<td>2.3E-2</td>
<td>5.6E-3</td>
<td>2.3E-4</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>1.1E+0(^e)</td>
<td>2.5E+0</td>
<td>1.8E+1</td>
<td>9.6E-5</td>
</tr>
<tr>
<td>Toluene</td>
<td>6.4E+0</td>
<td>6.4E+0</td>
<td>1.2E+2</td>
<td>2.4E-3</td>
</tr>
</tbody>
</table>

\(^a\)In milligrams per kilogram. All biotic media are based upon dry weight of the media. Soil concentration measurements are assumed to have been based upon dry weight. Values have been rounded to two significant digits after calculation.

\(^b\)Product of the soil concentration and the corresponding transfer factor.

\(^c\)Based upon the deer mouse with an omnivorous diet. Product of the average concentration ingested in food and soil times the food-to-muscle transfer factor times a wet weight-dry weight conversion factor of 3.125 (EPA 1993).

\(^d\)Maximum concentration of parameter was one-half the detection limit.

\(^e\)Estimated value.

COPEC = Constituent of potential ecological concern.
DSS = Drain and Septic Systems.
## Table 17
Toxicity Benchmarks for Ecological Receptors at DSS Site 1077

<table>
<thead>
<tr>
<th>COPEC</th>
<th>Mammalian NOAELS</th>
<th>Avian NOAELS</th>
<th>Burrowing Owl NOAEL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant Benchmark&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>Mammalian Test Species&lt;sup&gt;c,d&lt;/sup&gt;</td>
<td>Test Species NOAEL&lt;sup&gt;d,e&lt;/sup&gt;</td>
</tr>
<tr>
<td>Inorganic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium, total</td>
<td>1</td>
<td>Rat</td>
<td>2.737</td>
</tr>
<tr>
<td>Mercury, organic</td>
<td>0.3</td>
<td>Rat</td>
<td>0.03</td>
</tr>
<tr>
<td>Mercury, inorganic</td>
<td>0.3</td>
<td>Mouse</td>
<td>13.2</td>
</tr>
<tr>
<td>Selenium</td>
<td>1</td>
<td>Rat</td>
<td>0.2</td>
</tr>
<tr>
<td>Silver</td>
<td>2</td>
<td>Rat</td>
<td>17.8&lt;sup&gt;h&lt;/sup&gt;</td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>-</td>
<td>Mouse</td>
<td>26.4</td>
</tr>
<tr>
<td>Toluene</td>
<td>200</td>
<td>Mouse</td>
<td>26</td>
</tr>
</tbody>
</table>

<sup>a</sup>In mg/kg soil dry weight.
<sup>b</sup>Efroymson et al. 1997.
<sup>c</sup>Body weights (in kg) for the NOAEL conversion are as follows: lab mouse, 0.030; lab rat, 0.350.
<sup>d</sup>Sample et al. 1996, except where noted.
<sup>e</sup>In mg/kg body weight per day.
<sup>f</sup>Based upon NOAEL conversion methodology presented in Sample et al. 1996, using a deer mouse body weight of 0.0239 kg and a mammalian scaling factor of 0.25.
<sup>g</sup>Based upon NOAEL conversion methodology presented in Sample et al. 1996. The avian scaling factor of 0.0 was used, making the NOAEL independent of body weight.
<sup>h</sup>Based upon a rat LOAEL of 89 mg/kg-d (EPA 2003) and an uncertainty factor of 0.2.

**COPEC** = Constituent of potential ecological concern.
**DSS** = Drain and Septic Systems.
**kg** = Kilogram(s).
**LOAEL** = Lowest-observed-adverse-effect level.
**mg** = Milligram(s).
**mg/kg-d** = Milligram(s) per kilogram per day.
**NOAEL** = No-observed-adverse-effect level.
**-** = Insufficient toxicity data.
than vertebrates (Whicker and Schultz 1982), the dose of 0.1 rad/day should also offer sufficient protection to other components within the terrestrial habitat of DSS Site 1077.

VII.3.4 Risk Characterization

Maximum concentrations in soil and estimated dietary exposures were compared to plant and wildlife benchmark values, respectively. Table 18 presents results of these comparisons. HQs are used to quantify the comparison with benchmarks for plants and wildlife exposure.

The only HQ that exceeded unity at DSS Site 1077 was for plant exposure to total chromium. Because of a lack of sufficient toxicity information, an HQ for plants could not be determined for benzene. Similarly for the burrowing owl, HQs could not be determined for silver, benzene and toluene. As directed by the NMED, HIs were calculated for each of the receptors (the HI is the sum of chemical-specific HQs for all pathways for a given receptor). Only plants showed an HI greater than unity (HI = 21).

Tables 19 and 20 summarize the internal and external dose rate model results for U-235 and U-238 for the deer mouse ad burrowing owl, respectively. The total radiation dose rate to the deer mouse was predicted to be 2.8E-4 rad/day and that for the burrowing owl was 2.7E-4 rad/day. The dose rates for the deer mouse and the burrowing owl are less than the benchmark of 0.1 rad/day.

VII.3.5 Uncertainty Assessment

Many uncertainties are associated with the characterization of ecological risks at DSS Site 1077. These uncertainties result from assumptions used in calculating risk that could overestimate or underestimate true risk presented at a site. For this risk assessment, assumptions are made that are more likely to overestimate exposures and risk rather than underestimate them. These conservative assumptions are used to be more protective of the ecological resources potentially affected by the site. Conservatisms incorporated into this risk assessment include the use of maximum measured analyte concentrations in soil to evaluate risk, the use of wildlife toxicity benchmarks based upon NOAEL values, and the incorporation of strict herbivorous and strict insectivorous diets for predicting the extreme HO values for the deer mouse. Each of these uncertainties, which are consistent among each of the site-specific ecological risk assessments, is discussed in greater detail in the uncertainty section of the ecological risk assessment methodology document for the SNL/NM ER Project (IT July 1998).

Uncertainties associated with the estimation of risk to ecological receptors following exposure to U-235 and U-238 are primarily related to those inherent in the radionuclide-specific data. Radionuclide-dependent data are measured values that have their associated errors. The dose rate models used for these calculations are based upon conservative estimates on receptor shape, radiation absorption by body tissues, and intake parameters. The goal is to provide a realistic but conservative estimate of a receptor's internal and external exposure to radionuclides in soil. It should also be noted that neither of the radiological COPECs at this site was detected, and all are represented in the dose models by their maximum detection limit.

In the estimation of ecological risk, background concentrations are included as a component of maximum on-site concentrations. Conservatisms in the modeling of exposure and risk can
Table 18
HQs for Ecological Receptors at DSS Site 1077

<table>
<thead>
<tr>
<th>COPEC</th>
<th>Plant HQ&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Deer Mouse HQ (Herbivorous)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Deer Mouse HQ (Omnivorous)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Deer Mouse HQ (Insectivorous)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Burrowing Owl HQ&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inorganic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium, total</td>
<td>2.0E+01</td>
<td>3.5E-05</td>
<td>6.1E-05</td>
<td>8.7E-05</td>
<td>6.7E-02</td>
</tr>
<tr>
<td>Mercury, organic</td>
<td>7.5E-02</td>
<td>5.7E-02</td>
<td>5.7E-02</td>
<td>5.7E-02</td>
<td>3.2E-01</td>
</tr>
<tr>
<td>Mercury, inorganic</td>
<td>7.5E-02</td>
<td>2.6E-04</td>
<td>2.8E-04</td>
<td>2.6E-04</td>
<td>4.6E-03</td>
</tr>
<tr>
<td>Selenium</td>
<td>4.0E-01</td>
<td>8.3E-02</td>
<td>1.2E-01</td>
<td>1.6E-01</td>
<td>2.6E-02</td>
</tr>
<tr>
<td>Silver</td>
<td>1.1E-02</td>
<td>1.0E-04</td>
<td>6.5E-05</td>
<td>2.7E-05</td>
<td></td>
</tr>
<tr>
<td>Organic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benzene</td>
<td>–</td>
<td>1.4E-02</td>
<td>5.9E-02</td>
<td>1.0E-01</td>
<td>–</td>
</tr>
<tr>
<td>Toluene</td>
<td>3.2E-02</td>
<td>3.7E-02</td>
<td>3.5E-01</td>
<td>6.5E-01</td>
<td>–</td>
</tr>
<tr>
<td>H&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2.1E+01</td>
<td>1.9E-01</td>
<td>5.8E-01</td>
<td>9.8E-01</td>
<td>4.1E-01</td>
</tr>
</tbody>
</table>

<sup>a</sup>Bold text indicates HQ or HI exceeds unity.

<sup>b</sup>The HI is the sum of individual HQs.

COPEC = Constituent of potential ecological concern.
DSS = Drain and Septic Systems.
HI = Hazard index.
HQ = Hazard quotient.
- = Insufficient toxicity data available for risk estimation purposes.
Table 19
Total Dose Rates for Deer Mice Exposed to Radionuclides at DSS Site 1077

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Maximum Concentration (pCi/g)</th>
<th>Total Dose (rad/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-235</td>
<td>ND (0.187)</td>
<td>2.7E-4</td>
</tr>
<tr>
<td>U-238</td>
<td>ND (1.68)</td>
<td>5.1E-6</td>
</tr>
<tr>
<td>Total Dose</td>
<td></td>
<td>2.8E-4</td>
</tr>
</tbody>
</table>

DSS = Drain and Septic Systems.
MDA = Minimum detectable activity.
ND ( ) = Not detected above the MDA, shown in parentheses.
pCi/g = Picocurie(s) per gram.

Table 20
Total Dose Rates for Burrowing Owls Exposed to Radionuclides at DSS Site 1077

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Maximum Concentration (pCi/g)</th>
<th>Total Dose (rad/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-235</td>
<td>ND (0.187)</td>
<td>2.6E-4</td>
</tr>
<tr>
<td>U-238</td>
<td>ND (1.68)</td>
<td>3.9E-6</td>
</tr>
<tr>
<td>Total Dose</td>
<td></td>
<td>2.7E-4</td>
</tr>
</tbody>
</table>

DSS = Drain and Septic Systems.
MDA = Minimum detectable activity.
ND ( ) = Not detected above the MDA, shown in parentheses.
pCi/g = Picocurie(s) per gram.

result in the prediction of risk to ecological receptors when exposed at background concentrations. For total chromium, the HQ greater than unity was limited to plants; however, background may account for 80 percent of the maximum HQ for the site, and the background concentration of total chromium (15.9 milligrams [mg]/kilogram [kg]) also resulted in an HQ greater than 1 for plants (background HQ = 15.9). It should be noted that the plant toxicity benchmark for this metal (1 mg/kg) is based upon chromium VI (Efroymson et al. 1997), which may be more toxic to plants than the more common chromium III. The majority of the total chromium measured at DSS Site 1077 is expected to be chromium III. For this reason, it is uncertain whether the calculated HQ for total chromium accurately predicts the potential risk to plants. Further, this benchmark is conservatively based upon laboratory tests using soil amendments with a highly available form of chromium (K_{2}Cr_{2}O_{7}) (Efroymson et al. 1997). It is likely that only a small fraction the chromium in the soil at DSS Site 1077 is in a form that is highly available for plant uptake, and therefore, the plant toxicity benchmark for this metal probably overestimates risk to plants to a significant degree.

A further source of uncertainty associated with the prediction of ecological risks at this site is the use of the maximum measured concentrations to evaluate exposure and risk. This results in a conservative exposure scenario that does not necessarily reflect actual site conditions.
total chromium, the exposure point concentration (20 mg/kg) is based upon the maximum of two samples. The other data point (13 mg/kg) is less than the background screening value, and the mean of the two data points (16.5 mg/kg) is only slightly above the background screening value. Therefore, it is likely that the actual exposures to chromium at DSS Site 1077 are very close to, if not within, background levels, and risk from exposure to this COPEC is likely to be within background levels.

Based upon this uncertainty analysis, the potential for ecological risks at DSS Site 1077 is expected to be very low. Only one HQ greater than unity was predicted; however, closer examination of the exposure assumptions revealed an overestimation of risk primarily attributed to conservative toxicity benchmarks, the assumptions of maximum concentrations and maximum bioavailability, and the contribution of background risk.

VII.3.6 Risk Interpretation

Ecological risks associated with DSS Site 1077 were estimated through a risk assessment that incorporated site-specific information when available. An initial prediction of potential risk to plants from exposure to total chromium was based upon a highly conservative plant toxicity benchmark and assumptions of high bioavailability and maximum exposure point concentration. Actual risk to this receptor is expected to be near or within the range of background risk. Based upon this final analysis, the potential for ecological risks associated with DSS Site 1077 is expected to be very low.

VII.3.7 Risk Assessment Scientific/Management Decision Point

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

VIII. References


RISK ASSESSMENT FOR DSS SITE 1077


DOE, see U.S. Department of Energy.


EPA, see U.S. Environmental Protection Agency.


IAEA, see International Atomic Energy Agency.


IT, see IT Corporation.


Jones, J. (Sandia National Laboratories/New Mexico), June 1991. Internal Memorandum to D. Dionne listing the septic tanks that were removed from service with the construction of the Area III sanitary sewer system. June 21, 1991.


NCRP, see National Council on Radiation Protection and Measurements.


NMED, see New Mexico Environment Department.

NOAA, see National Oceanographic and Atmospheric Administration.


ORNL, see Oak Ridge National Laboratory.


Sandia National Laboratories/New Mexico (SNL/NM), March 2003. Database printout provided by SNL/NM Facilities Engineering showing the year that numerous SNL/NM building were constructed, Sandia National Laboratories, Albuquerque, New Mexico.


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


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


Yanicak, S. (Oversight Bureau, Department of Energy, New Mexico Environment Department), March 1997. Letter to M. Johansen (DOE/AIP/POC Los Alamos National Laboratory), "(Tentative) list of constituents of potential ecological concern (COPECs) which are considered to be bioconcentrators and/or biomagnifiers." March 3, 1997.


APPENDIX 1
EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

Introduction

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

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

At SNL/NM, all SWMUs exist within the boundaries of the Kirtland Air Force Base. Approximately 240 potential waste and release sites have been identified where hazardous, radiological, or mixed materials may have been released to the environment. Evaluation and characterization activities have occurred at all of these sites to varying degrees. Among other documents, the SNL/NM ER draft Environmental Assessment (DOE 1996) presents a summary of the hydrogeology of the sites and the biological resources present. When evaluating potential human health risk the current or reasonably foreseeable land use negotiated and approved for the specific SWMU/AOC, aggregate, or watershed will be used. The following references generally document these land uses: Workbook: Future Use Management Area 2 (DOE et al. September 1995); Workbook: Future Use Management Area 1 (DOE et al. October 1995); Workbook: Future Use Management Areas 3, 4, 5, and 6 (DOE and USAF January 1996); Workbook: Future Use Management Area 7 (DOE and USAF March 1996). At this time, all SNL/NM SWMUs have been tentatively designated for either industrial or recreational future land use. The NMED has also requested that risk calculations be performed based upon a residential land-use scenario. Therefore, all three land-use scenarios will be addressed in this document.

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

- Ingestion of contaminated drinking water
- Ingestion of contaminated soil
- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water
- Dermal contact with chemicals in soil
- Inhalation of airborne compounds (vapor phase or particulate)
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water; and exposure from ground surfaces with photon-emitting radionuclides)

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

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

- Ingestion of contaminated fish and shellfish
- Ingestion of contaminated fruits and vegetables
- Ingestion of contaminated meat, eggs, and dairy products
- Ingestion of contaminated surface water while swimming
- Dermal contact with chemicals in water

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

Based upon this evaluation, for future risk assessments the exposure routes that will be considered are shown in Table 1.
Table 1
Exposure Pathways Considered for Various Land-Use scenarios

<table>
<thead>
<tr>
<th>Industrial</th>
<th>Recreational</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ingestion of contaminated drinking water</td>
<td>Ingestion of contaminated drinking water</td>
<td>Ingestion of contaminated drinking water</td>
</tr>
<tr>
<td>Ingestion of contaminated soil</td>
<td>Ingestion of contaminated soil</td>
<td>Ingestion of contaminated soil</td>
</tr>
<tr>
<td>Inhalation of airborne compounds (vapor phase or particulate)</td>
<td>Inhalation of airborne compounds (vapor phase or particulate)</td>
<td>Inhalation of airborne compounds (vapor phase or particulate)</td>
</tr>
<tr>
<td>Dermal contact (nonradiological constituents only) soil only</td>
<td>Dermal contact (nonradiological constituents only) soil only</td>
<td>Dermal contact (nonradiological constituents only) soil only</td>
</tr>
<tr>
<td>External exposure to penetrating radiation from ground surfaces</td>
<td>External exposure to penetrating radiation from ground surfaces</td>
<td>External exposure to penetrating radiation from ground surfaces</td>
</tr>
</tbody>
</table>

Equations and Default Parameter Values for Identified Exposure Routes

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land-use scenarios. The general equation for calculating potential intakes via these routes is shown below. The equations are taken from "Assessing Human Health Risks Posed by Chemicals: Screening-Level Risk Assessment" (NMED March 2000) and "Technical Background Document for Development of Soil Screening Levels" (NMED December 2000). Equations from both documents are based upon the "Risk Assessment Guidance for Superfund" (RAGS): Volume 1 (EPA 1989, 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL 1993). The Nuclear Regulatory Commission (NRC) has approved the use of RESRAD for dose evaluation by licensees involved in decommissioning, NRC staff evaluation of waste disposal requests, and dose evaluation of sites being reviewed by NRC staff. EPA Science Advisory Board reviewed the RESRAD model. EPA used RESRAD in their rulemaking on radiation site cleanup regulations. RESRAD code has been verified, undergone several benchmarking analyses, and been included in the International Atomic Energy Agency's VAMP and BIOMOVS II projects to compare environmental transport models.

Also shown are the default values SNL/NM ER will use in RME risk assessment calculations for industrial, recreational, and residential land-use scenarios, based upon EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL 1993) or by directly accessing the RESRAD websites at: http://web.ead.anl.gov/resrad/home2/ or http://web.ead.anl.gov/resrad/documents/.
### Generic Equation for Calculation of Risk Parameter Values

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

\[
\text{Risk (or Dose)} = \text{Intake} \times \text{Toxicity Effect (either carcinogenic, noncarcinogenic, or radiological)}
\]

\[
= C \times (CR \times EFD/BW/AT) \times \text{Toxicity Effect}
\]  \hspace{1cm} (1)

where;

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

For nonradiological constituents of concern (COCs), the total risk/dose (either cancer risk or HI) is the sum of the risks/doses for all of the site-specific exposure pathways and contaminants. For radionuclides, the calculated radiation exposure, expressed as TEDE is compared directly to the exposure guidelines of 15 mrem per year (mrem/year) for industrial and recreational future use and 75 mrem/year for the unlikely event that institutional control of the site is lost and the site is used for residential purposes (EPA 1997).

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk of 1E-5 for nonradiological carcinogens. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the HI) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard HI of unity (1). The evaluation of the health hazard from radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site. This estimated dose is used to calculate an assumed risk. However, this calculated risk is presented for illustration purposes only, not to determine compliance with regulations.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA 1989) and are outlined below. The RESRAD Manual (ANL 1993) describes similar equations for the calculation of radiological exposures.

### Soil Ingestion

A receptor can ingest soil or dust directly by working in the contaminated soil. Indirect ingestion can occur from sources such as unwashed hands introducing contaminated soil to food that is then eaten. An estimate of intake from ingesting soil will be calculated as follows:

\[
I_t = \frac{C_r \times IR \times CF \times EF \times ED}{BW \times AT}
\]
where:

\[ I_s = \frac{C_s \times IR \times EF \times ED \times \sqrt{\frac{1}{VF}} \times \sqrt{\frac{1}{PEF}}}{BW \times AT} \]

where:

- \( I_s \) = Intake of contaminant from soil ingestion (milligrams [mg]/kilogram [kg]-day)
- \( C_s \) = Chemical concentration in soil (mg/kg)
- \( IR \) = Ingestion rate (mg soil/day)
- \( CF \) = Conversion factor (1E-6 kg/mg)
- \( EF \) = Exposure frequency (days/year)
- \( ED \) = Exposure duration (years)
- \( BW \) = Body weight (kg)
- \( AT \) = Averaging time (period over which exposure is averaged) (days)

It should be noted that it is conservatively assumed that the receptor only ingests soil from the contaminated source.

**Soil Inhalation**

A receptor can inhale soil or dust directly by working in the contaminated soil. An estimate of intake from inhaling soil will be calculated as follows (EPA August 1997):

\[ I_s = \frac{C_s \times IR \times EF \times ED \times \sqrt{\frac{1}{VF}} \times \sqrt{\frac{1}{PEF}}}{BW \times AT} \]

where:

- \( I_s \) = Intake of contaminant from soil inhalation (mg/kg-day)
- \( C_s \) = Chemical concentration in soil (mg/kg)
- \( IR \) = Inhalation rate (cubic meters [m³]/day)
- \( EF \) = Exposure frequency (days/year)
- \( ED \) = Exposure duration (years)
- \( VF \) = soil-to-air volatilization factor (m³/kg)
- \( PEF \) = particulate emission factor (m³/kg)
- \( BW \) = Body weight (kg)
- \( AT \) = Averaging time (period over which exposure is averaged) (days)

**Soil Dermal Contact**

\[ D_a = \frac{C_s \times CF \times SA \times AF \times ABS \times EF \times ED}{BW \times AT} \]

where:

- \( D_a \) = Absorbed dose (mg/kg-day)
- \( C_s \) = Chemical concentration in soil (mg/kg)
- \( CF \) = Conversion factor (1E-6 kg/mg)
- \( SA \) = Skin surface area available for contact (cm²/event)
- \( AF \) = Soil to skin adherence factor (mg/cm²)
- \( ABS \) = Absorption factor (unitless)
- \( EF \) = Exposure frequency (events/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (period over which exposure is averaged) (days)

Groundwater Ingestion

A receptor can ingest water by drinking it or through using household water for cooking. An estimate of intake from ingesting water will be calculated as follows (EPA August 1997):

\[
I_w = \frac{C_w \times IR \times EF \times ED}{BW \times AT}
\]

where:

- \( I_w \) = Intake of contaminant from water ingestion (mg/kg/day)
- \( C_w \) = Chemical concentration in water (mg/liter [L])
- \( IR \) = Ingestion rate (L/day)
- \( EF \) = Exposure frequency (days/year)
- \( ED \) = Exposure duration (years)
- \( BW \) = Body weight (kg)
- \( AT \) = Averaging time (period over which exposure is averaged) (days)

Groundwater Inhalation

The amount of a constituent taken into the body via exposure to volatilization from showering or other household water uses will be evaluated using the concentration of the constituent in the water source (EPA 1991 and 1992). An estimate of intake from volatile inhalation from groundwater will be calculated as follows (EPA 1991):

\[
I_w = \frac{C_w \times K \times IR_i \times EF \times ED}{BW \times AT}
\]

where:

- \( I_w \) = Intake of volatile in water from inhalation (mg/kg/day)
- \( C_w \) = Chemical concentration in water (mg/L)
- \( K \) = Volatilization factor (0.5 L/m³)
- \( IR_i \) = Inhalation rate (m³/day)
- \( EF \) = Exposure frequency (days/year)
- \( ED \) = Exposure duration (years)
- \( BW \) = Body weight (kg)
- \( AT \) = Averaging time (period over which exposure is averaged—days)

For volatile compounds, volatilization from groundwater can be an important exposure pathway from showering and other household uses of groundwater. This exposure pathway will only be evaluated for organic chemicals with a Henry’s Law constant greater than \( 1 \times 10^{-5} \) and with a molecular weight of 200 grams/mole or less (EPA 1991).

Tables 2 and 3 show the default parameter values suggested for use by SNL/NM at SWMUs, based upon the selected land-use scenarios for nonradiological and radiological COCs,
respectively. References are given at the end of the table indicating the source for the chosen parameter values. SNL/NM uses default values that are consistent with both regulatory guidance and the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways, based upon the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

**Summary**

SNL/NM will use the described default exposure routes and parameter values in risk assessments at sites that have an industrial, recreational, or residential future land-use scenario. There are no current residential land-use designations at SNL/NM ER sites, but NMED has requested this scenario to be considered to provide perspective of the risk under the more restrictive land-use scenario. For sites designated as industrial or recreational land use, SNL/NM will provide risk parameter values based upon a residential land-use scenario to indicate the effects of data uncertainty on risk value calculations or in order to potentially mitigate the need for institutional controls or restrictions on SNL/NM ER sites. The parameter values are based upon EPA guidance and supplemented by information from other government sources. If these exposure routes and parameters are acceptable, SNL/NM will use them in risk assessments for all sites where the assumptions are consistent with site-specific conditions. All deviations will be documented.
**Table 2**

Default Nonradiological Exposure Parameter Values for Various Land-Use scenarios

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Industrial</th>
<th>Recreational</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Exposure Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure Frequency (day/yr)</td>
<td>250&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>8.7 (4 hr/wk for 52 wk/yr)&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>350&lt;sup&gt;a,b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Exposure Duration (yr)</td>
<td>25&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>30&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>30&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Body Weight (kg)</td>
<td>70&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>70 Adult&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
<td>70 Adult&lt;sup&gt;a,b,c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Averaging Time (days)</td>
<td>25,550&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>25,550&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>25,550&lt;sup&gt;a,b&lt;/sup&gt;</td>
</tr>
<tr>
<td>for Carcinogenic Compounds (= 70 yr x 365 day/yr)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for Noncarcinogenic Compounds (= ED x 365 day/yr)</td>
<td>9,125&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>10,950&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>10,950&lt;sup&gt;a,b&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Soil Ingestion Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingestion Rate (mg/day)</td>
<td>100&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>200 Child&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>200 Child&lt;sup&gt;a,b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Inhalation Pathway</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhalation Rate (m&lt;sup&gt;3&lt;/sup&gt;/day)</td>
<td>20&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>15 Child&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10 Child&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Volatilization Factor (m&lt;sup&gt;3&lt;/sup&gt;/kg)</td>
<td>Chemical Specific</td>
<td>Chemical Specific</td>
<td>Chemical Specific</td>
</tr>
<tr>
<td>Particulate Emission Factor (m&lt;sup&gt;3&lt;/sup&gt;/kg)</td>
<td>1.36E9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.36E9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.36E9&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Water Ingestion Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingestion Rate (liter/day)</td>
<td>2.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.4&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td><strong>Dermal Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin Adherence Factor (mg/cm&lt;sup&gt;2&lt;/sup&gt;)</td>
<td>0.2&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.2 Child&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.2 Child&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Exposed Surface Area for Soil/Dust (cm&lt;sup&gt;2&lt;/sup&gt;/day)</td>
<td>3,300&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2,800 Child&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2,800 Child&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Skin Adsorption Factor</td>
<td>Chemical Specific</td>
<td>Chemical Specific</td>
<td>Chemical Specific</td>
</tr>
</tbody>
</table>

<sup>a</sup>Technical Background Document for Development of Soil Screening Levels (NMED 2000).


<sup>c</sup>Exposure Factors Handbook (EPA August 1997).

ED = Exposure duration.
EPA = U.S. Environmental Protection Agency.
hour(s).
kilogram(s).
meter(s).
milligram(s).
NA = Not available.
week(s).
year(s).

hr = Hour(s).
kg = Kilogram(s).
m = Meter(s).
mg = Milligram(s).
Table 3
Default Radiological Exposure Parameter Values for Various Land-Use scenarios

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Industrial</th>
<th>Recreational</th>
<th>Residential</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Exposure Parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exposure Frequency</td>
<td>8 hr/day for 250 day/yr</td>
<td>4 hr/wk for 52 wk/yr</td>
<td>365 day/yr</td>
</tr>
<tr>
<td>Exposure Duration (yr)</td>
<td>$25^{a,b}$</td>
<td>$30^{a,b}$</td>
<td>$30^{a,b}$</td>
</tr>
<tr>
<td>Body Weight (kg)</td>
<td>70 Adult$^{b}$</td>
<td>70 Adult$^{b}$</td>
<td>70 Adult$^{b}$</td>
</tr>
<tr>
<td><strong>Soil Ingestion Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingestion Rate</td>
<td>100 mg/day$^c$</td>
<td>100 mg/day$^c$</td>
<td>100 mg/day$^c$</td>
</tr>
<tr>
<td>Averaging Time (days) (= 30 yr x 365 day/yr)</td>
<td>10,950$^d$</td>
<td>10,950$^d$</td>
<td>10,950$^d$</td>
</tr>
<tr>
<td><strong>Inhalation Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inhalation Rate (m$^3$/yr)</td>
<td>7,300$^{a,c}$</td>
<td>10,950$^a$</td>
<td>7,300$^{a,c}$</td>
</tr>
<tr>
<td>Mass Loading for Inhalation g/m$^3$</td>
<td>1.36 E-5$^d$</td>
<td>1.36 E-5$^d$</td>
<td>1.36 E-5$^d$</td>
</tr>
<tr>
<td><strong>Food Ingestion Pathway</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ingestion Rate, Leafy Vegetables (kg/yr)</td>
<td>NA</td>
<td>NA</td>
<td>16.5$^e$</td>
</tr>
<tr>
<td>Ingestion Rate, Fruits, Non-Leafy Vegetables &amp; Grain (kg/yr)</td>
<td>NA</td>
<td>NA</td>
<td>101.8$^b$</td>
</tr>
<tr>
<td>Fraction Ingested</td>
<td>NA</td>
<td>NA</td>
<td>0.25$^{b,d}$</td>
</tr>
</tbody>
</table>

$^b$Exposure Factors Handbook (EPA August 1997).
$^c$EPA Region VI guidance (EPA 1996).
$^d$For radionuclides, RESRAD (ANL 1993).
$^e$SNL/NM (February 1998).
EPA = U.S. Environmental Protection Agency.
g = Gram(s)
hr = Hour(s).
kg = Kilo gram(s).
m = Meter(s).
mg = Milli gram(s).
NA = Not applicable.
wk = Week(s).
yr = Year(s).
References

ANL, see Argonne National Laboratory.


DOE, see U.S. Department of Energy.


EPA, see U.S. Environmental Protection Agency.


