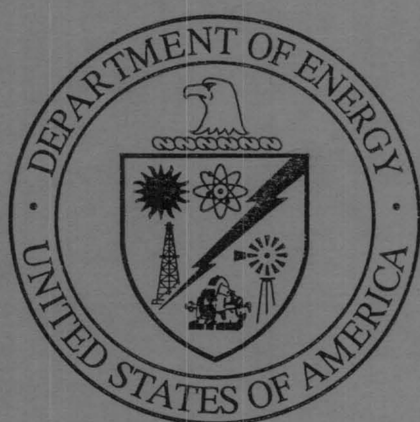
Sandia National Laboratories/New Mexico

PROPOSAL FOR RISK-BASED NO FURTHER ACTION ENVIRONMENTAL RESTORATION SITE 144 BUILDING 9980 SEPTIC SYSTEM OPERABLE UNIT 1295

May 1997

Environmental
Restoration
Project



United States Department of Energy
Albuquerque Operations Office

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

Prepared for
the U.S. Department of Energy

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ACRONYMS AND ABBREVIATIONS

amsl	above mean sea level
BA	butyl acetate
bgs	below ground surface
BTEX	benzene, toluene, ethylene, and xylene
COC	constituents of concern
DOE	Department of Energy
DOU	Document of Understanding
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
KAFB	Kirtland Air Force Base
MEK	methyl ethyl ketone
mg/kg	milligrams per kilogram
MIBK	methyl isobutyl ketone
mrem	millirems
NEPA	National Environmental Policy Act
NERI	Northeast Research Institute
NFA	No Further Action
NMED	New Mexico Environment Department
OU	Operable Unit
PCB	polychlorinated biphenyl
PCE	perchloroethene
QA/QC	quality assurance/quality control
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
SNL/NM	Sandia National Laboratories/New Mexico
SPT	Solar Power Tower
SVOC	semivolatile organic compound
SWMU	solid waste management unit
TCE	trichloroethene
TCLP	Toxicity Characteristic Leaching Procedure
TEDE	total estimated effective dose equivalent
UTL	upper tolerance limit
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 Description of ER Site 144

Sandia National Laboratories/New Mexico (SNL/NM) is proposing a No Further Action (NFA) decision based on confirmatory sampling for Environmental Restoration (ER) Site 144, Building 9980 Septic System, Operable Unit (OU) 1295. ER Site 144 is listed in the Hazardous and Solid Waste Amendments Module IV (EPA August 1993) of the SNL/NM Resource Conservation and Recovery Act (RCRA) Hazardous Waste Management Facility Permit (NM5890110518-1) (EPA August 1992).

SNL/NM occupies 2,829 acres of land owned by the Department of Energy (DOE), with an additional 14,920 acres of land provided by land-use permits with Kirtland Air Force Base (KAFB), the United States Forest Service, the State of New Mexico, and the Isleta Pueblo. SNL/NM has been involved in nuclear weapons research, component development, assembly, testing, and other research and development activities since 1945 (DOE September 1987).

ER Site 144 is located in the Coyote Test Field area in the far southern part of KAFB and is approximately 1.3 miles north of the Isleta Pueblo boundary and 1 mile west of Lovelace Road. It is reached by traveling south on Lovelace Road, and then west on Magazine Road for a distance of 1 mile (Figure 1-1). The site is just west of the Solar Power Tower (SPT) (or Building 9980), a prominent landmark in the area (Figure 1-2).

ER Site 144 consists of two contiguous areas that encompass a septic tank and drainfield about 500 feet west of the SPT, and a surface outfall location (referred hereinafter as the "surface outfall") about 300 feet west of the SPT. These two areas encompass approximately 0.3 acres of flat-lying land at an average mean elevation of 5,571 feet above mean sea level (amsl). In addition, samples were collected from a third area that is not a designated part of ER Site 144. This area is located immediately beyond the south edge of the asphalt apron surrounding the SPT, and reportedly received aqueous discharges from a facility wastewater tank on the east side of the SPT that drained off of the asphalt apron onto the unpaved area where the samples were collected (Figure 1-2). It will be referred to as the "surface discharge location" in the remainder of this document.

Vegetation consists predominantly of grasses including grama, muhly, dropseed, and galleta. Shrubs commonly associated with the grasslands include sand sage, winter fat, saltbrush, and rabbitbush. Cacti are common, and include cholla, pincushion, strawberry, and prickly pear (SNL/NM March 1993).

The surficial geology in the ER Site 144 area consists of middle to upper Pleistocene alluvial fan deposits. The alluvial fan materials originated from the Manzanita Mountains that are 3 to 4 miles east of ER Site 144, and typically have a moderate to high (sand + gravel)/(silt + clay) ratio, are poorly sorted, and exhibit moderately connected lenticular bedding. Based on drilling records of similar deposits at KAFB, the alluvial fan materials are highly heterogeneous, and are composed primarily of medium to fine silty sands with frequent coarse sand, gravel, and cobble lenses.

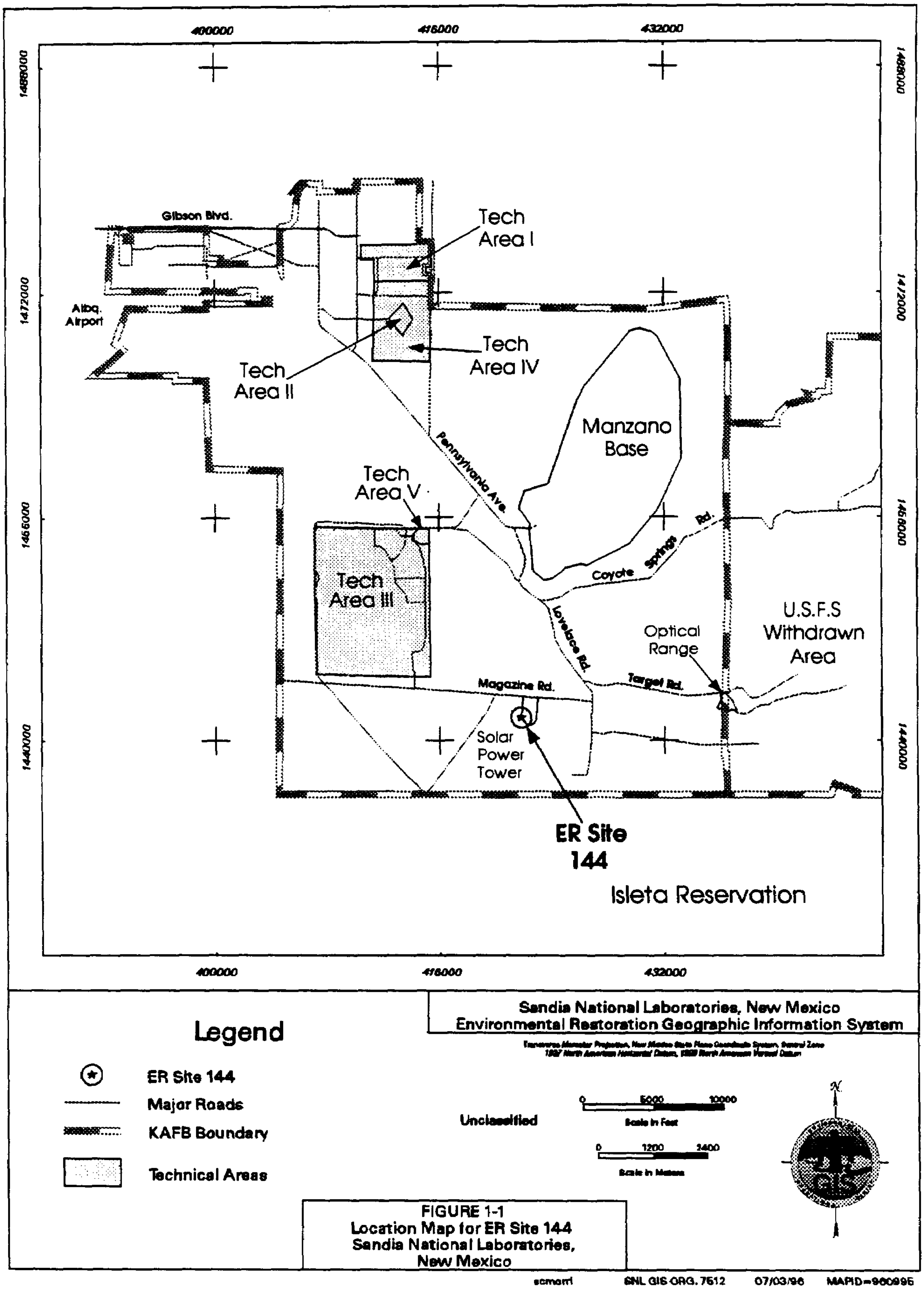
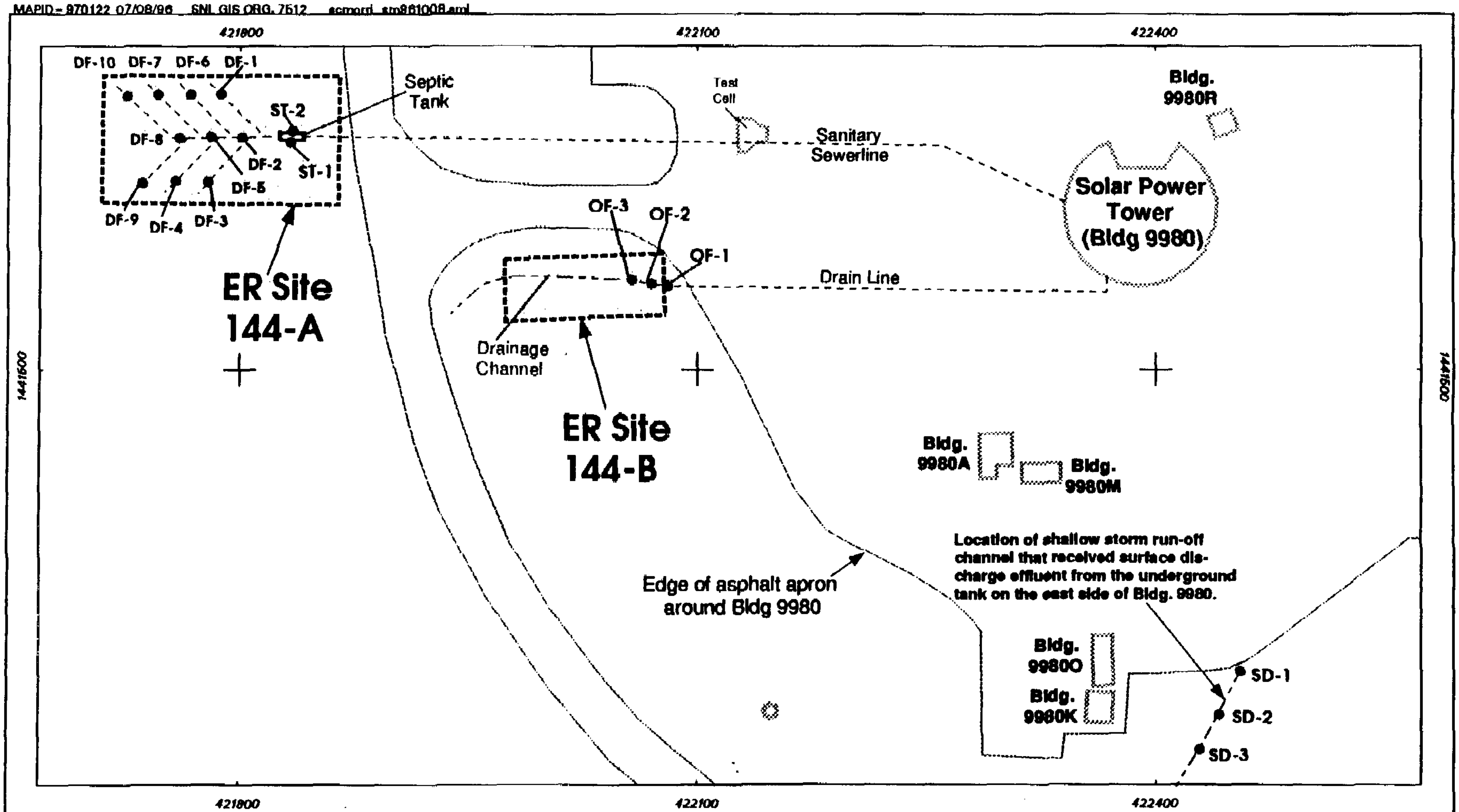


FIGURE 1-1
Location Map for ER Site 144
Sandia National Laboratories,
New Mexico



Legend

- Boring Location
- Drainage Channel
- KAFB Roads
- Septic Tank
- Sanitary Sewerline, Drainfield, Drain line
- Buildings
- ER Site 144
- Storm Channel

Sandia National Laboratories, New Mexico
Environmental Restoration Geographic Information System

Transverse Mercator Projection, New Mexico State Plane Coordinate System, Central Zone
1927 North American Horizontal Datum, 1929 North American Vertical Datum

DRAFT
Unclassified

0 52.5 105
Scale in Feet

0 12.6 25.2
Scale in Meters

FIGURE 1-2
Site Map for ER Site 144
Sandia National Laboratories, New Mexico

Individual beds range from 1 to 5 feet thick with a preferred east-west orientation, and have moderate to low hydraulic conductivities.

Monitoring well STW-1 was installed in June 1995 at the intersection of Magazine Road and Isleta Road, which is approximately 2,400 feet northwest of ER Site 144. During drilling at this location, several intervals of lost circulation were encountered in Tertiary conglomerate down to a total depth of 521 feet below ground surface (bgs). These intervals of lost circulation indicate that there are highly transmissive features in the alluvial materials that may be either poorly cemented conglomerate beds or fracture zones (SNL/NM March 1996).

The alluvial fan sediment package is approximately 1,900 feet thick beneath the site, and rests on a bedrock surface presumed to be Permian Abo and Yeso formation sedimentary rocks which consist of massive to thinly bedded red sandstones, siltstones, and shales, with local interbedded gypsum (Plates XIII and XV of SNL/NM December 1995b). ER Site 144 is located in a structurally complex zone of faulted bedrock ramps that lie between the sediment-filled Albuquerque Basin to the west, and the uplifted Manzanita Mountains to the east. The ramps are separated by generally west-dipping normal faults that trend northeast (and locally northwest), and exhibit down-to-the-west displacement. This extensive faulting has resulted in a detached and tilted block (the "Travertine Block" on Plate XV of SNL/NM December 1995b) capped by Abo and Yeso rock that dips in a southeasterly direction beneath the site.

The water-table elevation is approximately 5,460 feet amsl at the Site 144 location, so depth to groundwater beneath the site is approximately 111 feet. Local groundwater flow is believed to be in a generally westerly direction in the vicinity of this site (SNL/NM March 1996). The nearest groundwater monitoring wells include well STW-1 (2,400 feet northwest of the site), and NMED-1 which is about 3,000 feet south-southeast of the site (SNL/NM August 1996a). The water level elevation in STW-1 on August 7, 1996, was 5377.06 feet amsl, or about 153 feet bgs at the well location (SNL/NM August 1996b). The water level elevation measured in NMED-1 on October 4, 1996, was 5,531.62 feet amsl, or about 86 feet bgs at that well location (NMED November 1996). The nearest production wells are northwest of ER Site 145 and include KAFB-1, 2, 4, 7, and 14 which are approximately 5.6 to 8.0 miles away.

1.2 No Further Action Basis

Review and analysis of the ER Site 144 soil sample analytical data indicate that concentrations of constituents of concern (COC) detected in soils at this site are less than (1) SNL/NM or other applicable background concentrations, or (2) proposed Subpart S or other action levels, or (3) derived risk assessment action levels. Thus ER Site 144 is being proposed for an NFA decision based on confirmatory sampling data and risk assessment demonstrating that hazardous COCs that may have been released from this solid waste management unit (SWMU) into the environment pose an acceptable level of risk under current and projected future land use, NFA Criterion 5 of the Environmental Restoration Document of Understanding (DOU) (NMED April 1996).

2.0 HISTORY OF ER SITE 144

2.1 Historical Operations

The following historical information has been excerpted from several sources, including SNL/NM March 1993, IT March 1994, SNL/NM November 1994d, and SNL/NM March 1997.

The SPT was constructed in 1976 for research and development of solar thermal technology. It is a multistory concrete tower that houses solar receivers. Wash sinks and toilet facilities for up to 20 people were served by a septic tank and a drainfield with seven 50-foot distribution lines. The septic system is located on the west side of the west access road. Also, floor drains at the various levels in the SPT collect rainwater that leaks through openings in the building. These floor drains are connected to a galvanized pipe near ground level that drains to the asphalt apron surrounding the building. Rainwater also leaks into the building through the loose-fitting cover over the large movable module elevator shaft in the center of the SPT. This water may pick up small amounts of oil, grease and perhaps metal fragments as it drains down through the shaft to a sump in the Building 9980 basement. Water that accumulated in the sump used to be periodically pumped and discharged to a surface outfall located in a earthen depression between the parking lot and the west access road (Figure 1-2). This practice was discontinued around 1992; water that collects in the sump is now periodically pumped out and sprayed onto the asphalt apron with a fire hose and allowed to evaporate rather than drain to the soil. Also, five floor drains are located in a large room on the east side of the SPT and connect to the facility industrial wastewater tank, which is a 4,000-gallon underground fiberglass tank on the east side of Building 9980. One of these drains collects water from an emergency shower that is tested on a monthly basis; the other four are no longer used.

Large volumes of ethylene glycol coolant are used in Building 9980 as a heat exchange medium, along with small quantities of ammonium hydroxide for pH control, and hydrazine as an oxygen scavenger. No chromate rust inhibitors have been used. Trace quantities of copper and mercury may have been contained in test kits used to check cooling water quality, but there is no evidence or indication that contents from the test kits were dumped into tanks or on the ground. An aboveground stainless steel wastewater tank on the south side of the tower formerly received boiler blowdown containing ethylene glycol and hydrazine. The tank contents were occasionally discharged to the ground. The releases from the aboveground tank occurred about twice a month and involved small quantities (around 5 gallons per occurrence) of hot boiler blowdown water that was discharged to the large asphalt apron surrounding Building 9980. The discharges are now directed to the sanitary sewer. In a letter dated March 17, 1995 to the U.S. Environmental Protection Agency (EPA) (SNL/NM March 1995b), SNL/NM indicated that the releases from the aboveground tank did not warrant further investigation, and the EPA subsequently agreed with this opinion by not requiring additional work to address these aboveground tank discharges as one of the final conditions to be met for EPA approval of the OU 1295, Septic Tanks and Drainfields RCRA Facility Investigation (RFI) Work Plan (EPA March 1995).

Of greater concern were the large volumes of ethylene glycol, cooling tower blowdown, and boiler blowdown from other Building 9980 floor drains that drained to the 4,000-gallon underground tank. Effluent from this tank was discharged to the asphalt apron using a pump approximately once a month. A slight depression in the asphalt directed the discharge to the edge of the apron where it flowed into a shallow earthen storm run-off channel and soaked into the ground. The location of this shallow discharge channel is shown on Figure 1-2. SNL/NM agreed to collect soil samples from three boring locations in the discharge area of the channel as one of the final conditions required by the EPA for the OU 1295 RFI Work Plan approval (EPA March 1995). This sampling task is discussed in Section 3.6 below.

The septic tank and drainfield system as well as the surface outfall are no longer active. Building 9980, as of June 1991, was connected to an extension of the City of Albuquerque sanitary sewer system (SNL/NM June 1991). Solar facility personnel reported that the aboveground stainless steel tank on the south side of the tower is still in place, has not been used since about 1989, and is scheduled to be removed and scrapped. The remaining contents in the 4,000-gallon underground tank (which is also still in place) were pumped out around 1992, and only water from the monthly emergency shower testing was discharged to the tank since then. Facility personnel report that there are no immediate plans to remove this tank from the site (SNL/NM March 1997).

2.2 Previous Audits, Inspections, and Findings

ER Site 144 was first listed as a potential release site in the RCRA Facility Assessment (RFA) report to the EPA in 1987 (EPA April 1987). This report contained a generic statement about this and many other SNL/NM septic systems where sanitary and industrial wastes may have been discharged during past operations. This SWMU was included in the RFA report as Site 79, along with other septic and drain systems at SNL/NM. All the sites included in Site 79 are now designated by individual SWMU numbers.

3.0 EVALUATION OF RELEVANT EVIDENCE

3.1 Unit Characteristics and Operating Practices

There are no safeguards inherent in the drain systems from Building 9980 or in facility operations that could have prevented past releases to the environment. As discussed in Section 2.1, effluent was released to the Building 9980 septic tank and drainfield when the septic system was active. Effluent was also released to the surface outfall from Building 9980 floor drains and to the ground surface from the underground wastewater tank.

3.2 Results of Sampling/Surveys

3.2.1 Summary of Prior Investigations

The following sources of information were used to evaluate ER Site 144:

- Results of samples collected from the septic tank in 1992 (SNL/NM June 1993), 1994 (SNL/NM April 1994 and November 1994a), and 1995 (SNL/NM August 1995);
- Results of four surveys, including an archaeological/cultural resources survey (Hoagland and Dello-Russo 1995), a sensitive or special status species or environments survey (IT February 1995), a geophysical survey (Lamb 1994), and a passive soil gas survey (NERI June 1995 and August 1996);
- Confirmatory subsurface soil sampling conducted in November 1994 and May 1995 (SNL/NM November 1994b and 1994c, and May 1995a);
- Approved RFI Work Plan and addenda for OU 1295, Septic Tanks and Drainfields (SNL/NM March 1993, November 1994d, December 1994, January 1995, March 1995a, March 1995b, and May 1995b; and EPA September 1994, January 1995, and March 1995);
- Photographs and field notes collected at the site by SNL/NM ER staff;
- SNL/NM Facilities Engineering building drawings (SNL/NM July 1976, September 1976, and March 1977);
- SNL/NM Geographic Information System data; and
- Interviews with employees familiar with the site operational history.

3.2.2 Septic Tank Sampling

Liquid and sludge septage samples were collected from the ER Site 144 septic tank in July 1992. The liquid supernate samples were analyzed for volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), total metals, selected radionuclide constituents, and several other miscellaneous analytes. Two VOCs (trichloroethene [TCE] and methylene chloride) and one SVOC (n-nitrosodiphenylamine) were detected, but no pesticides or PCBs were identified. Very low levels of a number of metals, phenolic compounds, nitrates/nitrites, fluoride, and oil and grease were also detected. The sludge samples (composed of 96% water) were analyzed for total metals, gross alpha and beta activity, tritium, and selected radionuclide constituents. A number of metals and a few radionuclides were detected. The analytical results of these samples are presented in Section 6.1.

A second round of septic tank waste characterization sludge samples was collected in April 1994 (SNL/NM April 1994) and were analyzed for VOCs, phenolic compounds, and for the eight RCRA metals using the Toxicity Characteristic Leaching Procedure (TCLP). Seven VOCs (ethylbenzene, styrene, total xylenes, acetone, carbon disulfide, 2-butanone, and methylene chloride) were identified at near- or below-reporting limit concentrations in the sludge, and no phenolic compounds were identified in the material. Also, low concentrations of only two of the eight RCRA metals (barium and cadmium) were detected in the TCLP-derived leachate from the sludge sample. The analytical results for the April 1994 septic tank samples are presented in Section 6.2.

A third round of septic tank liquid and sludge waste characterization samples was collected in November 1994 (SNL/NM November 1994a). Below-reporting-limit concentrations of two SVOCs (4-chloroaniline and bis(2-ethylhexyl)phthalate) were detected in the sludge. Liquid and sludge samples were analyzed for tritium and isotopic uranium by a commercial laboratory, and were also screened for additional radionuclides using SNL/NM in-house gamma spectroscopy analysis. Low activity levels of three uranium isotopes were detected in both the liquid and sludge; tritium was not identified in either of them. No other gamma spectroscopy radionuclides were detected in the liquid, and only two constituents (lead-212 and potassium-40) were identified in the sludge. The analytical results of the November 1994 septic tank samples are also presented in Section 6.2.

In August 1995, one additional sample of the liquid supernate in the septic tank was collected and analyzed for VOCs (SNL/NM August 1995). Only trace levels of four VOCs (acetone, toluene, xylenes, and ethylbenzene) were identified in the liquid; these four compounds are common laboratory contaminants. The analytical results of this sample are also presented in Section 6.2.

3.2.3 Archaeological/Cultural Resources Survey

An archaeological/cultural resources survey was conducted at each of the 23 OU 1295 ER sites (including ER Site 144) in 1994, but no archaeological or cultural resources of concern were identified at any of these heavily disturbed sites (Hoagland and Dello-Russo 1995). Also, a field survey was conducted in the KAFB area in 1994 to identify sensitive or special status species or environments at numerous ER sites. All 23 of the OU 1295 ER sites were examined during this field effort, and no sensitive species or environments were identified at any of these highly disturbed septic and drain system sites (IT February 1995).

3.2.4 Geophysical Survey

A geophysical survey using a Geonics™ model EM-31 and EM-38 ground conductivity meter was performed in the area of the drainfield in February 1994 to attempt to locate the drainfield. The EM-31 instrument was used for deeper surveys (up to 18 feet bgs), and the EM-38 was employed for more shallow work. A relatively high conductivity area was identified south of the drainfield, and was interpreted to be a shallow (within 5 feet of the surface) septic leachate plume (Lamb 1994). Geophysical techniques were not useful in determining the locations of the drainlines in the drainfield. The actual drainline locations (Figure 1-2) were later determined using a backhoe (SNL/NM August 1994).

3.2.5 Passive Soil-Gas Survey

Two separate passive soil-gas surveys were conducted at ER Site 144 in May 1994 using PETREX™ sampling tubes to identify any releases of VOCs and SVOCs that may have occurred (SNL/NM May 1994a and 1994b). One survey was conducted in the area of the drainfield and the other in the area of the surface outfall. A PETREX™ soil-gas survey is a semi-quantitative screening procedure that can be used to identify many volatile and semivolatile organic compounds. This technique may be used to guide VOC and SVOC site investigations. The advantages of this sampling methodology are that large areas can be surveyed at relatively low cost, the technique is highly sensitive to organic vapors, and the result produces a measure of soil vapor chemistry over a two- to three-week period rather than at one point in time.

Each PETREX™ soil-gas sampler consists of two activated-charcoal coated wires housed in a reusable glass test tube container. At each sampling location, sample tubes are buried in an inverted position so that the mouth of the sampler is about 1 foot below grade. Samplers are left in place for a two- to three-week period, and are then removed from the ground and sent to the manufacturer, Northeast Research Institute (NERI), for analysis using thermal desorption-gas chromatography/mass spectrometry. The analytical laboratory reports all sample results in terms of "ion counts" instead of concentrations, and identifies those samples that contain compounds above the PETREX™ technique detection limits. In NERI's experience, levels below 100,000 ion counts for a single compound (such as perchloroethene [PCE] or TCE), and 200,000 ion counts for mixtures (such as benzene, tolune, ethylene, and xylene [BTEX] or aliphatic compounds [C4-C11 cycloalkanes]), under normal site conditions, would not represent detectable levels by standard quantitative methods for soils and/or groundwater (NERI June 1995).

A map showing the sampling locations and the analytical results of the ER Site 144 passive soil gas survey is presented in Section 6.3. Thirty PETREX™ tube samplers (numbers P-17 through P-46 on the map in Section 6.3) were placed in a grid pattern that covered the drainfield and septic tank area at this site (SNL/NM May 1994a). Part of this grid pattern included a row of five samplers (numbers P-18, P-40 through P-42, and P-44) about 25 feet south of the drainfield that provided information in the vicinity of the possible leachate plume identified in the geophysical survey. One of the samplers (P-23) was broken in transit to the laboratory and was therefore not analyzed (NERI July 1994). Three samplers (numbers P-47 through P-49) were also placed in the short drainage channel that received discharge from the Building 9980 surface outfall (SNL/NM May 1994b). One was placed at the discharge point and the two others were located about 20 feet and 40 feet downgradient from the discharge point of the surface outfall. All of the PETREX™ samplers placed at this site were analyzed for two individual constituents (PCE and TCE) and two groups of compounds (BTEX and aliphatic compounds); significant contaminant concentrations were not detected in soil gas at any of the 32 PETREX™ sampling locations at this site.

3.2.6 Confirmatory Soil Sampling

Although the likelihood of significant releases of hazardous constituents at ER Site 144 was considered low, confirmatory soil sampling was conducted to determine whether COCs above background or action levels were released via the septic system or surface release locations at this site. A backhoe was used in August 1994 to determine the location, dimensions, and depth of the drainfield, which had no surface expression (SNL/NM August 1994).

No visible evidence of soil discoloration, staining, or odors indicating residual contamination was observed when (1) the drainfield was located and partially excavated with the backhoe in August 1994 (SNL/NM August 1994), (2) soil samples were collected in the drainfield, around the septic tank, and in the immediate vicinity of the surface outfall in November 1994 (SNL/NM November 1994b and 1994c), and (3) soil samples were collected near the surface discharge location on the south side of the SPT in May 1995 (SNL/NM May 1995a).

Once the drainfield was located, soil samples were collected from boreholes within the drainfield, from either side of the septic tank, and in the short drainage channel that received discharge from the Building 9980 surface outfall using a Geoprobe™ unit (SNL/NM November 1994b and 1994c). Soil samples were also collected from three boreholes in the surface discharge location (SNL/NM May 1995a). The confirmatory soil sampling program was performed in accordance with the rationale and procedures described in the approved Septic Tank and Drainfields, OU 1295 RFI Work Plan (SNL/NM March 1993), and ER Site 144-pertinent addenda to the Work Plan (listed in bullet number 4 in Section 3.2.1 above) developed during the approval process. Routine SNL/NM chain-of-custody and sample documentation procedures were employed for all samples collected at this site. A summary of the types of samples, number of sample locations, sample depths and analytical requirements for confirmatory soil samples collected at this site is presented in Table 3-1.

Confirmatory soil samples were collected from one boring on either side of the septic tank, and from 10 borings in the drainfield, three of which were located along the main drainfield distribution line and seven of which were located 10 feet from the end of each of the 7 drainfield lateral lines (Figure 1-2). The septic tank soil samples were collected from one interval in each of the two boreholes starting at the outside bottom of the tank, which was measured to be 9 feet bgs at this site (SNL/NM November 1994b). The drainfield soil samples were collected from two intervals in each borehole. The top of the shallow interval started at the bottom of the drain line trenches

Table 3-1
ER Site 144: Confirmatory Sampling Summary Table

Sampling Area	Analytical Parameters	Number of Borehole Locations	Top of Sampling Interval(s) a Each Boring Location	Total Number of Investigative Samples	Total Number of Duplicate Samples	Date(s) Samples Collected
Drainfield	VOCs	10	6', 16'	20	1	11/16-21/94
	SVOCs	10	6', 16'	20	1	"
	RCRA metals	10	6', 16'	20	1	"
	Soil pH	10	6', 16'	20		"
	Isotopic uranium comp.	10	6', 16'	4		"
	Gamma spec. composite	10	6', 16'	4		"
	Tritium composite	10	6', 16'	2		"
Septic Tank	VOCs	2	9'	2		11/17/94
	SVOCs	2	9'	2		"
	RCRA metals	2	9'	2		"
	Soil pH	2	9'	2		"
Surface Outfall	VOCs	3	1', 11'	6	1	11/30/94
	SVOCs	3	1', 11'	6	1	"
	RCRA metals	3	1', 11'	6	1	"
	Soil pH	3	1', 11'	6		"
	Gamma spec. composite	3	1', 11'	2		"
	Tritium composite	3	1', 11'	2		"
Surface Discharge Location	Hydrazine	3	1', 11'	6	1	5/22-23/95
	RCRA metals	3	1', 11'	6	1	"

Notes:
RCRA = Resource Conservation and Recovery Act
Spec. = Spectroscopy
SVOCs = Semivolatile organic compounds
VOCs = Volatile organic compounds

which were 6 feet bgs on average at this site, and the lower (deep) interval started at 10 feet below the top of the upper interval, or 16 feet bgs.

Confirmatory soil samples were also collected from three borings in the short drainage channel that received discharge from the Building 9980 surface outfall. The first surface outfall sample borehole was located at the discharge pipe outfall, and the second and third sample locations were, respectively, approximately 11 feet and 24 feet downgradient (downstream) from the first sample location in the drainage channel (Figure 1-2). Surface outfall soil samples were collected at depth intervals starting at 1 foot and 11 feet bgs in each of the three boreholes. The upper interval starting depth of 1 foot bgs was selected in order to avoid collecting non-representative surficial soil that may have been recently deposited at the site by wind or water. The left photograph in Figure 3-1 shows the drainage ditch where the outfall soil samples were collected; the location of the discharge pipe is just to the right and downslope of the cut-off tree in the background.

Finally, in May 1995 another set of soil samples were collected at the surface discharge area on the south side of the SPT. This additional sampling was requested by the EPA as one of the final conditions for regulatory approval of the OU 1295 RFI Work Plan (EPA March 1995). Samples were collected from one shallow and one deep interval in each of three boreholes located in a shallow earthen storm run-off channel leading away from the southern edge of the asphalt apron surrounding Building 9980. The first borehole was about 1 foot out from the edge of the asphalt apron, and the second and third borings were located, respectively, 30 and 60 feet downgradient (downstream) from the first sample location (Figure 1-2). Surface discharge soil samples were also collected at depth intervals starting at 1 foot and 11 feet bgs in each of the three boreholes.

The Geoprobe™ sampling system was used to collect subsurface soil samples at this site. The Geoprobe™ sampling tool was fitted with a butyl acetate (BA) sampling sleeve and was then hydraulically driven to the top of the designated sampling depth. The sampling tool was opened, and driven an additional 2 feet in order to fill the 2-foot long by approximately 1.25-inch diameter BA sleeve. The sampling tool and soil-filled sleeve were then retrieved from the borehole. In order to minimize the potential for loss of volatile compounds (if present), the soil to be analyzed for VOCs was not emptied from the BA sleeve into another sample container. The filled BA sleeve was removed from the sampling tool, and the top 7 inches were cut off. Both ends of the 7-inch section of filled sleeve were immediately capped with a Teflon membrane and rubber end cap, sealed with tape, and placed in an ice-filled cooler at the site. The soil in this section of sleeve was then submitted for a VOC analysis.

Soil from the remainder of the sleeve was then emptied into a decontaminated mixing bowl. Following this, additional 2-foot sampling runs were completed in order to recover enough soil to satisfy sample volume requirements for the interval. Soil recovered from these additional runs was also emptied into the mixing bowl and blended with soil from the first sampling run. The blended soil was then transferred from the bowl into sample containers using a decontaminated plastic spatula.

Drainfield and septic tank soil samples were analyzed for VOCs, SVOCs, and RCRA metals by a commercial laboratory, and for soil pH by an SNL/NM laboratory. Also, to determine if radionuclides were released from past activities at this site, four composite soil samples from the

Above: Photo showing the Building 9980 (Solar Power Tower) surface outfall location (below the cutoff tree on the right side of the tower), and the drainage channel where the surface outfall soil samples were collected in November 1994. View looking east.

Below: Building 9980 septic tank septage removal and tank cleaning operation, October 24, 1995. View looking east.

Figure 3-1
ER Site 144 Photographs

drainfield were analyzed for isotopic uranium by a commercial laboratory, and also were screened for other radionuclides using SNL/NM in-house gamma spectroscopy. Although there is no history or evidence of radionuclide usage or releases from Building 9980, SNL/NM waste management personnel requested limited soil sampling to confirm that radionuclides had not been released to the environment at this site. The first composite sample consisted of blended fractions of soil from the shallow sampling intervals in boreholes DF-1 through DF-5 in the eastern part of the drainfield. The second composite sample was composed of blended soil fractions from the shallow sampling intervals in boreholes DF-6 through DF-10, which were in the western part of the drainfield (Figure 1-2). Likewise, the two deep interval composite samples were composed of blended soil fractions from the deep sampling intervals in boreholes DF-1 through DF-5 and DF-6 through DF-10. In addition, one composite soil sample consisting of blended soil fractions from each of the 10 drainfield shallow sampling intervals, and a second composite sample composed of blended soil from each of the 10 deep sampling intervals in the drainfield were collected and analyzed by a commercial laboratory for tritium in soil moisture.

Surface outfall soil samples were analyzed for VOCs, SVOCs, and RCRA metals by a commercial laboratory, and for soil pH by an SNL/NM laboratory. Also, to determine if radionuclides were released to the environment via the outfall, one composite soil sample consisting of blended soil fractions from each of the 3 surface outfall shallow sampling intervals, and a second composite sample composed of blended soil from each of the 3 deep sampling intervals were collected and analyzed by a commercial laboratory for tritium in soil moisture. The samples were also screened for other radionuclides using SNL/NM in-house gamma spectroscopy.

Surface discharge soil samples collected in May 1995 were analyzed by a commercial laboratory for hydrazine and RCRA metals, both of which may have been present in trace quantities in the underground tank effluent that drained into soil at this location.

3.2.6.1 Quality Assurance/Quality Control Summary

Quality assurance/quality control (QA/QC) samples collected during this effort consisted of one set of duplicate soil samples from each of the drainfield, surface outfall, and the surface discharge areas, one set of aqueous equipment rinsate blank samples, and two soil trip blanks. The duplicate soil samples included: (1) samples from the shallow interval in drainfield borehole DF-8 analyzed for VOCs, SVOCs and RCRA metals, (2) samples from the deep interval in surface outfall borehole OF-3 analyzed for VOCs, SVOCs and RCRA metals, and (3) samples from the deep interval of surface discharge borehole SD-1 analyzed for hydrazine and RCRA metals. Concentrations of the organic and inorganic constituents detected in the three sets of duplicate soil samples were in good agreement with those detected in the equivalent primary samples from the correlative intervals. Also, except for a trace concentration of one laboratory-introduced VOC (methylene chloride), no COCs were detected in the equipment rinsate samples.

A soil trip blank was included with each of the two shipments of soil samples to the laboratory in November 1994, and were analyzed for VOCs only. Several common VOC laboratory contaminants were detected in the trip blanks -- acetone, 2-hexanone, methyl ethyl ketone (MEK), methylene chloride, toluene, and total xylenes. These common laboratory contaminants were either not detected, or were for the most part found in lower concentrations in the soil characterization samples compared to the trip blanks. Soil used for the trip blanks was prepared by heating the material, and then transferring it immediately to the sample container. This heating process drives off any residual organic compounds (if present), and soil moisture, that may be contained in the material. It is thought that when the soil trip blank container was opened at the laboratory, it immediately adsorbed both moisture and VOCs present in the laboratory atmosphere, and therefore became slightly contaminated. Soil and aqueous laboratory method blank samples analyzed along with the ER Site 147 sample analytical batches also contained low levels of methylene chloride, methyl isobutyl ketone (MIBK), and xylenes.

Analytical data summary tables of organic and inorganic constituents analyzed for and detected by commercial laboratory analyses in the 1994 and 1995 confirmatory soil and associated QA samples, and the soil pH measurements completed by an SNL/NM in-house laboratory are contained in Section 6.4. Results of the SNL/NM in-house gamma spectroscopy screening for other radionuclides in soil samples from the drainfield and surface outfall area are presented in Sections 6.5 through 6.10. Complete soil sample analytical data packages for samples collected in 1994 and 1995 are archived in the SNL/NM Environmental Safety and Health Records Center and are readily available for review and verification (SNL/NM November 1994e and 1994f, May 1995c, and July 1995).

3.3 Gaps in Information

The most recent material present in the septic tank was not necessarily representative of all discharges to the unit that occurred since it was put into service in 1976. The analytical results of the various rounds of septic tank sampling were used, along with process knowledge and other available information, to help identify the most likely COCs that might be found in soils next to the septic tank, beneath the drainfield, near the surface outfall, and in the area of the surface discharge to select the types of analyses to be performed on soil samples collected from the site. While the history of past releases at the site is incomplete, analytical data from confirmatory soil samples collected in November 1994 and May 1995 (discussed below) are sufficient to determine whether significant releases of COCs occurred at the site.

3.4 Risk Evaluation

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

3.4.1 Human Risk Analysis

ER Site 144 has been recommended for industrial land-use (DOE 1996). A complete discussion of the risk assessment process, assumptions, results, and uncertainties is provided in Section 6.11. Due to the presence of several metals and radionuclides in concentrations slightly greater than the SNL/NM 95th percentile or upper tolerance limit (UTL) background levels, it was necessary to perform a human health risk assessment analysis for the site. The risk assessment process results in a quantitative evaluation of the potential adverse human health effects caused by constituents in the site's soil. The risk assessment report calculated the hazard index and excess cancer risk for both an industrial land-use and residential land-use setting. The excess cancer risk from nonradioactive COCs and the radioactive COCs is not additive (EPA 1989).

In summary, the total hazard index calculated for chemical compounds is 0.02 for an industrial land-use setting, which is less than the numerical standard of 1.0 suggested by risk assessment guidance (EPA 1989). The total excess cancer risk for chemical compounds is estimated to be 4×10^{-6} in an industrial land-use setting, which is at the low end of the suggested range of acceptable risk of 10^{-6} and 10^{-4} (EPA 1989).

For the radioactive constituents, the calculated incremental total estimated effective dose equivalent (TEDE) for an industrial land-use scenario is 0.02 millirems (mrem)/year, considerably less than the proposed EPA guidance incremental TEDE of 15 mrem/year (40 Code of Federal Regulations, Part 196 1994). The incremental cancer risk estimate is 4×10^{-7}.

The residential land-use scenarios for this site are provided only for comparison in the risk assessment analysis in Section 6.11. The analysis concludes that ER Site 144 does not have significant potential to affect human health under an industrial land-use scenario.

3.4.1 Ecological Risk Analysis

Ecological risk has not been addressed in this NFA proposal because the ecological risk analysis for ER Site 144 has not been estimated at this time. Site-wide ecological risk analyses are being conducted and the relevant analysis for this site will be presented when available. However, all the concentrations of metals and radionuclides detected are within the range of SNL/NM background levels. Much of the relevant ecological information for the site can be found in the National Environmental Policy Act (NEPA) compliance document (SNL/NM 1992).

4.0 RATIONALE FOR NO FURTHER ACTION DECISION

ER Site 144 is being proposed for an NFA determination for the following reasons:

- The passive soil-gas survey did not identify any potential VOC anomalies in the drainfield, septic tank or surface outfall areas.

- Confirmatory soil sampling around the septic tank, in the drainfield, and near the outfall area did not identify any residual COCs indicating past discharges that could pose a threat to human health or the environment. As shown in Section 6.4, only low to trace concentrations of seven VOC compounds which are common laboratory contaminants were detected in soil samples collected from this site. No SVOCs were detected, and the soil pH measurement were close to neutral pH, with pH values ranging from 6.68 to 8.09.

- Hydrazine was not detected in any of the seven soil samples collected in the surface discharge area. It was used as an oxygen scavenger and corrosion inhibitor in the coolant, and was probably spent by the time it was released to the environment.

- As shown in Section 6.4, analytical results of soil samples collected in the two ER Site 144 areas and from the surface discharge location indicate that six of the eight RCRA metals that were targeted in the Site 144 investigation were either not detected, or were detected in concentrations below the background UTL or 95th percentile concentrations presented in the SNL/NM study of naturally-occurring constituents (IT March 1996). Only 2 of the 37 soil samples collected at this site contained metals in concentrations above the background UTL for the respective metal, as follows. The shallow interval sample from drainfield borehole DF-9 (Figure 1-2) contained 78.1 milligrams per kilogram (mg/kg) of lead, which exceeds the SNL/NM soil background 95th percentile value of 11.8 mg/kg for that metal. However, the concentration of lead in this sample is still within the range of lead values (0.75 to 103 mg/kg) used in the SNL/NM soil background study, and it is also well below the 400 mg/kg residential action level proposed by the EPA for lead in soil (EPA July 1994). Also, the shallow interval sample from surface discharge borehole SD-2 (Figure 1-2) contained 3.1 mg/kg of silver, which exceeds the SNL/NM soil background 95th percentile value of <1 mg/kg for that metal. This silver concentration is still within the range of values (0.0016 to 8.7 mg/kg) used to establish the silver background UTL in the SNL/NM soil background study, and it is also substantially below the proposed Subpart S action level of 400 mg/kg for silver in soil.

- Isotopic uranium activities detected in the drainfield composite soil samples were found to be below the 95th percentile background activity levels presented in the IT March 1996 report for those radionuclides (Section 6.4), or were determined to result in a radiation dose much lower than the maximum acceptable radiation dose of 15 or 100 mrem/year referenced in the DOU (NMED April 1996).

- The gamma spectroscopy semi-qualitative screening of composite samples from the shallow and deep sampling intervals from the drainfield and surface outfall did not indicate significant concentrations of other radionuclides in soils at this site (Sections 6.5 through 6.10).

- Finally, the ER Site 144 septic tank contents were removed, and the tank was thoroughly cleaned and decontaminated in October 1995 (SNL/NM October 1995). The photograph on the right side of Figure 3-1 shows this septage removal and tank cleaning operation. The empty tank was then inspected by a representative of the New Mexico Environment Department (NMED) to verify that the tank contents had been removed and the tank closed in accordance with applicable State of New Mexico regulations (SNL/NM December 1995a).

Sample analytical results generated from this confirmatory sampling investigation have shown that detectable or significant concentrations of COCs are not present in soils at ER Site 144, and that additional investigations are unwarranted and unnecessary. Based on archival information and chemical and radiological analytical results of soil samples collected next to the septic tank, in the drainfield, and near the surface outfall and discharge locations and human health risk analysis, SNL/NM has demonstrated that COCs that may have been released from this SWMU into the environment pose an acceptable level of risk under current and projected future land use (DOU NFA Criterion 5), and the site does not pose a threat to human health or the environment. ER Site 144 is therefore recommended for an NFA determination.

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6.0 ANNEXES

6.1	Summary of Constituents in the 1992 Septic Tank Samples
6.2	Summary of Constituents in the 1994 and 1995 Septic Tank Samples
6.3	Summary of 1994 PETREX™ Passive Soil-Gas Survey Results
6.4	Organic and Inorganic Sample Analytical Data Summary Tables
6.5	Gamma Spectroscopy Screening Results for the Shallow Interval Composite Soil Sample From the Eastern Portion of the Drainfield
6.6	Gamma Spectroscopy Screening Results for the Shallow Interval Composite Soil Sample From the Western Portion of the Drainfield
6.7	Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the Eastern Portion of the Drainfield
6.8	Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the Western Portion of the Drainfield
6.9	Gamma Spectroscopy Screening Results for the Building 9980 Surface Outfall Shallow Intervals Composite Soil Sample
6.10	Gamma Spectroscopy Screening Results for the Building 9980 Surface Outfall Deep Intervals Composite Soil Sample

ER Site 144
Summary of Constituents in the 1992 Septic Tank Samples

Building 9980
Solar Tower at Coyote Test Field
Sample ID No. SNLA008424
Tank ID No.AD89050R

On July 14, 1992, aqueous and sludge samples were collected from the inactive septic tank serving Building 9980. Analytical results of concern are noted below.

- Methylene chloride was detected in the aqueous sample at a level of 0.15 mg/L, which exceeds the New Mexico Water Quality Control Commission discharge limit (NMDL) of 0.1 mg/L.
- Trichloroethene (TCE) was detected in the aqueous sample at a level of 6.1 mg/L, which exceeds the NMDL of 0.1 mg/L, the City of Albuquerque (COA) discharge limit of 5.0 mg/L, and the Resource Conservation and Recovery Act (RCRA) toxicity characteristic (TC) limit of 0.5 mg/L.
- Cadmium was detected in the aqueous sample at a level of 0.030 mg/L, which exceeds the NMDL of 0.01 mg/L.
- Copper was detected in the aqueous sample at a level of 2.6 mg/L, which exceeds the NMDL of 1.0 mg/L.
- Lead was detected in the aqueous sample at a level of 0.20 mg/L, which exceed the NMDL of 0.05 mg/L.
- Manganese was detected in the aqueous sample at a level of 0.24 mg/L, which exceeds the NMDL of 0.20 mg/L.
- Mercury was detected in the aqueous sample at a level of 0.0054 mg/L, which exceeds the NMDL of 0.002 mg/L.
- Total phenolic compounds were detected in the aqueous sample at a level of 0.062 mg/L, which exceeds the NMDL of 0.005 mg/L.
- Oil and grease were detected in the aqueous sample at a level greater than 374.8 mg/L, which exceeds the COA discharge limit of 150.0 mg/L.

No other parameters were detected in the aqueous fractions above NMDLs, COA discharge limits, or RCRA TC limits that identify hazardous waste.

Three items were noted during data review that qualify portions of the data for this septic tank. These items and the associated analyses are described below.

ER Site 144
Summary of Constituents in the 1992 Septic Tank Samples

- Holding times were exceeded for four analyses due to analytical laboratory error: semivolatile analysis by two days, polychlorinated biphenyls and pesticides analysis by ten days, cyanide analysis by seven days, and phenolics by six days. Exceeded holding times qualifies the data by presenting the possibility that the data is biased low.

- The value for oil and grease was quantitated incorrectly due to analyst error, with the result estimated to be 10 percent high. The sample could not be reanalyzed because of inadequate volume.

- The analytical laboratory noted that the fraction designated for nitrate/nitrite and phenolic analyses was not preserved as required.

During review of the radiological data, no parameters were detected that exceed U.S. Department of Energy (DOE) derived concentration guideline (DCG) limits or the investigation levels (IL) established during this investigation.

ER Site 144
Summary of Constituents in the 1992 Septic Tank Samples

Results of Septic Tank Analyses
(LIQUID SAMPLES)

Building No./Area:	9980 Solar Tower/CTF
Tank ID No.:	AD89050R
Date Sampled:	7/14/92
Sample ID No.:	SNLA-008424

Analytical Parameter	Measured Concentration	State Discharge Limit	COA Discharge Limit	Comments
Volatile Organics (EPA 624)	(mg/l)	(mg/l)	(mg/l)	
Methylene Chloride	0.15	0.1	(TTO=5.0)	Exceeds State Limit; Below reporting limit
Trichloroethene	6.1	0.1	(TTO=5.0)	Exceeds State limit; Exceeds RCRA TC limit of 0.5 mg/L
Semivolatile Organics (EPA 625)	(mg/l)	(mg/l)	(mg/l)	
N-Nitrosodiphenylamine	0.025	NR	(TTO=5.0)	Below reporting limit
Pesticides (EPA 608)	(mg/l)	(mg/l)	(mg/l)	
None detected above laboratory		NR	(TTO=5.0)	
reporting limits				
PCBs (EPA 608)	(mg/l)	(mg/l)	(mg/l)	
None detected above laboratory		0.001	(TTO=5.0)	
reporting limits				
Metals	(mg/l)	(mg/l)	(mg/l)	
Arsenic	0.013	0.1	2.0	
Barium	0.4	1.0	20.0	
Cadmium	0.030	0.01	2.8	Exceeds State limit
Chromium	0.043	0.05	20.0	
Copper	2.6	1.0	16.5	Exceeds State limit
Lead	0.20	0.05	3.2	Exceeds State limit
Manganese	0.24	0.20	20.0	Exceeds State limit
Mercury	0.0054	0.002	0.1	Exceeds State limit
Nickel	—	NR	12.0	Not analyzed
Selenium	0.0071	0.05	2.0	
Silver	ND (0.010)	0.05	5.0	
Thallium	ND (0.0050)	NR	NR	
Zinc	4.1	10.0	28.0	
Uranium	0.002	5.0	NR	
Miscellaneous Analytes	(mg/l)	(mg/l)	(mg/l)	
Phenolic Compounds	0.062	0.005	4.0	Exceeds State limit
Nitrates/Nitrites	4.6	10.0	NR	
Formaldehyde	ND (0.20)	NR	260.0	
Fluoride	0.57	1.6	180.0	
Cyanide	ND (0.010)	0.2	8.0	
Oil and Grease	>374.8	NR	150.0	Exceeds COA limit
Radiological Analyses	(pCi/l)	(pCi/l)	(pCi/l)	
Radium 226	0 +/- 0.1	30.0	NR	
Radium 228	0 +/- 30	30.0	NR	
Gross Alpha	64 +/- 79	NR	NR	
Gross Beta	214 +/- 220	NR	NR	
Tritium	<background	NR	NR	

NR = Not Regulated; ND(#.#) = Not Detected (Reporting Limit); TC = Toxicity Characteristic of Hazardous Waste

Note: City and State Discharge Limits are for comparison purposes only. City limits apply to discharge of sanitary effluent and not septic tank waste; state limits apply to effluent discharged onto or below the surface of the ground.

References - City of Albuquerque NM Sewer Use and Wastewater Control Ordinance (1990) Section 8-9-3 and New Mexico Water Quality Control Commission Regulations (1988) Section 3-100

Section 6.1, concluded:

ER Site 144
Summary of Constituents in the 1992 Septic Tank Samples

Results of Septic Tank Analyses (Sludge Sample)			
Building No./Area:	9980 SOLAR TOWER/CTF		
Tank ID No.:	AD89050R		
Date Sampled:	7/14/92		
Sample ID No.:	SNLA008424		
Analytical Parameter	**Measured Concentration**	**± 2 Sigma Uncertainty**	**Units**
Water Content	96.0	NA	%
Arsenic	0.82	NA	mg/kg
Barium	15.3	NA	mg/kg
Cadmium	2.1	NA	mg/kg
Chromium	1.9	NA	mg/kg
Copper	203	NA	mg/kg
Lead	16.2	NA	mg/kg
Manganese	8.9	NA	mg/kg
Mercury	0.31	NA	mg/kg
Nickel	---	NA	mg/kg
Selenium	ND(1.0)	NA	mg/kg
Silver	ND(1.0)	NA	mg/kg
Thallium	ND(0.50)	NA	mg/kg
Zinc	270	NA	mg/kg
Gross Alpha	28	16	pCi/g
Gross Beta	23	28	pCi/g
Gross Alpha	15	13	pCi/g
Gross Beta	18	24	pCi/g
Gross Alpha	23	14	pCi/g
Gross Beta	22	24	pCi/g
Gross Alpha	6	12	pCi/g
Gross Beta	23	28	pCi/g
Tritium	-1E+02	3E+02	pCi/L
Bismuth-214	0.0457	0.00702	pCi/mL
Cesium-137	<0.00952	NA	pCi/mL
Potassium-40	0.0343	0.00507	pCi/mL
Lead-212	0.00360	0.00663	pCi/mL
Lead-214	0.0448	0.00663	pCi/mL
Radium-226	0.410	0.00633	pCi/mL
Thorium-234	<0.154	NA	pCi/mL
Thallium-208	0.00191	0.00345	pCi/mL

ND = Not Detected
NA = Not Applicable

ER Site 144

Summary of Constituents in 1994 and 1995 Septic Tank Samples

Sample Number	Sample Matrix	Sample Type	Sample Date	Method	Compound Name	Result	Detection Limit or M.D.A.	+-2 Sigma Uncertainty for Rad Samples	Units
April 1994 Samples:									
15436-1	Sludge	Grab	4/7/94	8240 (VOCs)	Acetone	0.017 J	0.1	NA	mg/kg
				8240 (VOCs)	2-butanone	0.007 J	0.01	NA	mg/kg
				8240 (VOCs)	Carbon disulfide	0.002 J	0.005	NA	mg/kg
				8240 (VOCs)	Ethylbenzene	0.036	0.005	NA	mg/kg
				8240 (VOCs)	Methylene chloride	0.002 J,B	0.005	NA	mg/kg
				8240 (VOCs)	Styrene	0.001 J	0.005	NA	mg/kg
				8240 (VOCs)	Total xylenes	0.16	0.005	NA	mg/kg
15436-2	Sludge	Grab	4/7/94	9065	Phenolics	ND	13.0	NA	mg/kg
15436-2	Sludge	Grab	4/7/94	TCLP/7061	Arsenic	ND	0.002	NA	mg/L
				TCLP/7061	Barium	2.6	0.02	NA	mg/L
				TCLP/7061	Cadmium	0.02	0.005	NA	mg/L
				TCLP/7061	Chromium	ND	0.02	NA	mg/L
				TCLP/7061	Lead	ND	0.04	NA	mg/L
				TCLP/7061	Mercury	ND	0.0002	NA	mg/L
				TCLP/7061	Selenium	ND	0.002	NA	mg/L
				TCLP/7061	Silver	ND	0.01	NA	mg/L
November 1994 Samples:									
018435-1	Sludge	Grab	11/16/94	8270 (SVOCs)	4-Chloroaniline	150.0 J	660.0	NA	ug/kg
					Bis(2-ethylhexyl)phthalate	180.0 J	660.0	NA	ug/kg
18434-2	Liquid	Grab	11/16/94	EERF H01	Tritium	ND	191.0	107	pCi/L
018435-3	Sludge	Grab	11/16/94	EPA 600 906.0	Tritium	ND	240.0	140	pCi/L
18434-4	Liquid	Grab	11/16/94	HASL-300	Uranium 238	8.1	0.1	1.6	pCi/L
				HASL-300	Uranium 235	0.23	0.094	0.11	pCi/L
				HASL-300	Uranium 233/234	16.0 B	0.16	3.0	pCi/L
18435-3	Sludge	Grab	11/16/94	HASL-300	Uranium 238	6.5	0.043	0.73	pCi/g
				HASL-300	Uranium 235	0.22	0.032	0.062	pCi/g
				HASL-300	Uranium 233/234	13.0	0.048	1.5	pCi/g
18434-3	Liquid	Grab	11/16/94	Gamma Spec.	Multiple Radionuclides	ND	2.61 - 0.008	NR	pCi/mL
18435-2	Sludge	Grab	11/16/94		*Thorium Series:*				
				Gamma Spec.	Lead-212	0.043 J	0.044	0.030	pCi/g
					Other Radionuclides:				
				Gamma Spec.	Potassium-40	0.389 J	0.591	0.338	pCi/g

6.2, Concluded:

ER Site 144

Summary of Constituents in 1994 and 1995 Septic Tank Samples

Sample Number	Sample Matrix	Sample Type	Sample Date	Method	Compound Name	Result	Detection Limit or M.D.A.	+-2 Sigma Uncertainty for Rad. Samples	Units
August 1995 Sample:									
23880-0	Liquid	Grab	8/17/95	8240 (VOCs)	Acetone	15.0 J	20.0	NA	ug/L
				8240 (VOCs)	Ethylbenzene	6.0	2.0	NA	ug/L
				8240 (VOCs)	Toluene	1.0 J	2.0	NA	ug/L
				8240 (VOCs)	Xylenes	2.1 J	4.0	NA	ug/L

Notes

B = Compound detected in the laboratory blank.
J = Result is detected below the reporting limit or is an estimated concentration.
ug/L = Micrograms per liter
ug/kg = Micrograms per kilogram
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter
M.D.A. = Minimum Detectable Activity
NA = Not applicable
ND = Not detected
NR = Not reported by laboratory
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
Spec. = Spectroscopy
SVOCs = Semivolatile organic compounds
TCLP = Toxicity Characteristic Leaching Procedure
VOCs = Volatile organic compounds

Section 6.3

ER Site 144
Summary of 1994 PETREX™ Passive Soil-Gas Survey Results

PETREX Relative Soil Gas Response Values
(in ion counts)
STD Site 144

Sample	PCE	TCE	BTEX	Aliphatics
17	2,218	ND	58,702	35,724
18	ND	ND	ND	ND
19	ND	ND	19,634	8,171
20	5,970	ND	39,618	87,349
21	3,790	ND	60,018	48,380
22	ND	ND	ND	ND
24	2,326	ND	36,833	79,603
25	ND	ND	ND	ND
26	ND	ND	42,803	60,629
27	ND	ND	59,369	36,251
28	6,120	ND	101,672	46,639
29	ND	ND	71,940	38,971
30	17,136	ND	63,874	72,735
31	ND	ND	53,532	43,423
32	ND	ND	52,045	66,928
33	ND	ND	11,239	33,126
34	ND	ND	ND	ND
35	ND	ND	2,303	2,163
36	ND	ND	ND	ND
37	ND	ND	18,989	12,652
38	ND	ND	69,816	15,879
39	ND	ND	9,383	13,027
40	5,103	ND	26,230	21,396
41	ND	ND	8,363	ND
42	10,521	ND	149,023	86,484
43	2,285	ND	66,846	164,236
44	ND	ND	3,096	3,427
45	ND	ND	23,578	32,260
46	ND	ND	7,555	ND

ER Site 144
Summary of 1994 PETREX™ Passive Soil-Gas Survey Results

PETREX Relative Soil Gas Response Values
(in ion counts)
STD SITE 144

Sample	PCE	TCE	BTEX	Aliphatics
47	ND	ND	5855	15818
48	ND	ND	7106	5782
49	ND	ND	10298	57378
D-1047	ND	ND	3794	877
* 139	ND	ND	5334	10013
* 140	ND	ND	ND	2593

PCE- Tetrachloroethene
Indicator Mass Peak(s) 164

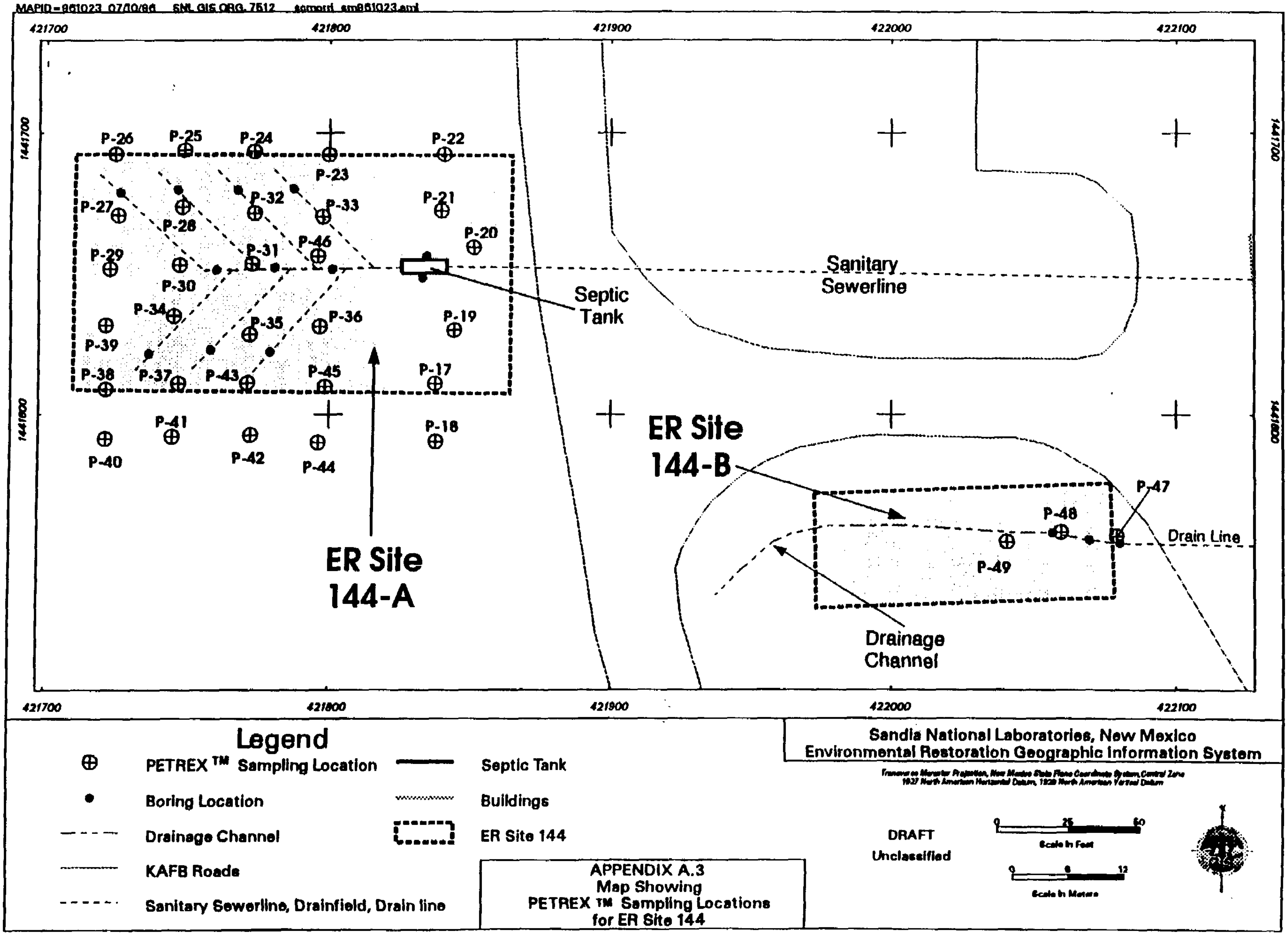
TCE - Trichloroethene
Indicator Mass Peak(s) 130

BTEX-Benzene, Toluene, Ethylbenzene/Xylene(s)
Indicator Mass Peak(s) 78, 92, 106

Aliphatics - C4-C11 Cycloalkanes/alkenes
Indicator Mass Peak(s) 56, 70, 84, 98, 112,
126, 140, 154

D - Duplicate Sample
Sample numbers in thousands duplicate of sample numbers in hundreds

* QA/QC Blank Sample - No Compounds Detected
above the PETREX Normal reporting Limits



Section 6.3, concluded:

ER Site 144
1994 PETREX™ Passive Soil-Gas Survey Sample Location Map

Section 6.4

ER Site 144
Summary of Organic Constituents and pH Measurements in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

						VOCs Method 8240								SVOCs			Soil pH ASTM Method 4972
Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2)	Top of Sample Interval (fbgs)	Acetone	2-Hexa-none	MEK	MIBK	Meth. Chloride	1,1,2,2-PCA	Toluene	Total Xylenes	Method 8270	Hydra-zine*	Units	(pH units)
Drainfield Soil and QA Samples:																	
018505-1,2	Soil	Field	11/21/94	DF-1	6	3.7 J	ND	ND	ND	4.5 J	ND	ND	ND	ND	NS	ug/kg	7.71
018506-1,2	Soil	Field	11/21/94	DF-1	16	4.7 J	ND	ND	ND	5.1	ND	ND	ND	ND	NS	ug/kg	7.97
018494-1,2	Soil	Field	11/17/94	DF-2	6	ND	ND	ND	ND	2.0 J	ND	1.0 J	ND	ND	NS	ug/kg	7.59
018495-1,2	Soil	Field	11/17/94	DF-2	16	ND	ND	ND	ND	2.6 J	ND	ND	ND	ND	NS	ug/kg	7.6
018487-1,2	Soil	Field	11/16/94	DF-3	6	5.1 J	ND	4.7 J	ND	2.2 J	ND	ND	ND	ND	NS	ug/kg	7.97
018488-1,2	Soil	Field	11/16/94	DF-3	16	4.1 J	ND	ND	ND	2.0 J	ND	ND	ND	ND	NS	ug/kg	7.97
018485-1,2	Soil	Field	11/16/94	DF-4	6	ND	ND	ND	1.2 J	2.5 J	ND	ND	ND	ND	NS	ug/kg	8.09
018486-1,2	Soil	Field	11/16/94	DF-4	16	ND	ND	ND	ND	1.8 J	ND	ND	ND	ND	NS	ug/kg	7.94
018492-1,2	Soil	Field	11/17/94	DF-5	6	ND	ND	ND	ND	1.0 J	ND	ND	ND	ND	NS	ug/kg	7.77
018493-1,2	Soil	Field	11/17/94	DF-5	16	4.3 J	ND	4.4 J	ND	2.0 J	ND	ND	ND	ND	NS	ug/kg	7.68
018503-1,2	Soil	Field	11/21/94	DF-6	6	ND	ND	ND	ND	5.1	ND	1.2 J	ND	ND	NS	ug/kg	7.64
018504-1,2	Soil	Field	11/21/94	DF-6	16	4.8 J	ND	ND	ND	5.7	ND	ND	ND	ND	NS	ug/kg	7.88
018501-1,2	Soil	Field	11/21/94	DF-7	6	2.4 J	ND	ND	ND	4.4 J	1.3 J	ND	ND	ND	NS	ug/kg	7.34
018502-1,2	Soil	Field	11/21/94	DF-7	16	ND	ND	ND	ND	4.7 J	ND	ND	ND	ND	NS	ug/kg	7.87
018489-1,2	Soil	Field	11/16/94	DF-8	6	ND	ND	ND	ND	1.8 J	ND	ND	ND	ND	NS	ug/kg	7.73
018490-1,2	Soil	Dupl.	11/16/94	DFD-8	6	1.9 J	ND	ND	ND	1.1 J	ND	ND	ND	ND	NS	ug/kg	NS
018491-1,2	Soil	Field	11/16/94	DF-8	16	ND	ND	7.1 J	ND	1.2 J	ND	ND	ND	ND	NS	ug/kg	8.03
018483-1,2	Soil	Field	11/16/94	DF-9	6	2.5 J	ND	26	1.3 J	2.4 J	ND	2.8 J	ND	ND	NS	ug/kg	7.75
018484-1,2	Soil	Field	11/16/94	DF-9	16	ND	ND	ND	ND	2.3 J	ND	ND	1.3 J	ND	NS	ug/kg	7.85
018496-1,2	Soil	Field	11/17/94	DF-10	6	ND	ND	ND	ND	1.8 J	ND	ND	ND	ND	NS	ug/kg	7.82
018500-1,2	Soil	Field	11/21/94	DF-10	16	10	ND	ND	ND	5.0	ND	1.4 J	ND	ND	NS	ug/kg	7.99
018507-1,2	Water	EB	11/21/94	Site 144	NA	ND	ND	ND	ND	1.4 B,J	ND	ND	ND	ND	NS	ug/L	NS

6.4, continued:

ER Site 144

Summary of Organic Constituents and pH Measurements in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2)	Top of Sample Interval (fbgs)	VOCs Method 8240: Acetone	2-Hexanone	MEK	MIBK	Meth. Chloride	1,1,2,2-PCA	Toluene	Total Xylenes	SVOCs Method 8270	Hydrazine*	Units	Soil pH ASTM Method 4972 (pH units)
Septic Tank Soil and QA Samples:																	
018497-1,2	Soil	Field	11/17/94	ST-1	9	ND	ND	ND	ND	1.8 J	ND	ND	ND	ND	NS	ug/kg	7.77
018498-1,2	Soil	Field	11/17/94	ST-2	9	3.4 J	ND	ND	ND	1.8 J	ND	ND	ND	ND	NS	ug/kg	7.75
018499-1	Soil	TB	11/17/94	Site 144	NA	74	3.2 J	22	ND	7.8	ND	1.6 J	2.1 J	NA	NA	ug/kg	NS
Surface Outfall Soil and QA Samples:																	
018756-1,2	Soil	Field	11/30/94	OF-1	1	3.6 J	ND	ND	ND	2.9 B,J	ND	ND	ND	ND	NS	ug/kg	7.05
018757-1,2	Soil	Field	11/30/94	OF-1	11	3.9 J	ND	ND	ND	2.4 B,J	ND	2.5 J	ND	ND	NS	ug/kg	6.83
018758-1,2	Soil	Field	11/30/94	OF-2	1	ND	ND	ND	ND	3.1 B,J	ND	ND	ND	ND	NS	ug/kg	6.69
018759-1,2	Soil	Field	11/30/94	OF-2	11	4.6 J	ND	ND	ND	1.8 B,J	ND	1.1 J	ND	ND	NS	ug/kg	6.76
018760-1,2	Soil	Field	11/30/94	OF-3	1	ND	ND	ND	ND	2.1 B,J	ND	ND	ND	ND	NS	ug/kg	6.71
018762-1,2	Soil	Field	11/30/94	OF-3	11	9.6 J	ND	ND	ND	1.6 B,J	ND	1.2 J	ND	ND	NS	ug/kg	6.68
018761-1,2	Soil	Dupl.	11/30/94	OFD-3	11	ND	ND	ND	ND	1.8 B,J	ND	ND	ND	ND	NS	ug/kg	NS
021081-1	Soil	TB	11/30/94	Site 144	NA	25	ND	14	ND	4.0 B,J	ND	2.6 J	ND	NA	NA	ug/kg	NS
Surface Discharge Location Soil Samples:																	
023842-1,2	Soil	Field	5/22/95	SD-1	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023843-1,2	Soil	Field	5/22/95	SD-1	11	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023844-1,2	Soil	Dupl.	5/22/95	SDD-1	11	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023845-1,2	Soil	Field	5/22/95	SD-2	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023846-1,2	Soil	Field	5/22/95	SD-2	11	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023847-1,2	Soil	Field	5/23/95	SD-3	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
023848-1,2	Soil	Field	5/23/95	SD-3	11	NS	NS	NS	NS	NS	NS	NS	NS	NS	ND	ug/kg	NS
Laboratory Reporting Limit for Soil						10	10	10	10	5.0	5.0	5.0	5.0	330 or 1,600	1	ug/kg	
Laboratory Reporting Limit for Water						10	10	10	10	5.0	5.0	5.0	5.0	10 - 50	NA	ug/L	
Proposed Subpart S Action Level For Soil						8E+06	None	5E+07	4E+06	9E+04	4E+04	2E+07	2E+08	NA	2E+04	ug/kg	

ER Site 144

Summary of Organic Constituents and pH Measurements in Confirmatory Soil Samples Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Notes:
B = Compound detected in associated blank sample
Dupl. = Duplicate soil sample
EB = Equipment blank
fbgs = feet below ground surface
J = Result is detected below the reporting limit or is an estimated concentration.
MEK = Methyl ethyl ketone
Meth. chloride = Methylene chloride
MIBK = 4-Methyl-2-pentanone
NA = Not applicable
ND = Not detected
NS = No sample
QA = Quality assurance
SVOCs = Semivolatile organic compounds
TB = Trip blank
ug/kg = Micrograms per kilogram
ug/L = Micrograms per liter
VOCs = Volatile organic compounds
1,1,2,2-PCA = 1,1,2,2-Tetrachloroethane
* Hydrazine analyses performed using colorimetric method based on ASTM method #D1385

6.4, continued:

ER Site 144
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2)	Top of Sample Interval (fbgs)	RCRA Metals Methods 6010, 7060, 7421, 7471, and 7740 for surface discharge location samples, and Methods 6010 and 7471 for all other samples								Units
						As	Ba	Cd	Cr, total	Pb	Hg	Se	Ag	
Drainfield Soil and QA Samples:														
018505-2	Soil	Field	11/21/94	DF-1	6	3.9	118	ND	7.1	9.9	ND	ND	ND	mg/kg
018506-2	Soil	Field	11/21/94	DF-1	16	3.3	103	ND	6.3	6.4	ND	ND	ND	mg/kg
018494-2	Soil	Field	11/17/94	DF-2	6	4.0	39.2	ND	4.1	11.4	ND	ND	ND	mg/kg
018495-2	Soil	Field	11/17/94	DF-2	16	2.6	45.6	ND	5.2	5.0	ND	ND	ND	mg/kg
018487-2	Soil	Field	11/16/94	DF-3	6	4.1	170	ND	7.2	6.9	ND	ND	ND	mg/kg
018488-2	Soil	Field	11/16/94	DF-3	16	3.2	79.3	ND	7.1	9.1	ND	ND	ND	mg/kg
018485-2	Soil	Field	11/16/94	DF-4	6	3.7	88.8	ND	6.7	6.7	ND	ND	ND	mg/kg
018486-2	Soil	Field	11/16/94	DF-4	16	3.7	156	ND	7.5	8.9	ND	ND	ND	mg/kg
018492-2	Soil	Field	11/17/94	DF-5	6	6.6	83.3	ND	6.0	6.6	ND	ND	ND	mg/kg
018493-2	Soil	Field	11/17/94	DF-5	16	3.2	131	ND	5.0	4.5 J	ND	ND	ND	mg/kg
018503-2	Soil	Field	11/21/94	DF-6	6	4.2	48.1	ND	4.8	8.5	ND	ND	ND	mg/kg
018504-2	Soil	Field	11/21/94	DF-6	16	3.8	126	ND	7.6	6.8	ND	ND	ND	mg/kg
018501-2	Soil	Field	11/21/94	DF-7	6	2.8	72.1	ND	5.0	6.2	ND	ND	ND	mg/kg
018502-2	Soil	Field	11/21/94	DF-7	16	3.4	51.3	ND	5.4	7.4	ND	ND	ND	mg/kg
018489-2	Soil	Field	11/16/94	DF-8	6	2.3	26.7	ND	2.3	4.9 J	ND	ND	ND	mg/kg
018490-2	Soil	Dupl.	11/16/94	DFD-8	6	3.8	55.0	ND	5.0	6.7	ND	ND	ND	mg/kg
018491-2	Soil	Field	11/16/94	DF-8	16	3.6	49.0	ND	5.7	5.5	ND	ND	ND	mg/kg
018483-2	Soil	Field	11/16/94	DF-9	6	4.7	73.7	ND	5.4	78.1	ND	ND	ND	mg/kg
018484-2	Soil	Field	11/16/94	DF-9	16	3.7	66.6	ND	7.1	7.9	ND	ND	ND	mg/kg
018496-2	Soil	Field	11/17/94	DF-10	6	2.3	34.0	ND	2.5	9.0	ND	ND	ND	mg/kg
018500-2	Soil	Field	11/21/94	DF-10	16	4.8	88.7	ND	10.5	10.1	ND	ND	ND	mg/kg
018507-3	Water	EB	11/21/94	Site 144	NA	ND	ND	ND	ND	ND	ND	ND	ND	mg/L

6.4, continued:

ER Site 144
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2)	Top of Sample Interval (fbgs)	RCRA Metals Methods 6010, 7060, 7421, 7471, and 7740 for surface discharge samples, and Methods 6010 and 7471 for all other samples								Units
						As	Ba	Cd	Cr, total	Pb	Hg	Se	Ag	
Septic Tank Soil Samples:														
018497-2	Soil	Field	11/17/94	ST-1	9	3.2	58.9	ND	2.4	ND	ND	ND	ND	mg/kg
018498-2	Soil	Field	11/17/94	ST-2	9	2.4	35.6	ND	3.3	5.0	ND	ND	ND	mg/kg
Surface Outfall Soil Samples:														
018756-2	Soil	Field	11/30/94	OF-1	1	2.9	117	ND	5.6	3.8 J	ND	ND	ND	mg/kg
018757-2	Soil	Field	11/30/94	OF-1	11	2.8	90.5	ND	4.5	3.8 J	ND	ND	ND	mg/kg
018758-2	Soil	Field	11/30/94	OF-2	1	2.7	145	ND	6.9	5.3	ND	ND	ND	mg/kg
018759-2	Soil	Field	11/30/94	OF-2	11	2.9	108	ND	4.4	ND	ND	ND	ND	mg/kg
018760-2	Soil	Field	11/30/94	OF-3	1	3.2	105	ND	6.7	4.4 J	ND	ND	ND	mg/kg
018762-2	Soil	Field	11/30/94	OF-3	11	3.8	85.2	ND	5.0	8.4	ND	ND	ND	mg/kg
018761-2	Soil	Dupl.	11/30/94	OFD-3	11	4.6	113	ND	4.7	5.2	ND	ND	ND	mg/kg

6.4, continued:

ER Site 144
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2)	Top of Sample Interval (fbgs)	RCRA Metals Methods 6010, 7060, 7421, 7471, and 7740 for surface discharge samples, and Methods 6010 and 7471 for all other samples								Units
						As	Ba	Cd	Cr, total	Pb	Hg	Se	Ag	
Surface Discharge Location Soil Samples:														
023842-2	Soil	Field	5/22/95	SD-1	1	3.3	170	ND	6.9	6.7	ND	ND	ND	mg/kg
023843-2	Soil	Field	5/22/95	SD-1	11	4.0	78	ND	7.4	9.8	ND	ND	ND	mg/kg
023844-2	Soil	Dupl.	5/22/95	SDD-1	11	3.4	75	ND	6.3	7.2	ND	ND	ND	mg/kg
023845-2	Soil	Field	5/22/95	SD-2	1	3.4	200	ND	6.0	5.4	ND	ND	3.1	mg/kg
023846-2	Soil	Field	5/22/95	SD-2	11	3.1	ND	ND	4.8	7.8	ND	ND	ND	mg/kg
023847-2	Soil	Field	5/23/95	SD-3	1	3.7	85	ND	7.8	5.9	ND	ND	ND	mg/kg
023848-2	Soil	Field	5/23/95	SD-3	11	3.7	ND	ND	5.7	11	ND	ND	ND	mg/kg
Laboratory R.L. for Soil (non-surface discharge location samples)						1.0	1.0	0.5	1.0	5.0	0.1	0.5	1.0	mg/kg
Laboratory R.L. for Soil (surface discharge location samples)						2.0	40	1.0	2.0	0.6	0.1	1.0	2.0	mg/kg
Laboratory Detection Limit for Water						0.01	0.01	0.005	0.01	0.003	0.0002	0.005	0.01	mg/L
Number of SNL/NM Background Soil Sample Analyses *						15	727	1,740	647	536	1,724	2,134	2,302	mg/kg
SNL/NM Soil Background Range *						2.1-7.9	0.5-495	0.0027-6.2	0.5-31.4	0.75-103	0.0001-0.68	0.037-17.2	0.0016-8.7	mg/kg
SNL/NM Soil Background UTL or 95th Percentile *						7	214	0.9	15.9	11.8	<0.1	<1	<1	mg/kg
Proposed Subpart S Action Level For Soil						0.5	6000	80	80,000 **	400 ***	20	400	400	mg/kg

6.4, continued:

ER Site 144
Summary of RCRA Metals in Confirmatory Soil Samples
Collected in the Drainfield, Around the Septic Tank, and at the Surface Outfall and Surface Discharge Locations

Notes:

As = Arsenic. Arsenic background concentrations presented above are based on analyses of subsurface soil samples collected in the Coyote Test Field (CTF) area.

Ba = Barium. Barium background concentrations presented above are based on analyses of subsurface soil samples collected in the Southwest and CTF areas.

Cd = Cadmium. Cadmium background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF, and Offsite areas.

Cr = Chromium. Chromium background concentrations presented above are based on analyses of subsurface soil samples collected in the Southwest area.

Pb = Lead. Lead background concentrations presented above are based on analyses of subsurface samples collected in the Southwest and Offsite areas.

Hg = Mercury. Mercury background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF and Offsite areas.

Se = Selenium. Selenium background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the North, Tijeras, Southwest, CTF and Offsite areas.

Ag = Silver. Silver background concentrations presented above are based on analyses of subsurface soil samples collected in the North, Tijeras, Southwest, CTF, and Offsite areas.

Dupl. = Duplicate soil sample
EB = Equipment blank
fbgs = Feet below ground surface
J = Result is detected below the reporting limit or is an estimated concentration.
mg/kg = Milligrams per kilogram
mg/L = Milligrams per liter
NA = Not applicable
ND = Not detected

R.L = Reporting limit
QA = Quality assurance
UTL = Upper Tolerance Limit
* IT March 1996
** 80,000 mg/kg is for Cr^{3+} only. For Cr^{6+}, proposed Subpart S action level is 400 mg/kg.
*** No proposed Subpart S action level for lead in soil, 400 ppm is EPA proposed action level (EPA July 1994)

6.4, continued:

ER Site 144
Summary of Isotopic Uranium and Tritium in Composite Confirmatory Soil Samples Collected in the Drainfield and Near the Surface Outfall

Sample Number	Sample Matrix	Sample Type	Sample Date	Sample Location (Figure 1-2	Top of Sample Interval (fbgs)	Isotopic Uranium Method EPI A-011B (pCi/g) U-233/ U-234 Result	U-233/ U-234 Error *	U-233/ U-234 M.D.A.	U-235 Result	U-235 Error *	U-235 M.D.A.	U-238 Result	U-238 Error *	U-238 M.D.A.	Tritium Method EPA-600 906.0 (pCi/L) Result	Error *	M.D.A.
Drainfield Soil Samples:																	
023868-1	Soil	Composite	11/16-21/94	DF-1/5	6	1.88	0.353	0.102	ND	0.046	0.09	1.67	0.319	0.09			
023869-1	Soil	Composite	11/16-21/94	DF-6/10	6	1.34	0.167	0.09	0.046 J	0.024	0.09	0.999	0.135	0.09			
023870-1	Soil	Composite	11/16-21/94	DF-1/5	16	0.97	0.144	0.09	0.033 J	0.021	0.09	0.826	0.129	0.09			
023871-1	Soil	Composite	11/16-21/94	DF-6/10	16	1.12	0.155	0.09	0.046 J	0.026	0.09	0.958	0.139	0.09			
018483-4	Soil	Composite	11/16-21/94	DF-1/10	6										ND	150.0	270.0
018484-4	Soil	Composite	11/16-21/94	DF-1/10	16										ND	150.0	250.0
Surface Outfall Soil Samples:																	
018756-4	Soil	Composite	11/30/94	OF-1/3	1										220.0	140.0	220.0
018757-4	Soil	Composite	11/30/94	OF-1/3	11										220.0	140.0	220.0
Number of SNL/NM Background Soil Sample Analyses **						14			283			90			U		
SNL/NM Soil Background Range **						0.44-<5.02			0.004-3			0.153-2.3			U		
SNL/NM Soil Background 95th Percentile **						<5.02			0.16			1.4			U		
Nationwide Tritium Range in Precipation and Drinking Water ***						NA			NA			NA			100.0-400.0		

6.4, concluded:

ER Site 144
Summary of Isotopic Uranium and Tritium in Composite Confirmatory Soil Samples Collected in the Drainfield and Near the Surface Outfall

Notes:
U-233 = Uranium 233
U-234 = Uranium 234. Uranium 233/234 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.
U-235 = Uranium 235. Uranium 235 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.
U-238 = Uranium 238. Uranium 235 background concentrations presented above are based on analyses of surface and subsurface soil samples collected in the Southwest area.

fbgs = Feet below ground surface
J = Result is detected below the reporting limit or is an estimated concentration.
M.D.A. = Minimum detectable activity
ND = Not detected
pCi/g = Picocuries per gram
pCi/L = Picocuries per liter
U = Undefined for SNL/NM soils
UTL = Upper Tolerance Limit
* Error = +- 2 sigma uncertainty
** IT March 1996
*** EPA October 1993

ER Site 144
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the Eastern Portion of the Drainfield

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*************************************************************************
*                    Sandia National Laboratories                       *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]   *
*                      7-21-95 12:45:31 AM                              *
*************************************************************************
*                                                                       *
* Analyzed by:        7/21/95           Reviewed by:         7/21/95    *
*************************************************************************

Customer              : GALLOWAY/D.BISWELL (7582/SMO)
Customer Sample ID    : 023868-1A
Lab Sample ID         : 50057501

Sample Description    : MARINELLI SOIL SAMPLE
Sample Type           : Solid
Sample Geometry       : 1SMAR
Sample Quantity       :   988.000  gram
Sample Date/Time      :  7-20-95  11:15:00 AM
Acquire Start Date    :  7-21-95  12:11:25 AM
Detector Name         : LAB01
Elapsed Live Time     :   1800 seconds
Elapsed Real Time     :   1801 seconds

Comments:
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Nuclide	Activity (pCi/gram)	2S Error	MDA
U-238	Not Detected	--------	1.80
TH-234	Not Detected	--------	7.84E-01
U-234	Not Detected	--------	1.74E+01
RA-226	1.78	6.96E-01	9.66E-01
PB-214	7.17E-01	1.27E-01	7.78E-02
BI-214	6.33E-01	1.14E-01	8.38E-02
PB-210	Not Detected	--------	1.18
TH-232	5.41E-01	1.82E-01	2.22E-01
RA-228	4.38E-01	1.90E-01	2.55E-01
AC-228	5.82E-01	1.54E-01	1.59E-01
TH-228	5.12E-01	2.67E-01	5.96E-01
RA-224	1.83	4.73E-01	6.05E-01
PB-212	5.91E-01	1.26E-01	5.37E-02
BI-212	8.68E-01	3.82E-01	5.17E-01
TL-208	4.57E-01	1.08E-01	1.06E-01
U-235	Not Detected	--------	3.21E-01
TH-231	Not Detected	--------	6.32E-01
PA-231	Not Detected	--------	1.82
AC-227	Not Detected	--------	2.33
TH-227	Not Detected	--------	4.57E-01
RA-223	Not Detected	--------	2.08E-01
RN-219	Not Detected	--------	2.72E-01
PB-211	Not Detected	--------	8.62E-01
TL-207	Not Detected	--------	1.93E+01
AM-241	Not Detected	--------	2.26E-01
PU-239	Not Detected	--------	2.83E+02
NP-237	Not Detected	--------	2.55E-01
PA-233	Not Detected	--------	8.29E-02
TH-229	Not Detected	--------	3.35E-01

ER Site 144
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the Eastern Portion of the Drainfield

[Summary Report] - Sample ID: 50057501

Nuclide	Activity (pCi/gram)	2S Error	MDA
AG-110m	Not Detected	--------	4.04E-02
AR-41	Not Detected	--------	9.09
BA-133	Not Detected	--------	8.93E-02
BA-140	Not Detected	--------	1.54E-01
CD-109	Not Detected	--------	8.75E-01
CD-115	Not Detected	--------	1.00E-01
CE-139	Not Detected	--------	4.31E-02
CE-141	Not Detected	--------	7.25E-02
CE-144	Not Detected	--------	3.30E-01
CO-56	Not Detected	--------	5.09E-02
CO-57	Not Detected	--------	4.07E-02
CO-58	Not Detected	--------	4.44E-02
CO-60	Not Detected	--------	4.87E-02
CR-51	Not Detected	--------	3.17E-01
CS-134	Not Detected	--------	7.49E-02
CS-137	Not Detected	--------	4.83E-02
CU-64	Not Detected	--------	2.30E+01
EU-152	Not Detected	--------	3.47E-01
EU-154	Not Detected	--------	2.39E-01
EU-155	Not Detected	--------	1.74E-01
FE-59	Not Detected	--------	1.02E-01
GD-153	Not Detected	--------	1.41E-01
HG-203	Not Detected	--------	4.03E-02
I-131	Not Detected	--------	4.15E-02
IN-115m	Not Detected	--------	6.57E-01
IR-192	Not Detected	--------	3.88E-02
K-40	1.80E+01	2.55	3.56E-01
LA-140	Not Detected	--------	4.66E-02
MN-54	Not Detected	--------	4.72E-02
MN-56	Not Detected	--------	1.77
MO-99	Not Detected	--------	3.73E-01
NA-22	Not Detected	--------	5.83E-02
NA-24	Not Detected	--------	8.63E-02
NB-95	Not Detected	--------	2.36E-01
ND-147	Not Detected	--------	2.82E-01
NI-57	Not Detected	--------	8.34E-02
BE-7	Not Detected	--------	3.25E-01
RU-103	Not Detected	--------	4.10E-02
RU-106	Not Detected	--------	3.86E-01
SB-122	Not Detected	--------	6.36E-02
SB-124	Not Detected	--------	4.89E-02
SB-125	Not Detected	--------	1.11E-01
SC-46	Not Detected	--------	7.65E-02
SR-85	Not Detected	--------	5.03E-02
TA-182	Not Detected	--------	2.21E-01
TA-183	Not Detected	--------	2.07E-01
TE-132	Not Detected	--------	4.43E-02
TL-201	Not Detected	--------	1.46E-01
V-48	Not Detected	--------	4.96E-02
XE-133	Not Detected	--------	1.79E-01
Y-88	Not Detected	--------	3.48E-02
ZN-65	Not Detected	--------	1.52E-01
ZR-95	Not Detected	--------	7.78E-02

ER Site 144
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the Western Portion of the Drainfield

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****************************************************************************
*                       Sandia National Laboratories                       *
*   Radiation Protection Sample Diagnostics Program [881 Laboratory]       *
*                          7-21-95  1:25:46 AM                             *
****************************************************************************
*                                                                          *
* Analyzed by:      7/21/95          Reviewed by:        7/21/95           *
****************************************************************************
```

Customer : GALLOWAY/D.BISWELL (7582/SMO)
Customer Sample ID : 023869-1A
Lab Sample ID : 50057502

Sample Description : MARINELLI SOIL SAMPLE
Sample Type : Solid
Sample Geometry : 1SMAR
Sample Quantity : 1092.000 gram
Sample Date/Time : 7-20-95 11:30:00 AM
Acquire Start Date : 7-21-95 12:51:58 AM
Detector Name : LAB01
Elapsed Live Time : 1800 seconds
Elapsed Real Time : 1801 seconds

Comments:

****

Nuclide	Activity (pCi/gram)	2S Error	MDA
U-238	Not Detected	--------	1.61
TH-234	6.24E-01	3.14E-01	4.66E-01
U-234	Not Detected	--------	1.52E+01
RA-226	1.22	6.40E-01	9.50E-01
PB-214	5.37E-01	1.01E-01	7.55E-02
BI-214	5.21E-01	9.28E-02	6.14E-02
PB-210	4.76E-01	3.86E-01	5.44E-01
TH-232	4.11E-01	1.54E-01	1.97E-01
RA-228	2.98E-01	1.78E-01	2.62E-01
AC-228	4.38E-01	1.35E-01	1.60E-01
TH-228	Not Detected	--------	1.17
RA-224	Not Detected	--------	5.15E-01
PB-212	4.91E-01	9.87E-02	4.87E-02
BI-212	2.09E-01	3.10E-01	5.04E-01
TL-208	4.57E-01	1.07E-01	1.06E-01
U-235	Not Detected	--------	2.93E-01
TH-231	Not Detected	--------	5.64E-01
PA-231	Not Detected	--------	1.63
AC-227	Not Detected	--------	2.14
TH-227	Not Detected	--------	4.12E-01
RA-223	Not Detected	--------	1.85E-01
RN-219	Not Detected	--------	3.32E-01
PB-211	Not Detected	--------	8.20E-01
TL-207	Not Detected	--------	1.90E+01
AM-241	Not Detected	--------	2.02E-01
PU-239	Not Detected	--------	3.32E+02
NP-237	Not Detected	--------	2.21E-01
PA-233	Not Detected	--------	7.40E-02
TH-229	Not Detected	--------	3.16E-01

ER Site 144
Gamma Spectroscopy Screening Results for the Shallow Interval
Composite Soil Sample From the Western Portion of the Drainfield

[Summary Report] - Sample ID: 50057502

Nuclide	Activity (pCi/gram)	2S Error	MDA
AG-110m	Not Detected	--------	3.59E-02
AR-41	Not Detected	--------	9.86
BA-133	Not Detected	--------	7.67E-02
BA-140	Not Detected	--------	1.39E-01
CD-109	Not Detected	--------	7.59E-01
CD-115	Not Detected	--------	9.28E-02
CE-139	Not Detected	--------	3.98E-02
CE-141	Not Detected	--------	6.66E-02
CE-144	Not Detected	--------	2.97E-01
CO-56	Not Detected	--------	4.67E-02
CO-57	Not Detected	--------	3.78E-02
CO-58	Not Detected	--------	4.05E-02
CO-60	Not Detected	--------	5.01E-02
CR-51	Not Detected	--------	2.86E-01
CS-134	Not Detected	--------	6.44E-02
CS-137	Not Detected	--------	4.12E-02
CU-64	Not Detected	--------	2.06E+01
EU-152	Not Detected	--------	3.37E-01
EU-154	Not Detected	--------	2.22E-01
EU-155	Not Detected	--------	1.62E-01
FE-59	Not Detected	--------	1.03E-01
GD-153	Not Detected	--------	1.28E-01
HG-203	Not Detected	--------	3.61E-02
I-131	Not Detected	--------	3.80E-02
IN-115m	Not Detected	--------	6.44E-01
IR-192	Not Detected	--------	3.51E-02
K-40	1.94E+01	2.73	3.70E-01
LA-140	Not Detected	--------	4.77E-02
MN-54	Not Detected	--------	4.38E-02
MN-56	Not Detected	--------	1.82
MO-99	Not Detected	--------	3.57E-01
NA-22	Not Detected	--------	5.47E-02
NA-24	Not Detected	--------	8.53E-02
NB-95	Not Detected	--------	2.13E-01
ND-147	Not Detected	--------	2.63E-01
NI-57	Not Detected	--------	8.73E-02
BE-7	Not Detected	--------	3.00E-01
RU-103	Not Detected	--------	3.59E-02
RU-106	Not Detected	--------	3.68E-01
SB-122	Not Detected	--------	6.06E-02
SB-124	Not Detected	--------	4.28E-02
SB-125	Not Detected	--------	1.04E-01
SC-46	Not Detected	--------	6.66E-02
SR-85	Not Detected	--------	4.53E-02
TA-182	Not Detected	--------	1.98E-01
TA-183	Not Detected	--------	1.86E-01
TE-132	Not Detected	--------	3.98E-02
TL-201	Not Detected	--------	1.29E-01
V-48	Not Detected	--------	4.67E-02
XE-133	Not Detected	--------	1.61E-01
Y-88	Not Detected	--------	2.95E-02
ZN-65	Not Detected	--------	1.30E-01
ZR-95	Not Detected	--------	6.80E-02

ER Site 144:
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the Eastern Portion of the Drainfield

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*************************************************************************
*                   Sandia National Laboratories                         *
*   Radiation Protection Sample Diagnostics Program [881 Laboratory]    *
*                     7-21-95  2:06:22 AM                                *
*************************************************************************
*                                                                        *
* Analyzed by: [signature] 7/21/95      Reviewed by: [signature] 7/21/95 *
*************************************************************************

Customer            : GALLOWAY/D.BISWELL (7582/SMO)
Customer Sample ID  : 023870-1A
Lab Sample ID       : 50057503

Sample Description  : MARINELLI SOIL SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :    899.000  gram
Sample Date/Time    :   7-20-95  11:40:00 AM
Acquire Start Date  :   7-21-95   1:32:14 AM
Detector Name       : LAB01
Elapsed Live Time   :    1800 seconds
Elapsed Real Time   :    1801 seconds

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

Nuclide	Activity (pCi/gram)	2S Error	MDA
U-238	8.52E-01	8.53E-01	1.35
TH-234	1.11	5.15E-01	5.77E-01
U-234	Not Detected	--------	1.74E+01
RA-226	1.41	6.81E-01	9.91E-01
PB-214	7.55E-01	1.34E-01	8.39E-02
BI-214	5.97E-01	1.11E-01	8.49E-02
PB-210	8.34E-01	4.25E-01	3.80E-01
TH-232	6.52E-01	1.95E-01	2.15E-01
RA-228	5.82E-01	3.63E-01	2.21E-01
AC-228	7.24E-01	1.75E-01	1.63E-01
TH-228	Not Detected	--------	1.38
RA-224	1.70	4.42E-01	5.93E-01
PB-212	6.89E-01	1.50E-01	5.61E-02
BI-212	7.98E-01	4.16E-01	5.92E-01
TL-208	4.99E-01	1.20E-01	1.20E-01
U-235	Not Detected	--------	3.30E-01
TH-231	Not Detected	--------	6.54E-01
PA-231	Not Detected	--------	1.92
AC-227	Not Detected	--------	2.43
TH-227	Not Detected	--------	5.03E-01
RA-223	Not Detected	--------	2.16E-01
RN-219	Not Detected	--------	2.59E-01
PB-211	Not Detected	--------	9.36E-01
TL-207	Not Detected	--------	2.14E+01
AM-241	Not Detected	--------	2.30E-01
PU-239	Not Detected	--------	3.72E+02
NP-237	Not Detected	--------	2.36E-01
PA-233	Not Detected	--------	8.11E-02
TH-229	Not Detected	--------	3.51E-01

ER Site 144:
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the Eastern Portion of the Drainfield

[Summary Report] - Sample ID: 50057503

Nuclide	Activity (pCi/gram)	2S Error	MDA
AG-110m	Not Detected	--------	4.14E-02
AR-41	Not Detected	--------	1.25E+01
BA-133	Not Detected	--------	9.37E-02
BA-140	Not Detected	--------	1.55E-01
CD-109	Not Detected	--------	8.11E-01
CD-115	Not Detected	--------	1.06E-01
CE-139	Not Detected	--------	4.53E-02
CE-141	Not Detected	--------	7.65E-02
CE-144	Not Detected	--------	3.43E-01
CO-56	Not Detected	--------	5.27E-02
CO-57	Not Detected	--------	4.03E-02
CO-58	Not Detected	--------	4.57E-02
CO-60	Not Detected	--------	5.38E-02
CR-51	Not Detected	--------	3.29E-01
CS-134	Not Detected	--------	7.74E-02
CS-137	Not Detected	--------	4.77E-02
CU-64	Not Detected	--------	2.31E+01
EU-152	Not Detected	--------	3.72E-01
EU-154	Not Detected	--------	2.67E-01
EU-155	Not Detected	--------	1.78E-01
FE-59	Not Detected	--------	9.86E-02
GD-153	Not Detected	--------	1.48E-01
HG-203	Not Detected	--------	4.46E-02
I-131	Not Detected	--------	4.04E-02
IN-115m	Not Detected	--------	7.90E-01
IR-192	Not Detected	--------	3.86E-02
K-40	1.55E+01	2.25	4.45E-01
LA-140	Not Detected	--------	6.42E-02
MN-54	Not Detected	--------	5.13E-02
MN-56	Not Detected	--------	2.36
MO-99	Not Detected	--------	4.15E-01
NA-22	Not Detected	--------	5.77E-02
NA-24	Not Detected	--------	1.09E-01
NB-95	Not Detected	--------	2.62E-01
ND-147	Not Detected	--------	2.98E-01
NI-57	Not Detected	--------	1.06E-01
BE-7	Not Detected	--------	3.37E-01
RU-103	Not Detected	--------	3.98E-02
RU-106	Not Detected	--------	4.12E-01
SB-122	Not Detected	--------	7.24E-02
SB-124	Not Detected	--------	5.35E-02
SB-125	Not Detected	--------	1.12E-01
SC-46	Not Detected	--------	7.87E-02
SR-85	Not Detected	--------	5.19E-02
TA-182	Not Detected	--------	2.33E-01
TA-183	Not Detected	--------	2.12E-01
TE-132	Not Detected	--------	4.54E-02
TL-201	Not Detected	--------	1.45E-01
V-48	Not Detected	--------	5.21E-02
XE-133	Not Detected	--------	1.92E-01
Y-88	Not Detected	--------	2.72E-02
ZN-65	Not Detected	--------	1.54E-01
ZR-95	Not Detected	--------	8.70E-02

ER Site 144
Gamma Spectroscopy Screening Results for the Deep Interval Composite Soil Sample From the Western Portion of the Drainfield

```
*************************************************************************
*                     Sandia National Laboratories                      *
*    Radiation Protection Sample Diagnostics Program [881 Laboratory]   *
*                        7-21-95   8:32:49 AM                           *
*************************************************************************
*                                                                       *
* Analyzed by: [signature] 7/21/95      Reviewed by: [signature] 7/21/95 *
*************************************************************************
```

```
Customer            : GALLOWAY/D.BISWELL (7582/SMO)
Customer Sample ID  : 023871-1A
Lab Sample ID       : 50057504

Sample Description  : MARINELLI SOLID SAMPLE
Sample Type         : Solid
Sample Geometry     : 1SMAR
Sample Quantity     :  1036.000  gram
Sample Date/Time    :  7-20-95  11:50:00 AM
Acquire Start Date  :  7-21-95   7:59:56 AM
Detector Name       : LAB01
Elapsed Live Time   :   1800 seconds
Elapsed Real Time   :   1801 seconds

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

Nuclide	Activity (pCi/gram)	2S Error	MDA	
U-238	Not Detected	--------	1.70	
TH-234	Not Detected	--------	5.22E-01	
U-234	~~2.09E+01~~	~~1.68E+01~~	1.67E+01	Not Detected. SE 9/5/96
RA-226	1.52	5.56E-01	7.46E-01	
PB-214	6.68E-01	1.22E-01	8.66E-02	
BI-214	6.06E-01	1.07E-01	7.12E-02	
PB-210	6.39E-01	4.18E-01	5.32E-01	
TH-232	4.93E-01	1.73E-01	2.16E-01	
RA-228	5.79E-01	1.94E-01	1.63E-01	
AC-228	6.52E-01	1.58E-01	1.50E-01	
TH-228	6.62E-01	2.71E-01	5.35E-01	
RA-224	1.44	3.63E-01	5.13E-01	
PB-212	5.26E-01	1.05E-01	5.07E-02	
BI-212	4.27E-01	3.00E-01	4.49E-01	
TL-208	5.11E-01	1.14E-01	1.05E-01	
U-235	Not Detected	--------	3.11E-01	
TH-231	Not Detected	--------	5.81E-01	
PA-231	Not Detected	--------	1.68	
AC-227	Not Detected	--------	2.26	
TH-227	Not Detected	--------	4.31E-01	
RA-223	Not Detected	--------	1.94E-01	
RN-219	Not Detected	--------	2.55E-01	
PB-211	Not Detected	--------	8.16E-01	
TL-207	Not Detected	--------	1.79E+01	
AM-241	Not Detected	--------	2.09E-01	
PU-239	Not Detected	--------	3.36E+02	
NP-237	Not Detected	--------	2.35E-01	
PA-233	Not Detected	--------	7.63E-02	
TH-229	Not Detected	--------	3.27E-01	

Section 6.8, concluded:

ER Site 144
Gamma Spectroscopy Screening Results for the Deep Interval
Composite Soil Sample From the Western Portion of the Drainfield

[Summary Report] - Sample ID: 50057504

Nuclide	Activity (pCi/gram)	2S Error	MDA
AG-110m	Not Detected	--------	3.72E-02
AR-41	Not Detected	--------	1.21E+02
BA-133	Not Detected	--------	8.40E-02
BA-140	Not Detected	--------	1.47E-01
CD-109	Not Detected	--------	8.10E-01
CD-115	Not Detected	--------	1.04E-01
CE-139	Not Detected	--------	4.15E-02
CE-141	Not Detected	--------	7.04E-02
CE-144	Not Detected	--------	3.09E-01
CO-56	Not Detected	--------	4.83E-02
CO-57	Not Detected	--------	3.92E-02
CO-58	Not Detected	--------	4.17E-02
CO-60	Not Detected	--------	5.08E-02
CR-51	Not Detected	--------	3.02E-01
CS-134	Not Detected	--------	6.91E-02
CS-137	Not Detected	--------	4.11E-02
CU-64	Not Detected	--------	3.05E+01
EU-152	Not Detected	--------	3.30E-01
EU-154	Not Detected	--------	2.32E-01
EU-155	Not Detected	--------	1.61E-01
FE-59	Not Detected	--------	9.64E-02
GD-153	Not Detected	--------	1.37E-01
HG-203	Not Detected	--------	3.90E-02
I-131	Not Detected	--------	4.21E-02
IN-115m	Not Detected	--------	1.88
IR-192	Not Detected	--------	3.63E-02
K-40	1.69E+01	2.41	4.54E-01
LA-140	Not Detected	--------	5.45E-02
MN-54	Not Detected	--------	4.35E-02
MN-56	Not Detected	--------	1.17E+01
MO-99	Not Detected	--------	4.00E-01
NA-22	Not Detected	--------	5.81E-02
NA-24	Not Detected	--------	1.08E-01
NB-95	Not Detected	--------	2.36E-01
ND-147	Not Detected	--------	2.69E-01
NI-57	Not Detected	--------	9.11E-02
BE-7	Not Detected	--------	2.94E-01
RU-103	Not Detected	--------	3.73E-02
RU-106	Not Detected	--------	3.46E-01
SB-122	Not Detected	--------	6.60E-02
SB-124	Not Detected	--------	4.59E-02
SB-125	Not Detected	--------	1.11E-01
SC-46	Not Detected	--------	7.26E-02
SR-85	Not Detected	--------	4.52E-02
TA-182	Not Detected	--------	2.08E-01
TA-183	Not Detected	--------	2.00E-01
TE-132	Not Detected	--------	4.35E-02
TL-201	Not Detected	--------	1.37E-01
V-48	Not Detected	--------	4.92E-02
XE-133	Not Detected	--------	1.83E-01
Y-88	Not Detected	--------	3.39E-02
ZN-65	~~3.72E-02~~	~~3.07E-02~~	6.05E-02 Not detected 7/21/95
ZR-95	Not Detected	--------	7.66E-02

ER Site 144
Gamma Spectroscopy Screening Results for the Building 9980
Surface Outfall Shallow Intervals Composite Soil Sample

```
*****************************************************************************
* SNL Radiation Sample Diagnostic Program (7715)/881  05-DEC-94 15:41:33 *
*****************************************************************************
B.GALLOWAY/J.ROSE (7582/SMO)  018756-3

Operator: [signature] 12/6/94    Reviewed by [signature] 12/6/94

*****************************************************************************
                                          *
Data File    : 94069005.DAT               * Sample Quantity: 689.000  GRAM
Acquire Date: 05-DEC-94 14:51:57          * Efficiency File: SMAR2.EFF
Sample  Date: 30-NOV-94 10:20:00          * Library    File: RSDP.LIB
Sample  Type: SOLID                       *
*****************************************************************************
                                          *
Preset  Live Time: 1800.0  sec            * FWHM at 1332 KeV        : 2.3  KeV
Elapsed Live Time: 1800.0  sec            * Peak Search Sensitivity: 4.0
Elapsed Real Time: 1800.0  sec            * Gaussian Assymetry      : 10.0 %
*****************************************************************************
                                          *
Detector    : DET2                        * Fit Iterations   : 20.
Calib Date : 01-NOV-94 09:53:16           * Energy Tolerance: 1.5  KeV
KeV/Channel: .36661                       * Half Life Ratio : 8.0
Offset      : -.47933                     * Abundance Limit : 50.00 %
*****************************************************************************
```

[Summary Report -- SNL (7715) -- version 1.2]

Nuclide	Activity (PCI /GRAM)	2-sigma Error	MDA (PCI /GRAM)
U-238	1.08E+00	5.65E-01	--------
TH-234	1.08E+00	5.66E-01	--------
U-234	Not Detected	--------	8.28E+00
RA-226	9.61E-01	7.10E-01	--------
PB-214	7.28E-01	1.10E-01	--------
BI-214	6.74E-01	9.89E-02	--------
PB-210	Not Detected	--------	1.97E+00
TH-232	8.65E-01	1.93E-01	--------
RA-228	8.65E-01	1.93E-01	--------
AC-228	7.81E-01	1.74E-01	--------
TH-228	6.90E-01	6.49E-02	--------
RA-224	1.00E+00	9.45E-01	--------
PB-212	6.93E-01	6.52E-02	--------
BI-212	7.10E-01	3.71E-01	--------
TL-208	6.64E-01	1.27E-01	--------
U-235	Not Detected	--------	4.70E-02
TH-231	Not Detected	--------	3.62E-01
PA-231	Not Detected	--------	1.08E+00
AC-227	Not Detected	--------	1.43E+00
TH-227	Not Detected	--------	2.05E-01
AM-241	Not Detected	--------	1.30E-01
NP-237	Not Detected	--------	2.32E-01
PA-233	Not Detected	--------	6.26E-02
TH-229	Not Detected	--------	1.01E-01

Section 6.9, concluded:

ER Site 144
Gamma Spectroscopy Screening Results for the Building 9980
Surface Outfall Shallow Intervals Composite Soil Sample

ID: B.GALLOWAY/J.ROSE (7582/SMO) 018756-3

Nuclide	Activity (PCI /GRAM)	2-sigma Error	MDA (PCI /GRAM)
PU-239	Not Detected	--------	3.32E+02
AG-110	Not Detected	--------	2.65E-02
BE-7	Not Detected	--------	1.80E-01
AR-41	Short Half-Life	--------	--------
BA-133	Not Detected	--------	3.88E-02
BA-140	Not Detected	--------	9.07E-02
BI-207	Not Detected	--------	2.13E-02
CD-109	Not Detected	--------	9.20E-01
CE-139	Not Detected	--------	2.29E-02
CE-144	Not Detected	--------	1.48E-01
CO-56	Not Detected	--------	2.92E-02
CO-57	Not Detected	--------	2.08E-02
CO-58	Not Detected	--------	2.27E-02
CO-60	Not Detected	--------	3.41E-02
CR-51	Not Detected	--------	2.57E-01
CS-134	Not Detected	--------	2.58E-02
CS-137	Not Detected	--------	2.79E-02
CU-64	Short Half-Life	--------	--------
EU-152	Not Detected	--------	6.23E-02
EU-154	Not Detected	--------	1.15E-01
EU-155	Not Detected	--------	9.85E-02
FE-59	Not Detected	--------	4.44E-02
GD-153	Not Detected	--------	6.65E-02
HG-203	Not Detected	--------	3.01E-02
HO-166	Not Detected	--------	2.83E-02
I-125	Not Detected	--------	2.52E+00
I-129	Not Detected	--------	1.74E+00
I-131	Not Detected	--------	4.17E-02
IN-115M	Short Half-Life	--------	--------
IR-192	Not Detected	--------	2.82E-02
K-40	1.29E+01	9.44E-01	--------
LA-140	Not Detected	--------	2.39E-01
MN-54	Not Detected	--------	2.33E-02
MN-56	Short Half-Life	--------	--------
NA-22	Not Detected	--------	2.62E-02
NA-24	Short Half-Life	--------	--------
NB-95	Not Detected	--------	2.63E-01
RU-103	Not Detected	--------	2.44E-02
RU-106	Not Detected	--------	2.17E-01
SB-124	Not Detected	--------	2.67E-02
SB-125	Not Detected	--------	7.78E-02
SB-126	Not Detected	--------	3.63E-02
SC-46	Not Detected	--------	2.12E-02
SN-113	Not Detected	--------	3.44E-02
SR-85	Not Detected	--------	2.72E-02
TA-182	Not Detected	--------	2.40E-01
TE-123M	Not Detected	--------	2.47E-02
TL-201	Not Detected	--------	6.32E-01
XE-133	Not Detected	--------	1.51E-01
Y-88	Not Detected	--------	3.00E-02
ZN-65	Not Detected	--------	6.07E-02
ZR-95	Not Detected	--------	4.81E-02

ER Site 144
Gamma Spectroscopy Screening Results for the Building 9980
Surface Outfall Deep Intervals Composite Soil Sample

```
****************************************************************************
* SNL Radiation Sample Diagnostic Program (7715)/881  05-DEC-94 16:16:30 *
****************************************************************************
B.GALLOWAY/J.ROSE (7582/SMO)  018757-3

Operator: [signature] 12/6/94          Reviewed by [signature] 12/6/94
****************************************************************************
                                    *
Data File    : 94069006.DAT         * Sample Quantity: 817.000  GRAM
Acquire Date: 05-DEC-94 15:41:42    * Efficiency File: SMAR2.EFF
Sample  Date: 30-NOV-94 10:45:00    * Library    File: RSDP.LIB
Sample  Type: SOLID                 *
****************************************************************************
                                    *
Preset  Live Time: 1800.0  sec      * FWHM at 1332 KeV        : 2.3  KeV
Elapsed Live Time: 1800.0  sec      * Peak Search Sensitivity: 4.0
Elapsed Real Time: 1800.0  sec      * Gaussian Assymetry      : 10.0 %
****************************************************************************
                                    *
Detector    : DET2                  * Fit Iterations   : 20.
Calib Date : 01-NOV-94 09:53:16     * Energy Tolerance: 1.5  KeV
KeV/Channel: .36661                 * Half Life Ratio : 8.0
Offset      : -.47933               * Abundance Limit : 50.00 %
****************************************************************************
```

[Summary Report -- SNL (7715) -- version 1.2]

Nuclide	Activity (PCI /GRAM)	2-sigma Error	MDA (PCI /GRAM)
U-238	Not Detected	--------	4.41E-01
TH-234	Not Detected	--------	4.43E-01
U-234	Not Detected	--------	7.01E+00
RA-226	1.26E+00	5.25E-01	--------
PB-214	5.95E-01	9.01E-02	--------
BI-214	5.85E-01	8.87E-02	--------
PB-210	Not Detected	--------	1.61E+00
TH-232	5.64E-01	1.55E-01	--------
RA-228	5.64E-01	1.55E-01	--------
AC-228	5.09E-01	1.40E-01	--------
TH-228	4.42E-01	5.48E-02	--------
RA-224	Not Significant	--------	--------
PB-212	4.44E-01	5.51E-02	--------
BI-212	3.84E-01	2.57E-01	--------
TL-208	4.60E-01	1.16E-01	--------
U-235	Not Detected	--------	3.93E-02
TH-231	Not Detected	--------	3.44E-01
PA-231	Not Detected	--------	1.08E+00
AC-227	Not Detected	--------	1.26E+00
TH-227	Not Detected	--------	1.81E-01
AM-241	Not Detected	--------	1.12E-01
NP-237	Not Detected	--------	1.86E-01
PA-233	Not Detected	--------	5.45E-02
TH-229	Not Detected	--------	8.53E-02

ER Site 144
Gamma Spectroscopy Screening Results for the Building 9980
Surface Outfall Deep Intervals Composite Soil Sample

ID: B.GALLOWAY/J.ROSE (7582/SMO) 018757-3

Nuclide	Activity (PCI /GRAM)	2-sigma Error	MDA (PCI /GRAM)
PU-239	Not Detected	--------	2.61E+02
AG-110	Not Detected	--------	2.09E-02
BE-7	Not Detected	--------	1.86E-01
AR-41	Short Half-Life	--------	--------
BA-133	Not Detected	--------	2.77E-02
BA-140	Not Detected	--------	8.19E-02
BI-207	Not Detected	--------	1.61E-02
CD-109	Not Detected	--------	7.06E-01
CE-139	Not Detected	--------	2.13E-02
CE-144	Not Detected	--------	1.37E-01
CO-56	Not Detected	--------	2.73E-02
CO-57	Not Detected	--------	1.76E-02
CO-58	Not Detected	--------	2.15E-02
CO-60	Not Detected	--------	3.50E-02
CR-51	Not Detected	--------	2.28E-01
CS-134	Not Detected	--------	2.07E-02
CS-137	Not Detected	--------	2.21E-02
CU-64	Short Half-Life	--------	--------
EU-152	Not Detected	--------	5.03E-02
EU-154	Not Detected	--------	9.71E-02
EU-155	Not Detected	--------	8.27E-02
FE-59	Not Detected	--------	4.80E-02
GD-153	Not Detected	--------	5.76E-02
HG-203	Not Detected	--------	2.70E-02
HO-166	Not Detected	--------	2.61E-02
I-125	Not Detected	--------	2.38E+00
I-129	Not Detected	--------	1.35E+00
I-131	Not Detected	--------	3.70E-02
IN-115M	Short Half-Life	--------	--------
IR-192	Not Detected	--------	2.33E-02
K-40	1.22E+01	8.80E-01	--------
LA-140	Not Detected	--------	1.93E-01
MN-54	Not Detected	--------	2.51E-02
MN-56	Short Half-Life	--------	--------
NA-22	Not Detected	--------	2.94E-02
NA-24	Short Half-Life	--------	--------
NB-95	Not Detected	--------	2.27E-01
RU-103	Not Detected	--------	2.10E-02
RU-106	Not Detected	--------	1.62E-01
SB-124	Not Detected	--------	2.38E-02
SB-125	Not Detected	--------	6.49E-02
SB-126	Not Detected	--------	2.96E-02
SC-46	Not Detected	--------	1.60E-02
SN-113	Not Detected	--------	3.20E-02
SR-85	Not Detected	--------	1.94E-02
TA-182	Not Detected	--------	1.95E-01
TE-123M	Not Detected	--------	2.10E-02
TL-201	Not Detected	--------	5.30E-01
XE-133	Not Detected	--------	1.37E-01
Y-88	Not Detected	--------	2.34E-02
ZN-65	Not Detected	--------	4.65E-02
ZR-95	Not Detected	--------	3.50E-02

6.11 Risk Assessment Analysis

6.11.1 Site Description and History

ER Site 144 is located in Coyote Test Field in the far southern part of KAFB and is approximately 1.3 miles north of the Isleta Reservation boundary and 1 mile west of Lovelace Road. ER Site 144 consists of two contiguous areas that encompass a septic tank and drainfield about 500 feet west of the Solar Power Tower (SPT), and a surface outfall location about 300 feet west of the SPT. These two areas encompass approximately 0.3 acres of flat-lying land at an average mean elevation of 5,571 feet above mean sea level (amsl).

The SPT was constructed in 1976 for research and development of solar thermal technology. It is a multistory concrete tower that houses solar receivers. Wash sinks and toilet facilities for up to 20 people were served by a septic tank and a drainfield with seven 50-foot distribution lines. The septic system is located on the west side of the west access road. Also, some of the floor drains in the Solar Power Tower drained to an underground sump at the base of the structure. Because of the open nature of the SPT, a fair amount of rain water passed through the floor drains to the sump. This rain water may have picked up oil, grease, and minor metal fragments as it washed to the sump. The sump was periodically pumped and discharged to a surface outfall located in a depression between the parking lot and the west access road.

Large volumes of ethylene glycol coolant are used in Building 9980 as a heat exchange medium, along with small quantities of ammonium hydroxide for pH control, and hydrazine as an oxygen scavenger. No chromate rust inhibitors were used. Trace quantities of copper and mercury may were contained in test kits used to check cooling water quality, but there is no evidence or indication that contents from the test kits were dumped into tanks or on the ground. An aboveground stainless steel wastewater tank on the south side of the tower formerly received boiler blowdown containing ethylene glycol and hydrazine. The tank contents were occasionally discharged to the ground. The releases from the aboveground tank occurred about twice a month and involved small quantities (around 5 gallons per occurrence) of hot boiler blowdown water that was discharged to the large asphalt apron surrounding Building 9980. The discharges are now directed to the sanitary sewer.

Of greater concern was the facility industrial wastewater tank, a 4,000 gallon underground tank located on the east side of the SPT that received large volumes of ethylene glycol, cooling tower blowdown, and boiler blowdown from other Building 9980 floor drains. Effluent from this tank was discharged to the asphalt apron using a pump approximately once a month. A slight depression in the asphalt directed the discharge to the edge of the apron where it flowed into a shallow earthen storm run-off channel and soaked into the ground. SNL/NM agreed to collect soil samples from three boring locations in the discharge area of the channel as one of the final conditions required by the EPA for the OU 1295 RFI workplan approval.

6.11.2 Risk Assessment Analysis

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

Step 1. Site data are described which provide information on the potential COCs, as well as the relevant physical characteristics and properties of the site.
Step 2. Potential pathways by which a representative population might be exposed to the COCs are identified.
Step 3. The potential intake of these COCs by the representative population is calculated using a tiered approach. The tiered approach includes screening steps, followed by potential intake calculations and a discussion or evaluation of the uncertainty in those calculations. Potential intake calculations are also applied to background screening data.
Step 4. Data are described on the potential toxicity and cancer effects from exposure to the COCs and associated background constituents and subsequent intake.
Step 5. Potential toxicity effects (specified as a Hazard Index) and cancer risks are calculated for nonradiological COCs and background. For radiological COCs, the incremental total effective dose equivalent (TEDE) and incremental estimated cancer risk are calculated by subtracting applicable background concentrations directly from maximum on-site contaminant values. This background subtraction only occurs when a radiological COC occurs as contamination and exists as a natural background radionuclide
Step 6. These values are compared with standards established by the United States (U.S.) Environmental Protection Agency (USEPA) and U.S. Department of Energy (USDOE) to determine if further evaluation, and potential site clean-up, is required. Nonradiological COC risk values are also compared to background risk so that an incremental risk may be calculated.
Step 7. Discussion of uncertainties in the previous steps.

6.11.2.1 Step 1. Site Data

Site history and characterization activities are used to identify potential COCs. The identification of COCs and the sampling to determine the concentration levels of those COCs across the site are described in the ER Site 144 No Further Action (NFA) proposal. In order to provide conservatism in this risk assessment, the calculation uses only the maximum concentration value of each COC determined for both release areas at the site. Both radioactive and nonradioactive COCs are evaluated. The only nonradioactive COCs evaluated are metals because VOCs were either non-detect or were determined to be laboratory contamination.

6.11.2.2 Step 2. Pathway Identification

ER Site 144 has been designated with a future land-use scenario of industrial (see Attachment 1 for default exposure pathways and parameters). Because of the location and the characteristics of the potential contaminants, the primary pathway for human exposure to nonradiological COCs is considered to be soil ingestion. For radiological COCs the primary pathway for human exposure is direct gamma for the industrial land-use scenario and radon inhalation for the residential land-use scenario. The inhalation pathway for metals is included because of the potential to inhale dust. It is included for radionuclides because of the potential to inhale dust and volatiles. No contamination at depth was determined and therefore no water pathways to the groundwater are considered. Depth to groundwater at Site 144 is approximately 111 feet. Because of the lack of surface water or other significant mechanisms for dermal contact, the dermal exposure pathway is considered to not be significant. No intake routes through plant, meat, or milk ingestion are considered appropriate for the industrial land-use scenario. However, plant uptake is considered for the residential land-use scenario.

Pathway Identification

Chemical Constituents	Radionuclide Constituents
Soil Ingestion	Soil Ingestion
Inhalation (Dust)	Inhalation (Dust and Volatiles)
Plant uptake (Residential only)	Plant uptake (Residential only)
	Direct Gamma

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

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

The risks from the COCs at ER Site 144 were evaluated using a tiered approach. The maximum concentrations of COCs were compared to the SNL/NM background screening level for this area (IT, 1996). If a SNL/NM-specific screening level was not available for a constituent, then a background value was obtained, when possible, from the U.S. Geological Survey (USGS) National Uranium Resource Evaluation (NURE) program (USGS, 1994). For the purpose of this investigation the background for tritium in soil moisture was assumed to be represented by samples taken by the EPA of rainwater throughout the United States (USEPA, 1993). Assuming that the atmospheric tritium concentration in this rainwater is in equilibrium with tritium in soil moisture this background range used is 100 - 400 pCi/liter (pCi/l) of soil moisture.

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

For radiological COCs that exceeded both the SNL/NM background screening levels and, if applicable, were above the EPA background tritium range, background values were subtracted from the individual maximum radionuclide concentrations. Those that did not exceed these background levels were not carried any further in the risk assessment. This approach is consistent with USDOE orders. Radioactive COCs that 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. This step is performed (rather than carry the below-background radioactive COCs through the risk assessment and then perform a background risk assessment to determine incremental TEDE and estimated cancer risk) to prevent the "masking" of radiological contamination that may occur if on-site background radiological COCs exist in concentrations far enough below the assigned background level. When this "masking" occurs, the final incremental TEDE and estimated cancer risk are reduced and, therefore, provide a non-conservative estimate of the potential impact on an on-site receptor. This approach is also consistent with the regulatory approach (40 CFR Part 196, 1994) which sets a TEDE limit to the on-site receptor in excess of background. The resultant radioactive COCs remaining after this step are referred to as background-adjusted radioactive COCs.

Next, the remaining maximum concentration for each remaining nonradiological COC was compared with action levels calculated using methods and equations promulgated in the proposed Resource Conservation and Recovery Act (RCRA) Subpart S (40 CFR Part 264, 1990) and Risk Assessment Guidance for Superfund (RAGS) (USEPA, 1989) documentation. Accordingly, all calculations were based on the assumption that receptor doses from both toxic and potentially carcinogenic compounds result most significantly from ingestion of contaminated soil. Because the samples with maximum COC concentrations were collected below ground surface, this assumption is conservative. If there are 10 or fewer COCs and each has a maximum concentration less than one-tenth of the action level, then the site would be judged to pose no significant health hazard to humans. If there are more than 10 COCs, the Subpart S screening procedure was skipped.

Third, hazard indices and risk due to carcinogenic effects were calculated using Reasonable Maximum Exposure (RME) methods and equations promulgated in RAGS (USEPA, 1989). The combined effects of all nonradiological COCs in the soils were calculated. The combined effects of all associated nonradiological background constituents in the soils were also calculated. For toxic compounds, this was accomplished by summing the individual hazard quotients for each compound into a total Hazard Index. This Hazard Index is compared to the recommended standard of 1. For potentially carcinogenic compounds, the individual risks were summed. The total risk was compared to the recommended acceptable risk range of 10^{-4} to 10^{-6} For the radioactive COCs, the incremental TEDE was calculated and the corresponding incremental cancer risk estimated using USDOE's RESRAD computer code.

Comparison to Background and Action Levels

Nonradioactive ER Site 144 COCs are listed in Table 6-1; radioactive COCs are listed in Table 6-2. Both tables show the associated 95th percentile or UTL background levels (IT, 1996) and the EPA background tritium range. The SNL/NM background levels have not yet been approved by the USEPA or the NMED but are the result of a comprehensive study of joint SNL/NM and U.S. Air Force data from the Kirtland Air Force Base (KAFB). The report was submitted for regulatory review in early 1996. The values shown in Table 6-1 supersede the background values described in an interim background study report (IT, 1994). Several compounds have maximum measured values greater than background screening levels.

Therefore all nonradiological COCs were retained for further analysis with the exception of lead. The maximum concentration value for lead is 78.1 mg/kg. The USEPA intentionally does not provide any toxicological data on lead and therefore, no risk parameter values can be calculated. However, EPA guidance for the screening value for lead for an industrial land-use scenario is 2000 mg/kg (EPA, 1996a); for a residential land-use scenario, the EPA screening guidance value is 400 mg/kg (EPA, 1994a). The maximum concentration value for lead at this site is less than both of those screening values and therefore lead is eliminated from further consideration in this risk assessment.

Because several nonradiological COCs had concentrations greater than their respective SNL/NM background 95th percentile or UTL, the site fails the background screening criteria and all nonradiological COCs proceed to the proposed Subpart S action level screening procedure. Table 6-3 shows the inorganic COCs. The table also shows the proposed Subpart S action level for the contaminants. The table compares the maximum concentration values to 1/10 of the proposed Subpart S action level. This methodology was guidance given to SNL/NM from the USEPA (USEPA, 1996b). This is the second screening process in the tiered risk assessment approach. One nonradioactive compound (arsenic) had a concentration value greater than 1/10 of the proposed Subpart S action level. Because of arsenic, the site fails the proposed Subpart S screening criteria and a Hazard Index value and cancer risk value must be calculated for the seven nonradioactive contaminants.

Radioactive contaminants do not have pre-determined action levels analogous to the proposed Subpart S and therefore this step in the screening process is not performed for radionuclides.

Identification of Toxicological Parameters

Tables 6-4 and 6-5 show the COCs that have been retained in the risk assessment and the values for the toxicological information available for those COCs. Dose conversion factors (DCFs) used in determining the excess dose values for the individual pathways were the default values provided in the RESRAD computer code as developed in the following:

- For ingestion and inhalation, DCFs are taken from Federal Guidance Report No. 11, *Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion* (USEPA, 1988a).

Exposure Assessment and Risk Characterization

Section 6.11.3.3.1 describes the exposure assessment for this risk assessment. Section 6.11.3.3.2 provides the risk characterization including the Hazard Index value and the excess cancer risk for both the potential nonradiological COCs and associated background; industrial and residential land-uses. The incremental TEDE and incremental estimated cancer risk are provided for the background-adjusted radiological COCs; industrial and residential land-uses.

- The DCFs for surface contamination (contamination on the surface of the site) were taken from USDOE/EH-0070, *External Dose-Rate Conversion Factors for Calculation of Dose to the Public* (USDOE, 1988).

- The DCFs for volume contamination (exposure to contamination deeper than the immediate surface of the site) were calculated using the methods discussed in, *Dose-Rate Conversion Factors for E*xternal Exposure to Photon Emitters in Soil (Health Physics 28:193-205) (Kocher, D.C., 1983), and ANL/EAIS-8, *Data Collection Handbook to Support Modeling the Impacts of Radioactive Material in Soil* (Yu, C., et al., 1993b).

Table 6-1
Nonradioactive COCs at ER Site 144 and Comparison to the Background Screening Values.

COC name	Maximum concentration (mg/kg)	SNL/NM 95th % or UTL Level (mg/kg)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
Arsenic	6.6	7	Yes
Barium	200	214	Yes
Cadmium	<0.5	0.9	Yes
Chromium, total	10.5	15.9	Yes
Lead	78.1	11.8	**No**
Mercury	<0.1	<0.1	**No***
Selenium	<0.5	<1.0	**No***
Silver	3.1	<1.0	**No**

* Uncertainty due to detection limits.

Table 6-2
Radioactive COCs at ER Site 144 and Comparison to the Background Screening Values.

COC name	Maximum concentration (pCi/g)	SNL/NM 95th % or UTL Level (pCi/g)	Is maximum COC concentration less than or equal to the applicable SNL/NM background screening value?
H-3	220 pCi/l	100-400 pCi/L	Yes
U-238	1.67	1.4	**No**
U-235	0.046 (J)	0.16	Yes
U-233/234	1.88	1.4*	**No**

*Background value provided as "<5.02", therefore background U-234 is assumed to be equal to that of it's parent radionuclide, U-238, as they would exist in secular equilibrium in their naturally-occurring state.
J - estimated value

Table 6-3
Comparison of ER Site 144 Nonradioactive COC Concentrations to Proposed Subpart S Action Levels.

COC name	Maximum concentration (mg/kg)	Proposed Subpart S Action Level (mg/kg)	Is individual contaminant less than 1/10 the Action Level?
Arsenic	6.6	0.5	No
Barium	200	6000	Yes
Cadmium	<0.5	80	Yes
Chromium, total*	10.5	400	Yes
Mercury	<0.1	20	Yes
Selenium	<0.5	400	Yes
Silver	3.1	400	Yes

*Assumed to be chromium VI (most conservative).

Table 6-4
Nonradioactive Toxicological Parameter Values for ER Site 144 COCs

COC name	RfD_o (mg/kg/d)	RfD_{inh} (mg/kg/d)	Confidence	Sf_o (kg-d/mg)	Sf_{inh} (kg-d/mg)	Cancer Class ^
Arsenic	0.0003	--	M	1.5	15.1	**A**
Barium	0.07	0.000143	M	--	--	**D**
Cadmium	0.0005	0.0000571	H	--	6.3	**B1**
Chromium, total	0.005	--	L	--	42	**A**
Mercury	0.0003	0.0000857	--	--	--	**D**
Selenium	0.005	--	H	--	--	**D**
Silver	0.005	--	--	--	--	**D**

*Total chromium assumed to be chromium VI (most conservative)
RfD_o - oral chronic reference dose in mg/kg-day
RfD_{inh} - inhalation chronic reference dose in mg/kg-day
Confidence - L = low, M = medium, H = high
SF_o - oral slope factor in $(mg/kg\text{-}day)^{-1}$
SF_{inh} - inhalation slope factor in $(mg/kg\text{-}day)^{-1}$
^ EPA weight-of-evidence classification system for carcinogenicity:

A - human carcinogen
B1 - probable human carcinogen. Limited human data are available
B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
C - possible human carcinogen
D - not classifiable as to human carcinogenicity
E - evidence of noncarcinogenicity for humans

-- information not available

Table 6-5
Radiological Toxicological Parameter Values for ER Site 144 COCs

COC name	Sf_o (1/pCi)	Sf_{inh} (1/pCi)	Sf_{ev} (g/pCi-yr)	Cancer Class^
U-233/234	4.4E-11	1.4E-08	2.1E-11	A
U-238	6.2E-11	1.2E-08	5.7E-08	A

SF_o - oral (ingestion) slope factor (risk/pCi)
SF_{inh} - inhalation slope factor (risk/pCi)
Sf_{ev}- external volume exposure slope factor (risk/year per pCi/g)
^ EPA weight-of-evidence classification system for carcinogenicity:

- A - human carcinogen
- B1 - probable human carcinogen. Limited human data are available
- B2 - probable human carcinogen. Indicates sufficient evidence in animals and inadequate or no evidence in humans.
- C - possible human carcinogen
- D - not classifiable as to human carcinogenicity
- E - evidence of noncarcinogenicity for humans

Exposure Assessment

Attachment 1 shows the equations and parameter values used in the calculation of intake values and the subsequent Hazard Index and excess cancer risk values for the individual exposure pathways. The appendix shows the parameters for both industrial and residential land-use scenarios. The equations are based on RAGS (USEPA, 1989). The parameters are based on information from RAGS (USEPA, 1989) as well as other USEPA guidance documents and reflect the RME approach advocated by RAGS (USEPA, 1989). For radionuclides, the coded equations provided in the RESRAD computer code were used to estimate the excess dose and cancer risk for the individual exposure pathways. Further discussion of this process is provided in Manual for Implementing Residual Radioactive Material Guidelines Using RESRAD, Version 5.0 (Yu, C., et al., 1993a).

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

Risk Characterization

Table 6-6 shows that for the ER Site 144 nonradioactive COCs, the Hazard Index value is 0.02 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario. The numbers presented included exposure from soil ingestion and dust inhalation for the nonradioactive COCs. Table 6-7 shows that for the ER Site 144 associated nonradiological background constituents, the Hazard Index is 0.02 and the excess cancer risk is 4×10^{-6} for the designated industrial land-use scenario.

For the radioactive COCs, contribution from the direct gamma exposure pathway is included. The incremental TEDE for industrial land-use is 0.02 mrem/year. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 15 mrem/year (40 CFR Part 196, 1994) for the probable land-use scenario (industrial in this case); the calculated dose value for ER Site 144 for the industrial land-use is well below this standard.

For the residential land-use scenario, the Hazard Index value increases to 1 and the excess cancer risk is 7 x 10^{-5}. The numbers presented included exposure from soil ingestion, dust inhalation, and plant uptake. Although USEPA (1991) generally recommends that inhalation not be included in a residential land-use scenario, this pathway is included because of the potential for soil in Albuquerque, NM, to be eroded and, subsequently, for dust to be present even in predominantly residential areas. Because of the nature of the local soil, other exposure pathways are not considered (see Attachment 1). Table 6-7 shows that for the ER Site 144 associated nonradiological background constituents, the Hazard Index increases to 1 and the excess cancer risk is 8 x 10^{-5}.

Table 6-6
Nonradioactive Risk Assessment Values for ER Site 144 COCs.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	6.6	0.02	4E-6	0.38	7E-5
Barium	200	0.00	--	0.03	--
Cadmium	<0.5	0.00	2E-10	0.41	3E-10
Chromium, total*	10.5	0.00	3E-8	0.01	4E-8
Mercury	<0.1	0.00	--	0.17	--
Selenium	<0.5	0.00	--	0.18	--
Silver	3.1	0.00	--	0.13	--
Total		**0.02**	**4E-6**	**1**	**7E-5**

*Total chromium assumed to be chromium VI (most conservative).
-- Information not available.

For the radioactive COCs, the incremental TEDE for residential land-use is 0.06 mrem/year. In accordance with proposed USEPA guidance, the standard being utilized is an incremental TEDE of 75 mrem/year (40 CFR Part 196, 1994) for a complete loss of institutional controls (residential land-use in this case); the calculated dose values for ER Site 144 for the residential land-use is well below this standard. It should also be noted that, consistent with the proposed guidance (40 CFR Part 196, 1994), ER Site 144 should be eligible for unrestricted radiological release as the residential scenario resulted in an incremental TEDE to the on-site receptor of less than 15 mrem/year.

Table 6-7
Nonradioactive Risk Assessment Values for ER Site 144 Background Constituents.

COC Name	Maximum concentration (mg/kg)	Industrial Land-Use Scenario		Residential Land-Use Scenario	
		Hazard Index	Cancer Risk	Hazard Index	Cancer Risk
Arsenic	7	0.02	4E-6	0.4	8E-5
Barium	214	0.00	--	0.03	--
Cadmium	0.9	0.00	4E-10	0.74	5E-10
Chromium, total	NC	--	--	--	--
Mercury	<0.1	--	--	--	--
Selenium	<1.0	--	--	--	--
Silver	<1.0	--	--	--	--
Total		**0.02**	**4E-6**	**1**	**8E-5**

-- Information not available.
NC - not calculated due to absence in SNL/NM background report (IT, 1996).

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

6.11.2.4 Step 6. Comparison of Risk Values to Numerical Standards.

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

For the industrial land-use scenario, the Hazard Index calculated is 0.02; this is much less than the numerical standard of 1 suggested in RAGS (USEPA, 1989). The excess cancer risk is estimated at 4×10^{-6}. In RAGS, the USEPA suggests that a range of values (10^{-6} to 10^{-4}) be used as the numerical standard; the value calculated for this site is in the low end of the suggested acceptable risk range. Therefore, for an industrial land-use scenario, the Hazard Index risk assessment values are significantly less than the established numerical standards and the excess cancer risk is in the low end of the suggested acceptable risk range. This risk assessment also determined risks considering background concentrations of the potential nonradiological COCs for both the industrial and residential land-use scenarios. For the industrial land-use scenario, the Hazard Index is 0.02. The excess cancer risk is estimated at 4×10^{-6}. Incremental risk is determined from subtracting risk associated with background from potential nonradiological COC risk. These numbers are not rounded before the difference is determined and therefore may appear to be inconsistent with numbers presented in tables and discussed within the text. The is no incremental Hazard Index or incremental cancer risk for the industrial land-use scenario.

For the radioactive components of the industrial land-use scenario, the calculated incremental TEDE is 0.02 mrem/year, which is significantly less than the numerical standard of 15 mrem/year suggested in the draft USEPA guidance. The incremental cancer risk estimate is 4 x 10^{-7}.

For the residential land-use scenario, the calculated Hazard Index is 1, which is at the numerical guidance. The excess cancer risk is estimated at 7 x 10^{-5}; this value is in the middle of the suggested acceptable risk range. The Hazard Index for associated background for the residential land-use scenario is also 1. The excess cancer risk is estimated at 8 x 10^{-5}. For the residential land-use scenario, the incremental Hazard Index is 0.14; there is no incremental cancer risk. The incremental TEDE from the radioactive components is 0.06 mrem/year, which is significantly less than the numerical guidance. The associated cancer risk is 8 x 10^{-7}.

6.11.2.5 Step 7 Uncertainty Discussion

The conclusion from the risk assessment analysis is that the potential effects caused by potential nonradiological COCs on human health are within the acceptable range compared to established numerical standards for the industrial land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate no contribution of risk from nonradiological COCs when considering the industrial land-use scenario.

The main contributor to the adverse effects on human health from nonradiological COCs is arsenic (6.6 mg/kg). Arsenic was not a COC based on site history. Also, arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination.

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

The potential effects on human health, for nonradiological COCs, are greater when considering the residential land-use scenario. Calculated incremental risk between potential nonradiological COCs and associated background indicate a small contribution of risk from nonradiological COCs when considering the residential land-use scenario. The increased effects on human health related to nonradiological COCs are primarily the result of including the plant uptake exposure pathway. Constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 144 is an industrial site, the likelihood of significant plant uptake in this area is highly unlikely as is the likelihood that this site will be residential in the near future (USDOE, 1996). The uncertainty in this conclusion is considered to be small.

For the radiological COCs the conclusion from the risk assessment is that the potential effects on human health, for the residential land-use scenario, is well within proposed standards (40 CFR

Part 196, 1994) and is a small fraction of the estimated 290 mrem/year received due to natural background (NCRP, 1987).

Because of the location, history of the site and the future land-use (USDOE, 1996), there is low uncertainty in the land-use scenario and the potentially affected populations that were considered in making the risk assessment analysis. Because the maximum concentrations of the COCs are found in sub-surface soils and because of the location and physical characteristics of the site, the exposure pathways relevant to the analysis are conservative. For example, in the case of the industrial land-use scenario, the soil ingestion pathway results are very conservative as a worker contacting the soil at depth would be likely involved in construction and would contact the soil for only a short time instead of 30 years.

The approach taken in determining potential effects on human health due to the radiological COCs is particularly conservative in that it was assumed that all radiological constituents existed in the upper six inches of the soil layer, rather than in the subsurface near the surface outfall, septic tank, and beneath the drainfield. Given this, the non-contaminated overburden was not accounted for in providing shielding for gamma radiation and an extended diffusion path for radon.

An RME approach was used to calculate the risk assessment values, which means that the parameter values used in the calculations were conservative and that the calculated intakes are likely overestimates. Maximum measured values of the concentrations of the COCs and minimum value of the 95th UTL or percentile concentration value, as applicable, of background concentrations associated with the COCs were used to provide conservative results.

Table 6-4 shows the uncertainties (confidence) in the nonradiological toxicological parameter values. There is a mixture of estimated values and values from the Health Effects Assessment Summary Tables (HEAST) (USEPA, 1996c) and Integrated Risk Information System (IRIS) (USEPA, 1988, 1994b) databases. Because of the conservative nature of the RME approach, the uncertainties in the toxicological values are not expected to be of high enough concern to change the conclusion from the risk assessment analysis.

The nonradiological risk assessment values are within the acceptable range for the industrial land-use scenario compared to the established numerical standards. Though the residential land-use Hazard Index is at the numerical standard, it has been determined that future land-use at this locality will not be residential (USDOE, 1996). The radiological incremental TEDE is a very small fraction of estimated background TEDE for both the industrial and residential land-use scenarios and both are well within proposed standards (40 CFR Part 196, 1994). The overall uncertainty in all of the steps in the risk assessment process is considered not significant with respect to the conclusion reached.

6.11.3 Summary

ER Site 144 had relatively minor contamination consisting of inorganic compounds and had no history of radiological material use. Because of the location of the site on KAFB, the designated industrial land-use scenario and the nature of the contamination, the potential exposure pathways identified for this site included soil ingestion and dust inhalation for chemical constituents and soil ingestion, dust and volatile inhalation, and direct gamma exposure for radionuclides. These exposure pathways are very conservative as a worker contacting the soil at depth would likely be involved in construction and would contact the soil for only a short time instead of 30 years.

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

The main contributors to the industrial land-use scenario nonradiological risk assessment values is arsenic (6.6 mg/kg). Arsenic was below the respective background screening level. Therefore, this risk assessment is considered conservative as arsenic is probably not indicative of contamination.

Using conservative assumptions and employing a RME approach to the risk assessment, the calculations show that for the industrial land-use scenario the Hazard Index (0.02) is significantly less than the accepted numerical guidance from the USEPA. The estimated cancer risk (4×10^{-6}) for nonradiological COCs is in the low end of the suggested acceptable risk range. There is no incremental Hazard Index or incremental cancer risk for nonradiological COCs for the industrial land-use scenario.

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated dose is 0.02 mrem/year for the industrial land-use scenario. This value is much less than the numerical guidance of 15 mrem/year in draft USEPA guidance. The corresponding estimated cancer risk value is 4×10^{-7} for the industrial land-use scenario.

The calculations show that for the residential land-use scenario the Hazard Index (1) is at the accepted numerical guidance from the USEPA. The estimated cancer risk (7×10^{-5}) for nonradiological COCs is in the middle the suggested acceptable risk range. The increased effects on human health are primarily the result of the inclusion of the plant uptake exposure pathway for the nonradiological COCs. Nonradiological constituents that posed little to no risk considering an industrial land-use scenario (some of which are below background screening levels), contribute a significant portion of the risk associated with the residential land-use scenario. These constituents bioaccumulate in plants. Because ER Site 144 is an industrial site (USDOE, 1996), the likelihood of significant plant uptake in this area is highly unlikely. Also the contamination occurs at depth, below typical plant root zones. The incremental Hazard Index is 0.14 with no incremental cancer risk when considering the residential land-use scenario. Increased risk from the nonradiological COCs was evident considering residential land-use, due to plant uptake, but future use will be restricted to industrial land-use (USDOE, 1996).

The incremental TEDE and corresponding estimated cancer risk from the radioactive components are much less than USEPA guidance values; the estimated dose is 0.06 mrem/year for the residential land-use scenario. This value is much less than the numerical guidance of 75 mrem/year in draft USEPA guidance. The corresponding estimated cancer risk value is 8 x 10^{-7} for the residential land-use scenario. The increased effects on human health are primarily the result of increased residence time, resulting in increased radon inhalation, for the radiological COCs.

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

Ecological Risk Assessment

The ecological risk for this site has not been estimated at this time. SNL/NM ecological risk analyses are being conducted and the relevant analysis for this site will be presented when available.

6.11.4 References

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ATTACHMENT 1.

Sandia National Laboratories Environmental Restoration Program

EXPOSURE PATHWAY DISCUSSION FOR CHEMICAL AND RADIONUCLIDE CONTAMINATION

BACKGROUND

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

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

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

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

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

- Inhalation of airborne compounds (vapor phase or particulate), and;
- External exposure to penetrating radiation (immersion in contaminated air; immersion in contaminated water and exposure from ground surfaces with photon-emitting radionuclides).

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

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

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

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

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

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

Table 1. Exposure Pathways Considered for Various Land Use Scenarios

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

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

EQUATIONS AND DEFAULT PARAMETER VALUES FOR IDENTIFIED EXPOSURE ROUTES

In general, SNL/NM expects that ingestion of compounds in drinking water and soil will be the more significant exposure routes for chemicals; external exposure to radiation may also be significant for radionuclides. All of the above routes will, however, be considered for their appropriate land use scenarios. The general equations for calculating potential intakes via these routes are shown below. The equations are from the Risk Assessment Guidance for Superfund (RAGS): Volume 1 (EPA, 1989a and 1991). These general equations also apply to calculating potential intakes for radionuclides. A more in-depth discussion of the equations used in performing radiological pathway analyses with the RESRAD code may be found in the RESRAD Manual (ANL, 1993). Also shown are the default values SNL/NM ER suggests for use in Reasonable Maximum Exposure (RME) risk assessment calculations for industrial, recreational, and residential scenarios, based on EPA and other governmental agency guidance. The pathways and values for chemical contaminants are discussed first, followed by those for radionuclide contaminants. RESRAD input parameters that are left as the default values provided with the code are not discussed. Further information relating to these parameters may be found in the RESRAD Manual (ANL, 1993).

Generic Equation for Calculation of Risk Parameter Values

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

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

= C x (CR x EFD/BW/AT) x Toxicity Effect
(1)

where

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

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

The evaluation of the carcinogenic health hazard produces a quantitative estimate for excess cancer risk resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of the quantitative estimate with the potentially acceptable risk range of 10^{-4} to 10^{-6}. The evaluation of the noncarcinogenic health hazard produces a quantitative estimate (i.e., the Hazard Index) for the toxicity resulting from the COCs present at the site. This estimate is evaluated for determination of further action by comparison of this quantitative estimate with the EPA standard Hazard Index of unity (1). The evaluation of the health hazard due to radioactive compounds produces a quantitative estimate of doses resulting from the COCs present at the site.

The specific equations used for the individual exposure pathways can be found in RAGS (EPA, 1989) and the RESRAD Manual (ANL, 1993). Table 2 shows the default parameter values suggested for used by SNL at ER sites, based on the selected land use scenario. References are given at the end of the table indicating the source for the chosen parameter values. The intention of SNL is to use default values that are consistent with regulatory guidance and consistent with the RME approach. Therefore, the values chosen will, in general, provide a conservative estimate of the actual risk parameter. These parameter values are suggested for use for the various exposure pathways based on the assumption that a particular site has no unusual characteristics that contradict the default assumptions. For sites for which the assumptions are not valid, the parameter values will be modified and documented.

<u>Summary</u>

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

Table 2. Default Parameter Values for Various Land Use Scenarios

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

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

[a] RAGS, Vol 1, Part B (EPA, 1991).

[b] Exposure Factors Handbook (EPA, 1989b)

[c] EPA Region VI guidance.

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

[e] Dermal Exposure Assessment, 1992.

References

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