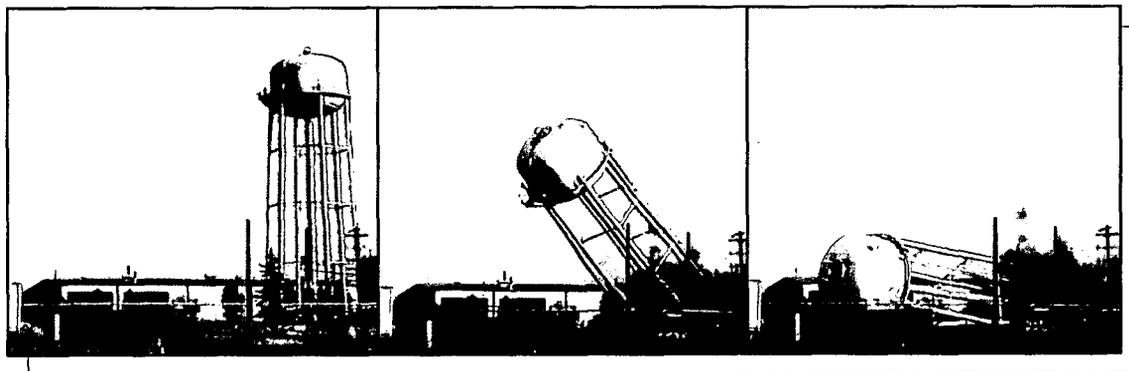


# U.S. Department of Energy

## Radionuclide Air Emissions Annual Report

Calendar Year 2003

### Rocky Flats Environmental Technology Site



*November 8, 2003*

ADMIN RECORD

SW-A-006012

1/30

**Cover Photos: Demolition of the Rocky Flats Water Tower on November 8, 2003**



The Site water tower served as the primary supply for the treated water distribution system on Site. Constructed in 1952, the 155-foot tall, 300,000-gallon elevated tank was the tallest, and most visible, structure at Rocky Flats. On November 8, 2003, small-scale explosives were used to safely drop the tank on its side. The water tower's absence provides a visible indicator of progress toward Site closure.

**Water Tower 1963**

# Radionuclide Air Emissions Annual Report for Calendar Year 2003

Prepared in accordance with  
40 CFR 61, Subpart H  
and  
CAQCC Regulation No. 8, Part A, Subpart H

**Site Name:** Rocky Flats Environmental Technology Site

## Operations Office Information

**Office:** Rocky Flats Project Office

**Address:** U.S. Department of Energy  
Rocky Flats Environmental Technology Site  
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Golden, Colorado 80403-8200

**Contact:** Robert Birk Phone: (303) 966-5921

## Site Information

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**Address:** Rocky Flats Environmental Technology Site  
10808 Hwy 93, Unit B  
Golden, Colorado 80403-8200

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## EXECUTIVE SUMMARY

As required by Title 40 of the Code of Federal Regulations (CFR), Part 61, Subpart H, and Colorado Air Quality Control Commission Regulation No. 8, Part A, Subpart H, the airborne radiation dose to the public from the Rocky Flats Environmental Technology Site (Site) is determined annually and reported to the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE). These regulations limit the air pathway dose from Site activities to any member of the public to an annual effective dose equivalent (EDE) of 10 millirem (mrem). The Site was in compliance with the 10-mrem standard during 2003.

To provide context for the 10-mrem annual limitation standard, the average annual EDE for residents of the Denver area from all sources of radiation is approximately 420 mrem. Over 80% of this average annual EDE is due to natural background radiation (Roberts, 1998). The health risk associated with 1 mrem of EDE from naturally occurring sources of background radiation (such as uranium or thorium in rock or soil, cosmic rays, and radon emitted from soil or bedrock) is the same as that produced from anthropogenic sources of radiation (such as Site activities or medical x-rays).

Compliance with the 10-mrem standard was determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when each measured radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2003, each measured radionuclide air concentration was less than 2% of the corresponding concentration level for environmental compliance and the fractional sum of all radionuclides was less than 3% of the allowable level at the sampler with the highest fractional sum (the critical receptor). The highest fractional sum measured in 2003 corresponds to an annual dose of 0.252 mrem or 2.52% of the 10-mrem standard.

As has been the case in previous years, airborne radionuclides appear to have been dominated by naturally occurring uranium isotopes in 2003. For example, at the critical receptor (the receptor having the maximum dose potential), uranium isotopes characteristic of naturally occurring uranium contributed more than 88% of the fractional sum. In addition, the location where the highest total radionuclide levels were measured in 2003 (north of the Site) was influenced by off-Site activities that generated dust (the sampler is located immediately adjacent to a dirt road that has seen increasing traffic volumes due to expanded commercial development in the Superior area). Although the critical receptor is located to the north of the Site, rather than to the northwest as in recent years, the dominance of apparently naturally occurring uranium isotopes combined with nearby fugitive dust sources is consistent with sampling results from 1997, 1998, 1999, 2000, 2001, and 2002. The sampler location that was the critical receptor in previous years had the second highest dose potential across the compliance sampling network in 2003.

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## ABBREVIATIONS AND ACRONYMS

Am	Americium
Bq	Becquerel(s)
CAP88-PC	Clean Air Act Assessment Package-1988
CAQCC	Colorado Air Quality Control Commission
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
Ci	Curie(s)
Ci/m <sup>3</sup>	Curies per cubic meter
Ci/yr	Curies per year
cm	Centimeter(s)
cm <sup>2</sup>	Square centimeter(s)
DOE	U.S. Department Of Energy
dpm	Disintegrations per minute
DRCOG	Denver Regional Council of Governments
EDE	Effective dose equivalent
EIS	Effluent Information System
EPA	U.S. Environmental Protection Agency
HEPA	High efficiency particulate air (filter)
Kg	Kilogram
km	Kilometer(s)
km <sup>2</sup>	Square kilometer(s)
m	Meter(s)
m <sup>2</sup>	Square meter(s)
m <sup>3</sup>	Cubic meters(s)
mrem	Millirem(s)
m/s	Meters per second
mSv	MilliSievert(s)
N	Number of samples analyzed
ODIS	On-Site Discharge Information System
Pu	Plutonium
pCi/g	Picocuries per gram
RAAMP	Radioactive Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
rem	Reference man
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFPO	Rocky Flats Project Office
RSAL	Radionuclide Soil Action Levels
Site	Rocky Flats Environmental Technology Site
SNM	Special nuclear material
Sv	Sievert(s)
TRU	Transuranic

U	Uranium
WARP	Well Abandonment and Replacement Program
USC	United States Code
WIPP	Waste Isolation Pilot Plant
°C	Degrees Celsius
μCi	Microcurie(s)

## 1.0 INTRODUCTION

The Rocky Flats Environmental Technology Site (RFETS or Site) is subject to *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy Facilities* (Title 40 of the Code of Federal Regulations [CFR], Part 61, Subpart H). Regulation 40 CFR 61, Subpart H, applies to operations at any facility owned or operated by the U.S. Department of Energy (DOE) that emits radionuclides (other than radon-222 and radon-220) into the air. The standard requires that emissions of radionuclides to the ambient air from the Site not exceed those amounts that would cause any member of the public to receive in any year an effective dose equivalent (EDE) of 10 millirem (mrem) (0.1 milliSieverts [mSv]). Colorado has incorporated 40 CFR 61, Subpart H, by reference as Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart H.

Regulation 40 CFR 61, Subpart H, Section 61.94, requires the Site to demonstrate compliance with the standard for the previous calendar year and to submit this information, along with other data, to the U.S. Environmental Protection Agency (EPA) in an annual report (CAQCC Regulation No. 8, Part A, Subpart H, requires submittal to the Colorado Department of Public Health and Environment [CDPHE]). This report fulfills the reporting requirements of 40 CFR 61.94 and CAQCC Regulation No. 8, Part A, Section 61.94, for the 2003 calendar year.

In 1997, DOE filed an application with EPA and CDPHE requesting approval of an alternative compliance demonstration method for 40 CFR 61, Subpart H (DOE, 1997). The alternative method is based on environmental measurements of radionuclide air concentrations at critical receptor locations, rather than the dispersion modeling approach outlined in the regulation itself. In cases where nonpoint sources of emissions are the primary contributors to dose, as has been the case at the Site since before 1995, such an alternative method based on environmental measurements is recommended by EPA (EPA, 1991).

The alternative compliance demonstration method was approved by CDPHE and EPA. The compliance sampling network, which consists of 14 samplers located around the perimeter of the Site, became fully operational in 1999. The samplers are part of the Site's Radioactive Ambient Air Monitoring Program (RAAMP) network. Compliance has been determined using the alternative method for this annual report.

## 2.0 FACILITY INFORMATION

This section describes the Rocky Flats Environmental Technology Site, lists the radioactive materials present at the Site, and describes the handling and processing that the radioactive materials undergo. New construction or modifications in calendar year 2003 for which construction approval and startup notification were waived per 40 CFR 61.96 are also identified in this section. Construction approval and startup notification were not required for any new construction or modification in 2003.

### 2.1 Site Description

The Rocky Flats Environmental Technology Site is operated by Kaiser-Hill Company, L.L.C., with oversight by the Rocky Flats Project Office (RFPO) of the U.S. Department of Energy. Prior to 1989, the Site fabricated nuclear weapons components from plutonium, uranium, beryllium, and stainless steel. Production activities included metal fabrication and assembly, chemical recovery and purification of process-produced transuranic (TRU) radionuclides, and related quality control functions. Plutonium weapons operations were curtailed at the Site in 1989 due to safety concerns, and in February 1992, the Site's weapons production mission was discontinued.

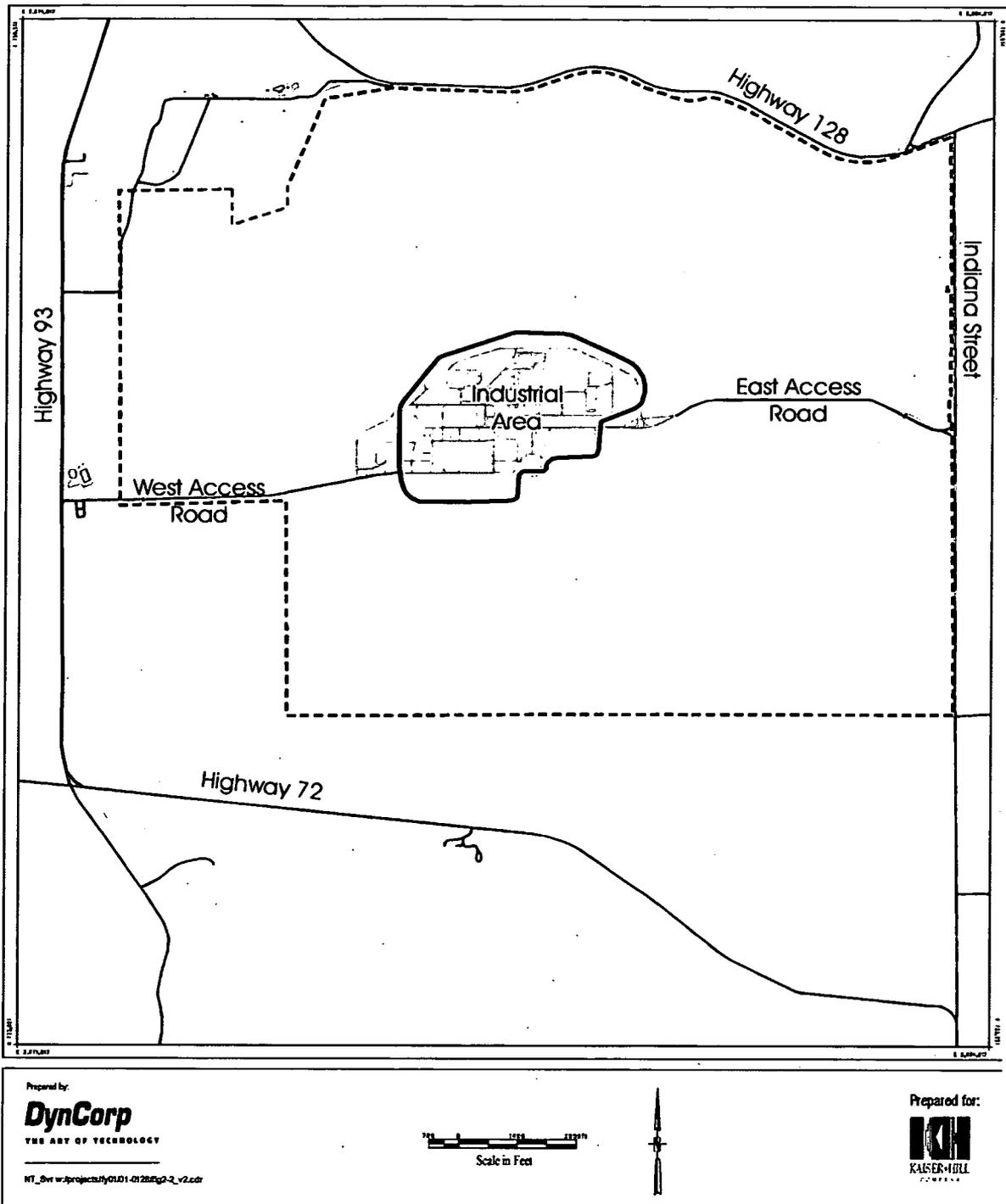
In 2003, the Site's mission included management and shipment of special nuclear material, nuclear decontamination and building demolition, waste management and shipment, environmental cleanup, and Site closure. Accelerated actions are targeted to be completed or implemented by the end of 2006. Sometime after all accelerated actions are completed or implemented, the Site will become a National Wildlife Refuge under the management of the U.S. Fish and Wildlife Service, with DOE retaining primary control of some areas that may have residual contamination.

The Site occupies an area of 26.5 square kilometers (km<sup>2</sup>) in northern Jefferson County, Colorado, about 25.7 kilometers (km) northwest of Denver. The Site is located at approximately 1,829 meters (m) above mean sea level on the eastern edge of a geological bench known locally as Rocky Flats. This bench, about 8.1 km wide in an east-west direction, flanks the eastern edge of the Rocky Mountains.

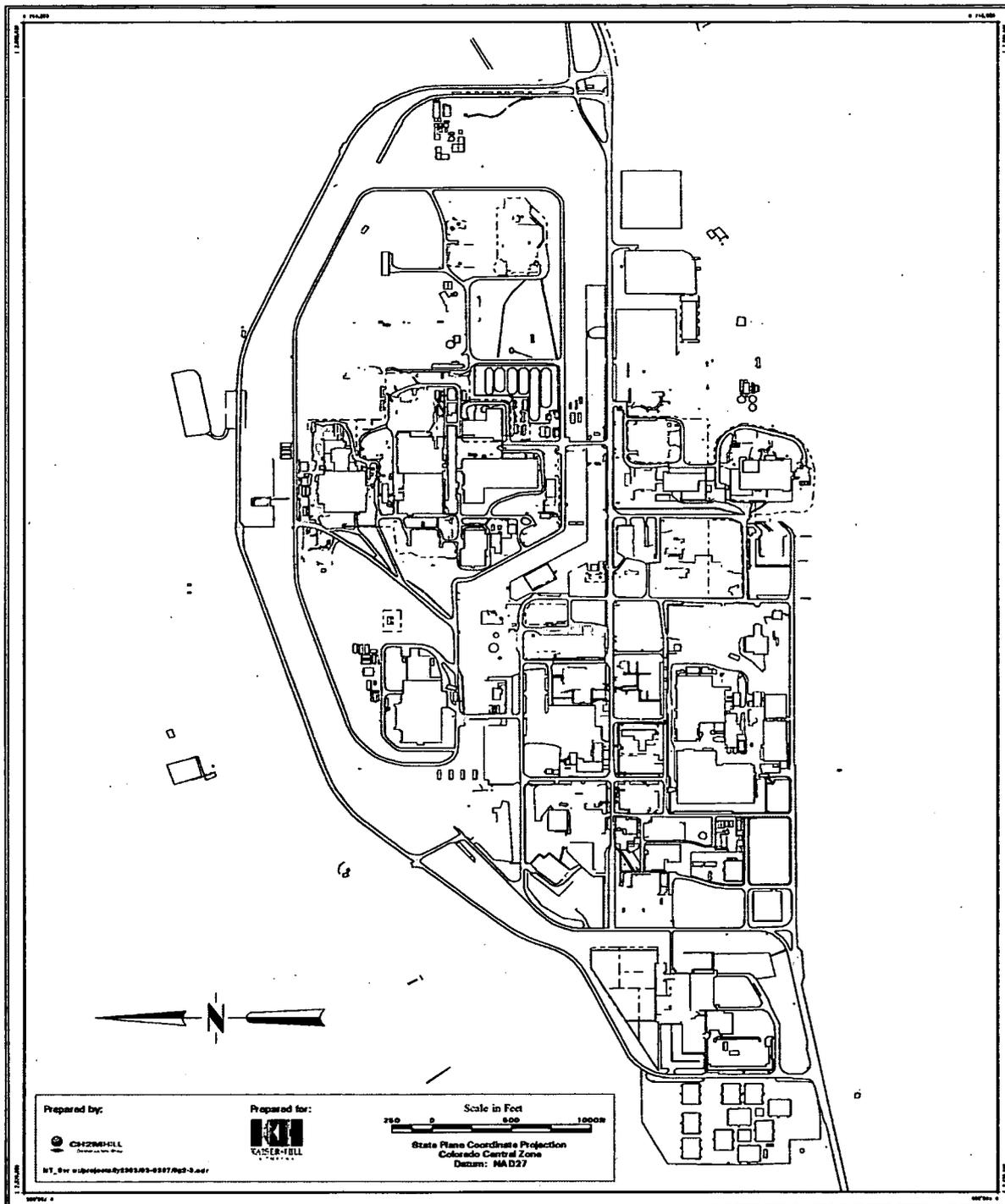
Over 3 million people live within 80 km of the Site. Adjacent land use is a mixture of agriculture, open space, industry, and residential housing. Surrounding communities include the city of Golden to the south of the Site; the cities of Arvada, Broomfield, and Westminster to the east; and the cities of Boulder and Superior to the north. An area map is shown in Figure 2-1.

The former production facilities are located near the center of the Site. The remaining Site area historically contained support facilities and served as a buffer zone for former production facilities. As of January 2004, approximately 330 of the Site's 805 buildings and structures had been demolished. A map of the Site is shown in Figure 2-2; a simplified map of the central portion of the Site (the "Industrial Area") showing the location of the former production facilities can be seen in Figure 2-3.





**Figure 2-2. Rocky Flats Environmental Technology Site Location Map**



**Figure 2-3. Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area)**

## **2.2 Radionuclide Air Emissions Source Description**

Activities involving radioactive material handling at the Site during 2003 focused on environmental restoration, building decommissioning and demolition, waste processing, and shipping support. Most of the radionuclide air emissions from the Site resulted from nonpoint (diffuse) sources, including mechanical and natural disturbances of contaminated soil. Soil contamination was caused by past radioactive material spills and other releases. In addition, the soils on and around the Site contain small quantities of naturally occurring radionuclides.

Past weapons-related activities in Site buildings resulted in residual radioactive material being deposited in Site ventilation systems and associated equipment such as gloveboxes. During 2003, some of this residual material was resuspended and released through building stacks or vents (point sources). Where radioactive material was emitted from points sources, the effluent was generally cleaned prior to release by passing it through multiple stages of high efficiency particulate air (HEPA) filters. As a result, radionuclide point source emissions from the Site were very low in 2003.

### **2.2.1 Radioactive Materials Handling During Calendar Year 2003**

In 2003, radionuclide emissions from the Site occurred from several activities that either disturbed resident contamination in buildings or in soil, or that processed or used radionuclide-containing substances such that emissions to the atmosphere resulted. Appendix A lists radioactive materials associated with the Site. The list of radionuclides includes plutonium (Pu)-239/240, americium (Am)-241, uranium (U)-233/234, U-235, and U-238. The Site also has small quantities of beta- and gamma-emitting sealed sources and low activity analytical stock solutions, powders, and plated sources; emissions from these sources were negligible.

The major sources of Site radionuclide emissions in calendar year 2003 are described below.

#### **Hold-up in Ducts**

Radionuclide emissions were generated through disturbance of radionuclide-contaminated dust and other deposits on the surfaces of ventilation ducts exiting former process areas. These materials were deposited on duct walls and in rapidly decreasing amounts on successive stages of HEPA filters during many years of weapons component production. Routine air movement and pressure changes in the ducts entrain a small amount of this contamination on an ongoing basis. In addition, decontamination and equipment removal or reconfiguration activities disturbed a portion of the hold-up in certain ducts in 2003, resulting in additional emissions to the atmosphere. Ducts containing hold-up were vented through multiple stages of HEPA filters.

#### **Resident Contamination**

In some former process areas, contamination may be found on glovebox surfaces and floors, and, in limited cases, in the rooms themselves. As with hold-up, resident contamination was emitted in 2003 due to routine exposure to ventilation air and due to active disturbance by project activities, particularly decontamination and equipment

movement. Ducts venting areas with significant contamination were exhausted through multiple stages of HEPA filters.

### **Consolidation of Special Nuclear Material (SNM)**

SNM is plutonium and enriched uranium contained in weapons components, metals, metal alloys, and oxides. SNM-related consolidation activities continued in calendar year 2003 and included size-reduction of metal, and packaging and interim storage of SNM. These consolidation activities are defined as follows:

- Size-reduction: Reduction of material size by breaking, cutting, sawing, or pressing to accommodate storage container requirements.
- Packaging and storage: Placement of material in approved, inert atmosphere, storage containers, which in turn are placed in storage vaults or vault-type rooms. Storage vaults are repositories of SNM materials that satisfy required safety and risk criteria.

Consolidation activities resulted in radionuclide emissions in 2003 through exposure of SNM to ventilation air, as well as through mechanical disturbance of SNM. Consolidation was performed in areas where ventilation air was exhausted through HEPA filters. All SNM was removed from the Site by mid-2003.

### **Waste Handling**

Most of the low-level and TRU waste materials at the Site were generated during plutonium weapons component production and radionuclide recovery operations conducted prior to 1989. In 2003, solid waste, including contaminated gloveboxes and duct work, was segregated and size-reduced prior to packaging for storage and disposal. Such activities disturbed the radioactive contamination in the waste, resulting in radioactive particles in the room air.

Radioactive wastes were handled (segregated, size-reduced, and packaged) inside buildings or other structures. Venting the air through HEPA filters controlled emissions from these operations.

In addition to solid waste, liquid waste in tanks and pipes may also release radionuclides to the atmosphere, either through routine passive venting, or when liquid waste is exposed to the atmosphere when systems are drained or the materials treated. In addition to routine emissions from tank vents, liquid radioactive waste movement projects contributed to emissions during 2003. These activities took place in areas that vented through HEPA filters.

### **Waste Storage**

Packaged low-level and TRU wastes are stored in drums at various locations on Site prior to shipping. Drums are vented to prevent pressure buildup from hydrogen gas, which is generated by radiolytic activity affecting packaged materials. Radionuclide emissions would only occur from these drums during venting if the inner packaging failed. To minimize emissions should the inner packaging fail, the drums are equipped with small filter cartridges that function like HEPA filters. For purposes of estimating emission

potential for compliance with 40 CFR 61, Subpart H, the packaged materials inside these drums are considered sealed sources (in accordance with Appendix D to 40 CFR 61).

### **Waste Repackaging**

Radionuclide emissions were generated in 2003 from waste characterization and repackaging activities that support waste shipment activities. Various radionuclide-contaminated wastes and residues were characterized and repackaged in preparation for shipment to the Nevada Test Site, Savannah River Site, the Waste Isolation Pilot Plant (WIPP), or other off-Site facilities. Most of the waste repackaging activities that occurred in 2003 took place in areas that were vented through HEPA filters.

### **Building/Structure Demolition Projects**

Demolition projects at the Site are performed in accordance with the Rocky Flats Cleanup Agreement (RFCA). RFCA is a negotiated, interagency agreement governing Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup activities at the Site. RFCA states that all unneeded buildings at the Site will be demolished. In most cases, contaminated systems are decontaminated and removed prior to demolition.

The following structures were demolished in 2003:

- Buildings 281, 992, 885, 453, 427, 449, 112, 441, 553, 554, 556, 428, 790, 334, 830, 551, 372, 372A, 865, 867, 868, 773, 552, 569, 570, 126, 763, 557, 116, 984, 985, 455, Water Tower, 549, 989, 869, 668, 566, and 119;
- Trailers T904A, T121A, T441A, T131A, T771H, T771E, T707F, T707G, T771K, T771T, T771F, T115A, and T115C; and
- Tents 8, 9, 10, and 11 on the 904 Pad.

With the exception of Building 867, these structures were not radiologically contaminated above free-release criteria.

### **Miscellaneous Point Sources**

In late 1997, several laboratory operations were transferred to a new modular laboratory. The modular analytical laboratory continued operations for the first part of 2003, and was then closed. Radionuclide emissions from the handling of contaminated media (such as filters) were negligible.

Two new point sources were initiated in 2003: 1) Trailer T130A laboratory; and 2) 750 Pad, Tent 5 low-level and low-level mixed waste repackaging. In addition, a waste chemical repackaging operation was moved from the 904 Pad to the 750 Pad, Tent 5. These operations are described in more detail in Section 2.2.2.

Miscellaneous point source operations that continued from the previous year included a drum crushing activity at the 750 Pad, Tent 5, which operated intermittently during 2003; and the Building 778 decontamination showers.

## Miscellaneous Nonpoint Sources

Another contributor to Site radionuclide emissions in 2003 was the resuspension of contaminated soils. Contaminated soils were resuspended by wind erosion, vehicle traffic, and other mechanical soil disturbances. Miscellaneous nonpoint sources that emitted radionuclides in 2003 included the 750 Pad Solar Pond sludge removal project, 903 Pad remediation, Building 993 slab removal, Building 701/779 asphalt pad removal, Building 865 slab removal, monitoring well abandonment, Tank 207 demolition, removal of the original plant incinerator, 903 Lip Area vacuum excavation demonstration, 903 Lip Area remediation, Building 867 demolition, Site valve vault removals, and demolition of Building 774, Rooms 220 and 320 (these sources are described in more detail in Section 2.2.2). Emissions generated by wind erosion were uncontrolled, while radionuclide emissions from vehicle traffic and mechanical disturbances were sometimes controlled using dust suppression techniques.

### 2.2.2 New Construction and Modifications in Calendar Year 2003

Fourteen new or modified activities that contributed to the Site air pathway dose in calendar year 2003 are described below. As part of the project evaluation process (prior to the startup of each project), the maximum annual (controlled) off-Site EDE that could result from each new or modified activity was calculated to determine approval and notification requirements. Maximum potential radionuclide emissions were estimated using emission and control factors from Appendix D to 40 CFR 61, combined with information regarding radionuclide contaminant levels and material forms, radionuclide release mechanisms, and the radionuclide emission controls employed. In cases where HEPA filters were employed, credit was taken for a maximum of two stages, although up to four stages may actually have been employed. Emissions were modeled using the Clean Air Act Assessment Package-1988 (CAP88-PC), and recent Site meteorological data to estimate annual EDEs at the most impacted off-Site residence and business locations.

To place the reported EDE values in context, it should be noted that the emission estimation and modeling methods used in this exercise are designed to generate "worst case" dose estimates. The emission factors, control device efficiencies, and modeling approach are mandated by 40 CFR 61, Appendix D, to ensure that project dose will not be underestimated when determining whether notification and approval are necessary under the regulation. In fact, actual emissions and dose will often be much lower than the estimates used to determine approval and notification requirements.

Detailed data and calculations used to develop emission estimates and resulting dose projections are maintained in Site files. The estimated EDE (shown below) for each new construction or modification was less than 1% of the 10-mrem (0.1-mSv) standard, and construction approval and startup notification were unnecessary under 40 CFR 61.96.

The project- or process-specific EDEs used in making regulatory applicability decisions regarding approval requirements are discussed below.

**Trailer T130A Laboratory:** In 2003, many of Building 559's laboratory operations were moved to Trailer T130A. Trailer T130A was modified to safely allow radiological sample collection, receiving, packaging, and shipping, as well as gamma spectroscopy

operations and low-level analytical services. Maximum process rates, and worst-case scenario radiological activity levels, were taken from Appendix 2 of the Trailer T130A Auditable Safety Analysis document.

During 2003, low-level sample work was performed in fume hoods, and high-level sample work was performed in gloveboxes that exhausted through at least one stage of HEPA filters. The off-Site EDE was calculated based on the maximum process rates, worst-case scenario radiological activity levels, and an emission factor from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be  $3.5 \times 10^{-8}$  mrem ( $3.5 \times 10^{-10}$  mSv).

**750 Pad, Tent 5 Repackaging of Waste Chemicals:** In 2003, drums of legacy waste chemicals were repackaged in the Tent 5 containment structure on the 750 Pad. Prior to 2003, this operation was performed in Tent 11 on the 904 Pad. The drums were evaluated, characterized, and repackaged for off-Site disposal, or returned to on-Site storage.

The containment structure air exhausted through two stages of HEPA filters. Dose calculations for this project were based on the conservative assumption that all drums were at the maximum allowable concentration for low-level waste (100 nanocuries plutonium per gram waste), and on the assumption that there would be 20 drums within the containment structure open to the atmosphere at all times. Emission factors were taken from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE for this project was estimated to be  $7.5 \times 10^{-5}$  mrem ( $7.5 \times 10^{-7}$  mSv).

**750 Pad, Tent 5 Repackaging of Low-level/Low-level Mixed Waste:** In 2003, both low-level and low-level mixed waste were repackaged in the Tent 5 containment structure on the 750 Pad. Waste drums and boxes that were identified as noncompliant with off-Site disposal requirements were transported to the Tent 5 containment structure, characterized, sorted, and repackaged to bring them into compliance. The repackaged containers were then stored for eventual shipment to an approved off-Site disposal facility.

Negative air pressure was maintained within the repackaging containment structure, and exhausted through at least one stage of HEPA filters. Dose calculations for this project were based on the conservative assumption that all waste forms were at the maximum allowable concentration for low-level waste (100 nanocuries plutonium per gram waste), and on the assumption that the process would operate at its maximum design rate. Emission factors were taken from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE for this project was estimated to be  $4.0 \times 10^{-6}$  mrem ( $4.0 \times 10^{-8}$  mSv).

**Calendar Year 2003 Well Abandonment and Replacement Program (WARP):** The first phase of the 2003 WARP scope included abandoning 334 groundwater monitoring wells and well points across the Site. Approximately 53 locations required minor excavation of potentially contaminated soil. Soil contaminant levels below 50 picocuries Pu-239/240 and 50 picocuries Am-241 per gram of soil (pCi/g) were expected in the areas requiring excavation.

Dose calculations from excavation and soil handling activities were based on the assumption that all excavated soil was contaminated at 50 pCi/g Pu-239/240 and Am-241, on the volume of soil excavated, and on emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (EPA, 1995). The maximum annual off-Site EDE from these activities was estimated to be  $1.7 \times 10^{-5}$  mrem ( $1.7 \times 10^{-7}$  mSv).

**Building 993 Slab Remediation:** In 2003, Building 993 was demolished and the remaining building slab was remediated. During the slab remediation activities, concrete was size-reduced for transport, soil was removed, and the area was backfilled with clean soil.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of contaminated concrete that was size-reduced; and the maximum allowable radionuclide contamination level for low-level waste. The maximum annual off-Site EDE from the project was estimated to be  $3.7 \times 10^{-4}$  mrem ( $3.7 \times 10^{-6}$  mSv).

**Building 865 Slab Remediation:** In 2003, the Building 865 slab was remediated. During the slab remediation activities, concrete was size-reduced for transport, soil was removed, and the area was backfilled with clean soil.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of contaminated concrete that was size-reduced; and the maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $6.5 \times 10^{-6}$  mrem ( $6.5 \times 10^{-8}$  mSv).

**Building 701 and 779 Pad Asphalt Repair:** In 2003, three areas east and south of the 779 Pad, and one area southwest of Building 701, were excavated up to 0.6 m below grade, then backfilled, compacted, and covered with new asphalt to alleviate safety hazards to waste package loading equipment. Approximately 46 cubic meters ( $m^3$ ) of excavated soil was suspected to be contaminated with radionuclides at low levels.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of contaminated soil excavated; and maximum allowable low-level radionuclide contamination levels. The maximum annual off-Site EDE from the project was estimated to be  $7.6 \times 10^{-7}$  mrem ( $7.6 \times 10^{-9}$  mSv).

**Removal of Incinerator and Concrete Washout From West Central Buffer Zone:** In 2003, concrete that was washed out of trucks, and the original Site incinerator, were removed from the west-central Buffer Zone. The project used heavy equipment to break up and remove an estimated 1,500 to 2,300  $m^3$  of concrete and soil. Approximately 28  $m^3$  of this material was contaminated with low levels of radionuclides.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of contaminated soil that was excavated and the volume of contaminated concrete that was size-reduced; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $1.2 \times 10^{-4}$  mrem ( $1.2 \times 10^{-6}$  mSv).

**Removal of Site Valve Vaults:** In 2003, 17 Site valve vaults were removed. The project used heavy equipment to break up and remove an estimated 15 m<sup>3</sup> of concrete and 187 m<sup>3</sup> of soil. The concrete and soil were assumed to be contaminated at worst case levels of 1,000 pCi/g Pu-239/240.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of contaminated soil that was excavated and the volume of contaminated concrete that was size-reduced; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $1.7 \times 10^{-5}$  mrem ( $1.7 \times 10^{-7}$  mSv).

**Tank 207 Demolition:** In 2003, sludge was removed from the bottom of Tank 207, and the tank was demolished using a track-mounted shear for size-reduction. A permanent fixative was used as the primary engineering control of potential emissions.

The EDE estimation used an emission factor from Appendix D to 40 CFR 61; the total area of the tank; and maximum surface radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $1.6 \times 10^{-4}$  mrem ( $1.6 \times 10^{-6}$  mSv).

**903 Pad Lip Area Remediation:** In 2003, excavation began on the 903 Pad Lip Area. The remedial objective is to remove and dispose of any contaminated soil with radionuclide levels that exceed RFCA Radionuclide Soil Action Levels (RSALs). The RFCA RSALs represent contaminant levels that are calculated to pose an acceptable level of lifetime excess cancer risk for a wildlife refuge worker. Soils contaminated above the RSALs must be removed to specified depths.

The 903 Pad Lip Area covers approximately 35 acres, which was divided into smaller working cells. Soil from approximately 0.15 to 0.46 m in depth was excavated, packaged, and shipped to an off-Site disposal facility.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and the average isotopic contamination levels in the soil. The maximum annual off-Site EDE from the project was estimated to be  $7.0 \times 10^{-2}$  mrem ( $7.0 \times 10^{-4}$  mSv).

**903 Pad Lip Area Vacuum Excavation Demonstration:** In 2003, a field demonstration project was performed at the 903 Pad Lip Area to demonstrate the feasibility of using air excavation coupled with vacuum extraction as a remedial alternative for radionuclide contaminated surficial soils. The demonstration was conducted over 10 plots, each 10 square meters (m<sup>2</sup>) in area, with increasing radionuclide contamination levels. Soil was excavated to a depth of 10 centimeters (cm).

The EDE estimation used an emission factor derived from previous vacuum excavation demonstrations conducted at the Site; the volume of soil excavated; and the maximum isotopic contamination levels in the soil. The maximum annual off-Site EDE from the project was estimated to be  $2.3 \times 10^{-4}$  mrem ( $2.3 \times 10^{-6}$  mSv).

**Building 867 Demolition:** In 2003, Plenum Building 867 was demolished. The building did not meet free-release criteria for radionuclide contamination. The entire

inside surface area of the building was assumed to be contaminated at the maximum detected levels.

The EDE estimation used emission factors from Appendix D to 40 CFR 61; the total inside surface area of the building to be demolished; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $1.5 \times 10^{-6}$  mrem ( $1.5 \times 10^{-8}$  mSv).

**Building 774, Rooms 220 and 320 Demolition:** In 2003, Rooms 220 and 320 in Building 774 were demolished. The rooms did not meet free-release criteria for radionuclide contamination. The entire inside surface area of both rooms was assumed to be contaminated at the maximum detected levels.

The EDE estimation used the demolition release rate approved in the *Building 776/777 Air Modeling Technical Document* (Kaiser-Hill, 2002); the total inside area of the rooms to be demolished; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be  $1.7 \times 10^{-7}$  mrem ( $1.7 \times 10^{-9}$  mSv).

### 3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 2003. The stacks, vents, and other points where radioactive materials were released to the atmosphere are described, and control measures employed by the Site to minimize emissions are discussed.

#### 3.1 Emission Determination Process

This section presents an estimate of Site radionuclide air emissions in calendar year 2003. Where air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured, those data are presented here. In many cases, however, emissions from activities that generated airborne radionuclides were not measured. Given the Site's cleanup and closure mission, it is not surprising that an increasing number of Site emission sources are not amenable to direct measurement methods. For these activities, emissions were estimated based on project-specific information, combined with emission factors from various sources. Emission sources that were clearly negligible were not quantified.

Where emissions were estimated, rather than directly measured, the emission estimates were based on:

- The radionuclide content of materials or debris handled or processed;
- The form of the radioactive material (gas, liquid, solid, or particulate; fixed or removable);
- The mechanisms by which radionuclides were released to the atmosphere;
- The time over which the activities that released radionuclides occurred or the time that the radioactive material was exposed to the atmosphere;
- The control measures employed to reduce radionuclide emissions; and
- Emission factors appropriate to a given activity.

Emission factors were derived from several sources. Radionuclide emission factors listed in Appendix D to 40 CFR 61 were used to calculate emissions due to exposure of radioactive material to the atmosphere during processing or handling. Additional emissions resulting from the release of radionuclide-contaminated particles through handling or processing soil and debris were based on emission factors in EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (EPA, 1995). For the 903 Pad Lip Area vacuum excavation demonstration, emission factors were developed during a previous demonstration of an earlier version of the excavation technology. The appropriate emission factors were combined with project- or process-specific information to yield estimated radionuclide emissions. Finally, in the case of Building 774, Rooms 220 and 320 Demolition, emission estimates were based on the demolition release rate approved in the *Building 776/777 Air Modeling Technical Document* (Kaiser-Hill, 2002).

In addition to emissions from specific projects or processes, an ongoing source of radionuclide emissions from the Site is the resuspension of contaminated surface soils by

wind erosion. Emissions from this source were estimated by combining information regarding Site-wide surface soil concentrations of radionuclide contaminants with a Site-specific soil resuspension factor. Development of the resuspension factor was discussed in detail in a previous annual report (DOE, 1996). Historical surface soil radionuclide data from a Site-specific soil sampling database provided the contaminant concentration data needed to complete the wind erosion emission calculations.

The emissions discussed in this section include all isotopes that have the potential to contribute 10% or more to the Site's total air pathway EDE. These include:

- Uranium isotopes typical of the depleted and enriched uranium that have been used at the Site, as well as uranium isotopes that are naturally present in Site soils;
- Pu-239/240, which contributes more than 97% of the alpha activity in Site plutonium; and
- Am-241, a decay product of Pu-241, which is a minor component of the weapons-grade plutonium that was used at the Site.

### **3.2 Point Sources**

Radionuclide emissions released through stacks and vents are termed "point" sources. In 2003, radionuclide point source emissions at the Site included both measured releases from stacks and vents in the Industrial Area and releases that were estimated as described in Section 3.1. Point source emissions for calendar year 2003 and the control technology used at each point source are described in this section.

#### **3.2.1 Measured Point Source Emissions**

During calendar year 2003, radionuclide emissions were collected and measured only at significant release points. Significant release points are those that have the potential to discharge radionuclides into the air in quantities that would result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration). Insignificant release points are those that have the potential to discharge radionuclides in lesser quantities. Unless it can be shown to be impractical for a given significant release point, significant release points must be continuously monitored or sampled, while insignificant release points require periodic confirmatory measurements to verify low emissions (40 CFR 61.93).

Prior to 1999, periodic confirmatory measurements to verify low emissions were made at insignificant release points using the effluent sampling systems described below. Effluent sampling was discontinued at insignificant locations in 1999 and 2000, and the compliance sampling network (an ambient air monitoring network that is described in Section 4.1.1) has been used since then to confirm low emissions.

In addition, sampling has been discontinued at several release points because they are undergoing active decommissioning, making it impractical to continue effluent monitoring. During active decommissioning, air flow through the ventilation systems is disturbed sufficiently that the measurement and quantification of radionuclide releases becomes unreliable and no longer representative, or the sampler locations themselves become compromised by removal of necessary infrastructure. At that point, sampling

locations undergoing active decommissioning are removed from service and any radioactive particulate matter release associated with such locations is accounted for through the compliance sampling network.

### **Effluent Sampling Methods**

Point source emissions are measured at the Site with sampling systems that continuously draw a portion of the duct or vent airstream through a filter. Radioactive particles are collected on the filters, which are generally exchanged weekly. Following collection, the filters are screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples are composited monthly by location and analyzed for plutonium, americium, and uranium isotopes. All radionuclides that could contribute greater than 10% of the potential EDE for a release point were measured during calendar year 2003.

### **Calendar Year 2003 Effluent Sampling**

In calendar year 2003, particulate matter samples were collected at 12 air effluent sampling locations, representing six discrete release points (three of the sampling systems employed multiple probes and filters, which were then composited by release point). These locations were sampled all year. One sampling location, representing a single release point, was discontinued in late April 2003. An additional 18 sampling locations, representing 18 release points, were discontinued in early January 2003. Their emissions were included in the 2002 annual report required by 40 CFR 61, Subpart H, and are not reported here. Appendix B lists the sampling locations monitored during 2003.

Historically, particulate matter samples were collected at many effluent release points that were identified as insignificant. Several of these locations, while not currently sampled, are still considered release points. However, the quantities of radionuclides emitted from these locations in 2003 were negligible, and low emissions from these points were verified using the ambient sampler network. Appendix C to the calendar year 2000 annual report (DOE, 2001) contains additional information regarding previously sampled insignificant release point locations.

As noted above, several changes in point source emission measurements took place during 2003. All remaining operational samplers in Building 707 were discontinued at the first filter exchange in January 2003 because the building was undergoing active decommissioning. Similarly, the remaining operational sampler in Building 771 (771-MAI) was discontinued in late April 2003 because of active decommissioning.

Sampling continued throughout much of 2003 at Building 440 to support waste repackaging activities. Sampling was discontinued for approximately 24 hours in early January 2003 due to sample pump failure. No waste repackaging activities occurred while the sampler was out of service, and there is no holdup contamination in the Building 440 duct work that would trigger monitoring when waste repackaging activities are shut down.

Measured calendar year 2003 emissions of plutonium, americium, and uranium are shown in Table 3-1.

**Table 3-1. Measured Point Source Radionuclide Emissions**

Building/ Location <sup>a</sup>	Isotope Emissions (Ci/yr) <sup>b,c,d</sup>				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
371-N01	2.75E-08	4.65E-09	3.62E-09	1.18E-09	1.49E-09
371-N02	8.83E-09	8.69E-10	2.18E-09	7.32E-10	4.72E-09
371-SSS	1.29E-08	1.69E-09	1.88E-09	1.13E-11	5.01E-10
374-MAI	5.85E-09	2.17E-09	6.72E-09	6.87E-10	1.47E-09
440-101	5.14E-10	3.86E-10	1.02E-09	3.26E-10	2.91E-10
559-561	6.18E-09	3.75E-09	6.40E-09	1.48E-09	4.43E-09
771-MAI <sup>e</sup>	2.49E-08	7.67E-09	1.64E-08	2.40E-09	4.34E-09

<sup>a</sup> The first number in this column designates the building cluster, the second set of characters designates the specific duct(s) or vent(s). The location of each release point is shown in Figure 3-1 of this report.

<sup>b</sup> Values were corrected for filter blanks.

<sup>c</sup> All measured point sources were controlled by HEPA filters with a tested control efficiency of at least 99.97 percent.

<sup>d</sup> All isotopes that could contribute greater than 10% of the potential EDE for a release point were measured.

<sup>e</sup> Sampler removed from service on 4/29/03 due to active decommissioning.

Notes:

The samplers that were removed from service on 1/7/03 due to active decommissioning were: 707-R21A/B, 707-R22A/B, 707-R23A/B, 707-R25A/B, 707-45A/B, 707-46A/B, 707-101/103, 707-102/104, 707-105, 707-106, 707-107, and 707-108.

- Am = Americium
- Ci/yr = Curies per year, 1 Ci = 3.7 x 10<sup>10</sup> Becquerel (Bq)
- E# = x 10<sup>#</sup>
- EDE = Effective dose equivalent
- HEPA = High efficiency particulate air
- Pu = Plutonium
- U = Uranium

Appendix C shows calendar year 2003 measured point source emissions data, formatted to conform to DOE's Effluent Information System (EIS), a historical database for recording and reporting radioactive effluent data for airborne and waterborne discharges that travel off site from facilities under DOE control. DOE no longer requires its facilities to submit an EIS report.

### 3.2.2 Calculated Point Source Emissions

During 2003, several point sources operated at the Site that did not trigger continuous sampling requirements because they had low emission potential or were of short duration. Sources that continued operation from 2002 included a drum crusher in Tent 5 at the 750 Pad, and the operation of decontamination showers in Building 778. New sources included the repackaging of waste chemicals in Tent 5 at the 750 Pad (moved from the 904 Pad in 2003), low-level and low-level mixed waste repackaging in Tent 5 at the 750 Pad, and the Trailer T130A laboratory; these sources are described in greater detail in Section 2.2.2. Point sources with calculated emissions that continued operation from 2002 are described below. Emissions were calculated for these insignificant release points as described in Section 3.1. Table 3-2 shows calculated point source emission estimates for calendar year 2003.

**Building 778 Decontamination Shower Installation:** In 2002, temporary decontamination showers were installed in Building 778, Room 112. When a worker was decontaminated, a pump was activated, along with an air mover that provided a negative pressure for the room. The room air was vented through a HEPA filter.

The off-Site EDE was calculated based on 20 visits to the showers per year (conservative estimate based on past experience), maximum possible skin and clothing contamination levels, and an emission factor from Appendix D to 40 CFR 61.

**750 Pad, Tent 5 Drum Crusher:** In 2000, a drum crusher was installed within the Tent 5 containment structure at the 750 Pad and has operated since that time. Operation of the drum crusher was initially limited to empty drums with contamination levels less than or equal to 20 disintegrations per minute (dpm) per 100 square centimeters (cm<sup>2</sup>). The maximum process rate of the drum crusher was approximately 30 drums per hour. In 2001, the maximum contamination level of the drums was raised to 100,000 dpm/100 cm<sup>2</sup>.

The containment structure air exhausted through a single-stage HEPA filter. For 2003, dose calculations were based on the conservative assumptions that the crusher would operate at the maximum process rate 24 hours per day, 5 days per week, 52 weeks per year and that each drum was contaminated at 100,000 dpm/100 cm<sup>2</sup> over the entire surface area. In fact, the drum crusher operated only intermittently during 2003, so actual emissions would have been substantially less than estimated here.

**Table 3-2. Calculated Point Source Radionuclide Emissions**

Activity or Building	Isotope Emissions (Ci/yr) <sup>a</sup>				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
750 Pad, Tent 5 Drum Crusher <sup>b</sup>	4.7E-08	4.2E-09	--	--	--
Trailer T130A Laboratory <sup>b</sup>	1.1E-09	1.3E-10	--	--	--
Building 778 Decontamination Showers <sup>b</sup>	8.3E-09	7.4E-10	--	--	--
750 Pad, Tent 5 Low-level and Low-level Mixed Waste Repackaging	1.4E-07	1.6E-08	--	--	--
750 Pad, Tent 5 Waste Chemical Repackaging <sup>b</sup>	2.2E-06	2.3E-07	--	--	--

<sup>a</sup> Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. Isotopes for which emissions were not estimated are shown as "--". The locations of the release points listed are shown in Figure 3-1 of this report.

<sup>b</sup> HEPA filtration used with a control efficiency of at least 99.97 percent.

Notes:

Am	= Americium	Ci/yr	=	Curies per year, 1 Ci = 3.7 x 10 <sup>10</sup> Becquerel (Bq)
E#	= x 10 <sup>#</sup>	EDE	=	Effective dose equivalent
HEPA	= High efficiency particulate air	Pu	=	Plutonium
U	= Uranium	--	=	Not estimated/negligible

**Unmonitored Building Stacks and Vents:** Small amounts of radionuclides continued to be released from various building stacks and vents that have been classified as insignificant release points. Individually, none of these release points had the potential to release radionuclides in amounts that could result in an off-Site EDE in excess of 1% of the 10 mrem standard, even if the emissions were uncontrolled. Many of these release points were controlled by two or more stages of HEPA filters; consequently, actual emissions would have been a fraction of a percent of the standard limitation. As a result, no attempt has been made to estimate emissions from these sources; instead, the compliance sampling network data have been used to demonstrate that none of these points released significant quantities of radionuclides during calendar year 2003 (see Section 4.1 of this report).

### **3.2.3 Control Technology for Point Sources**

HEPA filters are used to control radioactive particulate matter emissions from air effluent systems. All of the point source locations listed in Table 3-1 used HEPA filtration in 2003. Effluent air from areas where plutonium or plutonium-contaminated wastes were processed was typically cleaned by a minimum of four stages of HEPA filters. Effluent air from uranium processing areas was generally cleaned by a minimum of two stages of HEPA filters. HEPA filters were bench tested prior to installation in the buildings to ensure that they would meet a minimum filter efficiency of 99.97% (Novick, et al., 1985). Filter assemblies were tested again for leaks following installation.

The Building 778 decontamination showers; the Trailer T130A laboratory operations; and the 750 Pad, Tent 5 chemical repackaging, low-level/low level mixed waste repacking, and drum crusher operations were controlled by a minimum of one HEPA filter.

### **3.3 Nonpoint Sources**

Radionuclide emissions that are not released through specific stacks or vents are termed "nonpoint" (or diffuse) sources. Table 3-3 summarizes emissions from nonpoint sources for calendar year 2003.

#### **3.3.1 Nonpoint Source Descriptions**

In calendar year 2003, nonpoint sources of radionuclide emissions at the Site included resuspension of contaminated soils by wind erosion and by mechanical disturbance due to excavation, handling, and vehicle traffic. Mechanical disturbance of contaminated soils was associated with:

- 903 Pad Lip Area remediation;
- 903 Pad Lip Area vacuum excavation demonstration;
- 903 Pad remediation;
- Well abandonment and replacement program;
- Building 701/779 asphalt pad repair;
- Building 865 slab removal;

**Table 3-3. Nonpoint Source Radionuclide Emissions**

Source or Project <sup>b</sup>	Isotope Emissions (Ci/yr) <sup>a</sup>				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
Resuspension by Wind Erosion	4.8E-05	1.5E-05	2.2E-07	3.2E-08	1.5E-07
Incinerator Removal	--	--	5.4E-08	6.3E-09	1.3E-05
903 Pad Remediation	4.9E-06	1.1E-06	6.5E-09	9.4E-10	2.7E-08
Building 865 Slab Remediation	3.1E-07	8.3E-10	7.4E-08	9.8E-09	6.8E-07
Building 993 Slab Remediation	1.3E-05	1.5E-06	--	--	--
Building 701/779 Asphalt Pad Repair	3.1E-08	3.7E-09	--	--	--
903 Pad Lip Area Soil Remediation	1.7E-03	3.0E-04	--	--	--
903 Pad Lip Area Vacuum Excavation Demonstration	7.0E-06	8.2E-07	--	--	--
Abandoning Monitoring Wells	2.5E-07	2.5E-07	--	--	--
750 Pad Solar Pond Sludge Removal	5.0E-04	1.2E-03	3.4E-05	2.3E-06	5.1E-05
Tank 207 Demolition	6.8E-06	8.0E-07	--	--	--
Building 867 Demolition	--	--	--	--	1.5E-07
Building 774, Rooms 220 and 320 Demolition	6.8E-09	8.0E-10	--	--	--
Site Valve Vault Removal	7.1E-07	8.3E-08	--	--	--

<sup>a</sup> Emissions of all isotopes that could contribute greater than 10% of the potential EDE for a release point were estimated. The locations of the nonpoint release emission sources are shown in Figure 3-1 and in Appendix D.

<sup>b</sup> Emissions assumed to be uncontrolled.

Notes:

- Am = Americium
- Ci/yr = Curies per year, 1 Ci = 3.7 x 10<sup>10</sup> Becquerel (Bq)
- E# = x10<sup>#</sup>
- EDE = Effective dose equivalent
- Pu = Plutonium
- U = Uranium

- Removal of incinerator and concrete washout from west central Buffer Zone; and
- Site valve vault removal.

Calendar year 2003 nonpoint sources also included the Building 867 demolition project, demolition of Rooms 220 and 320 in Building 774, and demolition of Tank 207.

Several other structures were demolished during 2003, including:

- Buildings 281, 992, 885, 453, 427, 449, 112, 441, 553, 554, 556, 428, 790, 334, 830, 551, 372, 372A, 865, 868, 773, 552, 569, 570, 126, 763, 557, 116, 984, 985, 455, Water Tower, 549, 989, 869, 668, 566, and 119;
- Trailers T904A, T121A, T441A, T131A, T771H, T771E, T707F, T707G, T771K, T771T, T771F, T115A, and T115C; and
- Tents 8, 9, 10, and 11 on the 904 Pad.

These structures were not radiologically contaminated above free-release criteria. Therefore, no radionuclide emissions were calculated for these demolition projects.

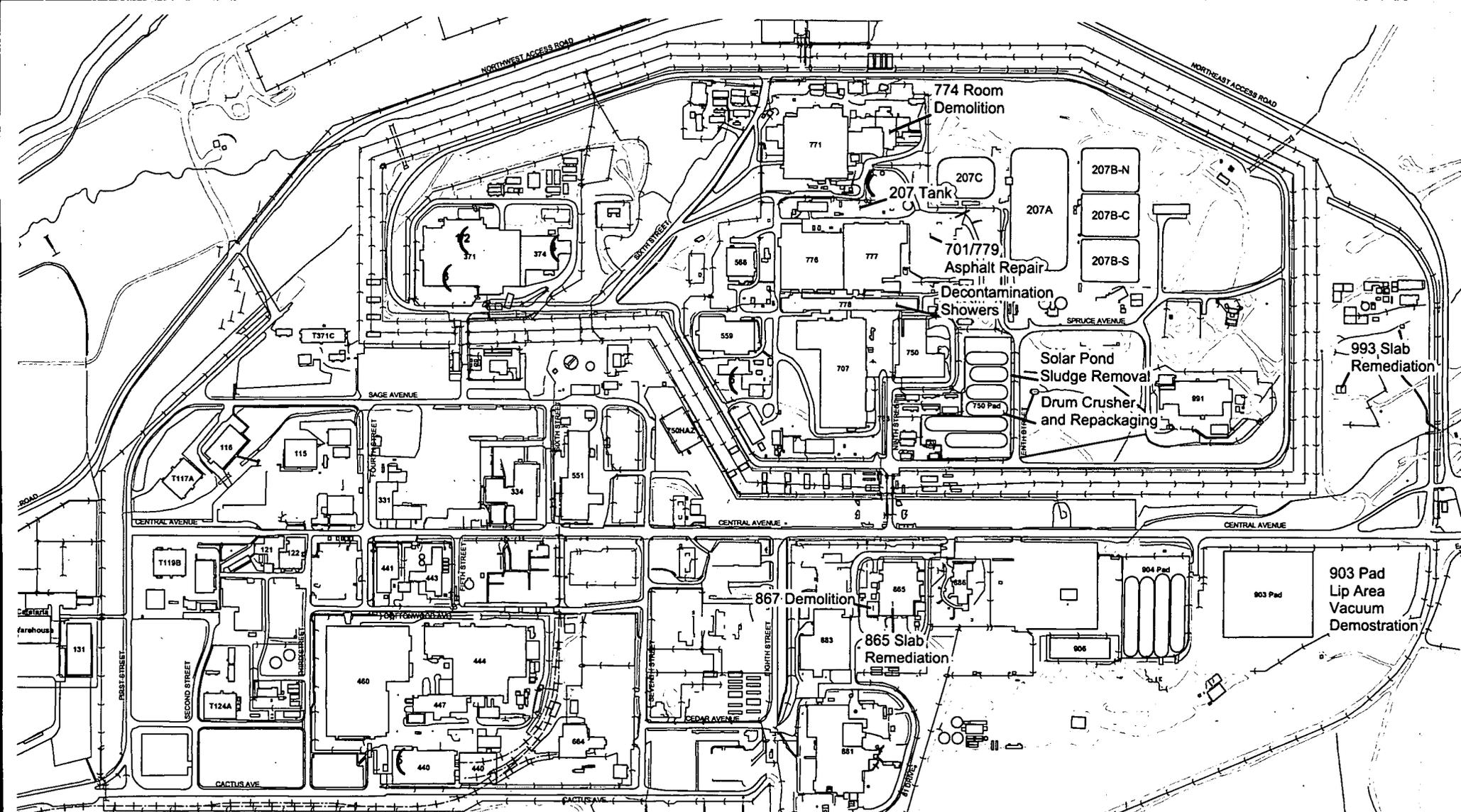
Calendar year 2003 nonpoint sources also included emissions from the removal of Solar Pond sludge from the 750 Pad, and, as described in Section 3.1, the resuspension of contaminated soil.

### **3.3.2 Control Technology for Nonpoint Sources**

Particulate emissions from significant earth-moving activities at the Site and from decommissioning activities were controlled by water spray or other dust suppression measures, with an estimated control efficiency of 50 percent. Fugitive dust control plans that specify the control measures to be used to minimize emissions of contaminated dust are developed for each project with the potential to generate significant radionuclide emissions from soil or debris handling, or from demolition activities. For calculation purposes, all projects listed in Table 3-3 were assumed to be uncontrolled, even though fugitive dust control measures were employed for most of the projects.

### **3.4 Release Locations**

Figure 3-1 shows the location of various emission sources listed in Tables 3-1 through 3-3. Source areas for wind erosion of radionuclides are shown in Appendix D.



<u>Map Identifier</u>	<u>Monitored Emission Point ID</u>	<u>Calculated Point Sources</u>
1	371-NO1	<ul style="list-style-type: none"> <li>750 Pad, Tent 5 Repackaging</li> <li>Drum crusher 750 Pad, Tent 5</li> <li>Building 778 Decontamination Showers</li> <li>T130A Laboratory</li> </ul>
2	371-NO2	
3	371-SSS	
4	374-MAI	<p style="text-align: center;"><u>Nonpoint Sources</u></p> <ul style="list-style-type: none"> <li>903 Pad Remediation</li> <li>Building 865 Slab Remediation</li> <li>Building 993 Slab Remediation</li> <li>Building 701/779 Asphalt Repair</li> <li>750 Pad Solar Pond Sludge Removal</li> <li>Incinerator Removal</li> <li>903 Pad Lip Vacuum Demonstration</li> <li>Tank 207 Demolition</li> </ul>
5	440-101	
6	559-561	
7	771-MAI	

## **4.0 COMPLIANCE ASSESSMENT**

This section describes the compliance assessment performed for the Site for the 2003 calendar year.

### **4.1 Compliance Demonstration Based on Environmental Measurements**

Historically, the Site demonstrated compliance with the annual 10-mrem public dose standard in 40 CFR 61, Subpart H, through measurement and dispersion modeling of measured point source emissions, and emission estimation and dispersion modeling of nonpoint and calculated point source emissions, to determine the dose to the most impacted off-Site resident. Beginning with calendar year 1998, the Site transitioned to an alternative compliance demonstration method based on environmental measurements, as allowed by 40 CFR 61.93(b)(5). The calendar year 2003 compliance assessment is based on the alternative method, which is described below.

#### **4.1.1 Description of Compliance Sampling Network**

The Site operates a network of high-volume, size-fractionating ambient air samplers located on and around the Site, and in nearby communities (the RAAMP network). The compliance sampling network consists of 14 of these samplers located along the Site perimeter. The compliance sampling network is shown in Figure 4-1, along with nearby businesses or residences (receptors).

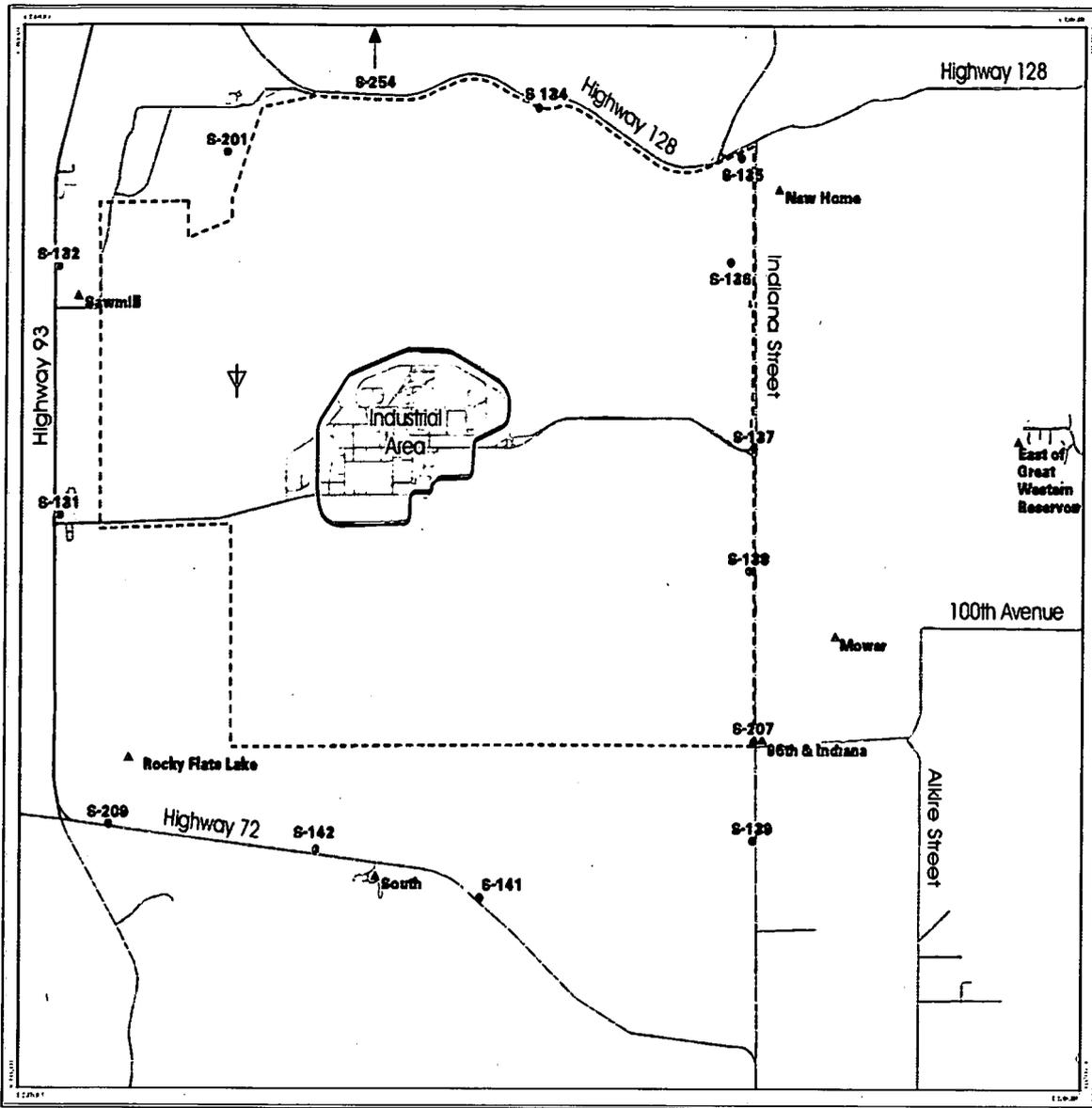
The ambient air samplers continuously collect both fine and coarse particulate matter fractions on filters and removable impactor surfaces that are exchanged and analyzed on a monthly schedule. The samples are analyzed for the plutonium, americium, and uranium isotopes that represent most of the radioactive materials handled at or residing on the Site. These isotopes account for all materials that have the potential to contribute 10% or more of the dose to the public.

Residential and commercial development on and around the Site is reviewed on a quarterly basis. If new development or privatization projects warrant additional or revised sampler locations, EPA and CDPHE will be notified. Sampler installation will be scheduled so that samplers will be operational when the new residence or business is occupied. No development that warranted additional or revised sampler location occurred in calendar year 2003.

Following the transition to the alternative compliance demonstration method, effluent collection and measurement were discontinued for insignificant release points on Site and the ambient network is now used to verify low emissions from these locations, as required by Section 61.93(b)(4). Emissions from significant release points will continue to be measured with the existing effluent sampling systems until the buildings are actively being decommissioned or until the operations that exceeded the 0.1 mrem trigger have ceased.

#### **4.1.2 Compliance Sampling Network Measurements for 2003**

Filters from the compliance sampling network were generally exchanged monthly during 2003, then analyzed for Pu-239/240, Am-241, U-233/234, U-235, and U-238. (In a few cases, high dust loading required that filters be exchanged more often than monthly.)



<p>Prepared by:  <b>DynCorp</b>          THE ART OF TECHNOLOGY  <small>NT_Svrw\projects\fy01\01-012B\fig4-1_v2.cdr</small></p>	<p>Prepared for:    <b>KAISER-MILL</b>  <small>ALUMINA</small></p>		<p><b>EXPLANATION</b></p> <ul style="list-style-type: none"> <li> Meteorological Tower</li> <li> On-Site and Perimeter RAAMP Samplers</li> <li> Receptor</li> </ul>
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**Figure 4-1. Receptor Locations and Nearby Samplers**

When this was necessary, the filters were composited for the month by location and the composite sample was analyzed for the isotopes listed above.)

These isotopes accounted for all materials that had the potential to contribute 10% or more of the dose to the public. Annual average isotopic concentrations were calculated at each sampler from monthly isotopic concentration and sample volume data. The annual average isotopic concentrations for each compliance sampler are shown in Table 4-1.

A *fractional sum* was calculated for each sampler location by dividing each annual isotopic concentration by that isotope's corresponding *compliance level* as listed in Table 2 of Appendix E to 40 CFR 61, then summing the fractions. The fractional sums are also shown in Table 4-1.

## 4.2 Compliance Assessment Results

This section discusses the results of the compliance assessment for calendar year 2003.

### 4.2.1 Compliance Demonstration

As reported in Section 4.1 of this report, the maximum annual concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 measured at the compliance sampling network were compared to the compliance levels listed in Table 2 of Appendix E to 40 CFR 61. In each case, the maximum measured concentration of each isotope, as shown in Table 4-1, was less than 2% of the corresponding compliance level. In addition, the fractional sum of all isotopes at the *critical receptor* location (the sampler showing the highest concentrations in 2003) was determined to be 0.0252. (This corresponds to an annual dose of 0.252 mrem, or 2.52% of the 10-mrem standard.) The facility is in compliance when the annual concentration of each isotope is less than its corresponding Table 2 compliance level and when the fractional sum of all isotopes is less than 1.

Figure 4-2 shows data from the 2003 compliance sampling network at all locations. The data are presented as percentages of the compliance level for each isotope; the total height of each bar in Figure 4-2 represents the fractional sum expressed as a percent of the allowable sum (percent of 1). Data are presented for each sampler, beginning with S-131 at the west gate of the Site, and continuing around the Site perimeter in a clockwise direction. Sampler locations are shown in Figure 4-1.

In 2003, the maximum measured radionuclide levels occurred to the north of the Site, at sampler S-254. Sampler S-254 is located immediately adjacent to an unpaved road that has seen increasing traffic volumes in the past year due to expanded commercial development at one end of the road, leading to its use as a "short cut" to the Superior area. This is a different sampler than the one that has had the highest measured radionuclide concentrations in recent years, S-132. S-132, located to the northwest of the Site along Highway 93, had the second highest measured radionuclide concentrations in

**Table 4-1. Annual Average Isotopic Concentrations at Compliance Sampling Network Locations**

Sampler	Pu-239/240 (Ci/m <sup>3</sup> )	Am-241 (Ci/m <sup>3</sup> )	U-233/234 (Ci/m <sup>3</sup> )	U-235 (Ci/m <sup>3</sup> )	U-238 (Ci/m <sup>3</sup> )	Fractional Sum
S-131	1.08E-18	3.61E-19	3.22E-17	1.55E-18	3.37E-17	0.0095
S-132	6.21E-19	6.45E-19	4.28E-17	1.72E-18	4.09E-17	0.0118
S-134	3.15E-19	2.14E-19	2.05E-17	1.21E-18	1.96E-17	0.0057
S-135	3.64E-19	2.09E-19	2.52E-17	1.43E-18	2.59E-17	0.0072
S-136	3.89E-18	5.06E-19	2.07E-17	1.26E-18	2.23E-17	0.0080
S-137	5.37E-19	2.95E-19	2.29E-17	9.67E-19	2.24E-17	0.0065
S-138	1.02E-18	1.03E-19	2.27E-17	1.52E-18	2.38E-17	0.0068
S-139	2.93E-19	1.68E-19	3.06E-17	1.53E-18	3.18E-17	0.0086
S-141	4.57E-19	2.50E-20	2.37E-17	1.72E-18	2.63E-17	0.0070
S-142	4.66E-19	5.58E-20	2.08E-17	1.29E-18	2.09E-17	0.0059
S-201	7.56E-19	5.67E-19	2.27E-17	1.18E-18	2.40E-17	0.0069
S-207	9.33E-19	3.16E-19	2.56E-17	1.10E-18	2.50E-17	0.0074
S-209	4.87E-18	1.50E-18	2.35E-17	1.31E-18	2.30E-17	0.0095
S-254	4.03E-18	7.53E-19	8.58E-17	4.16E-18	8.36E-17	<b>0.0252</b>
<b>Compliance Level (Ci/m<sup>3</sup>)<sup>a</sup></b>	<b>2.0E-15</b>	<b>1.9E-15</b>	<b>7.1/7.7E-15</b>	<b>7.1E-15</b>	<b>8.3E-15</b>	<b>1</b>

<sup>a</sup> Compliance levels are listed for each isotope in Table 2 of Appendix E to 40 CFR 61.

Notes:

- Am = Americium
- Ci/m<sup>3</sup> = Curies per cubic meter; 1 Ci = 3.7 x 10<sup>10</sup> Becquerel (Bq)
- E# = x 10<sup>#</sup>
- Pu = Plutonium
- U = Uranium

2003 (fractional sum of 0.0118) and is also located in an area that is surrounded by fugitive dust-generating activities (traffic, quarrying, aggregate operations, etc.).

Examination of the isotopic data presented in Table 4-1 and Figure 4-2 shows that the higher overall radionuclide levels (fractional sum) at S-254, relative to other samplers in the compliance sampling network, were primarily due to higher levels of U-233/234 and U-238 (Pu-239/240 levels, which were somewhat elevated as well, are discussed below). The ratio of U-233/234 to U-238 activities at S-254 (and at other compliance samplers) was close to 1:1, which is characteristic of naturally occurring uranium. (In contrast, depleted or enriched uranium that might be emitted from on-Site sources would show different isotopic ratios.) As noted previously, S-254 is located in an area that experienced elevated dust levels in 2003 due to traffic on the immediately adjacent unpaved road. The soils surrounding Rocky Flats contain naturally occurring uranium, which likely explains the elevated activities at this sampler. Figure 4-3 shows the isotopic breakdown at S-254 as a percentage of the total fractional sum at that location; over 88% of the fractional sum is due to U-233/234 and U-238.

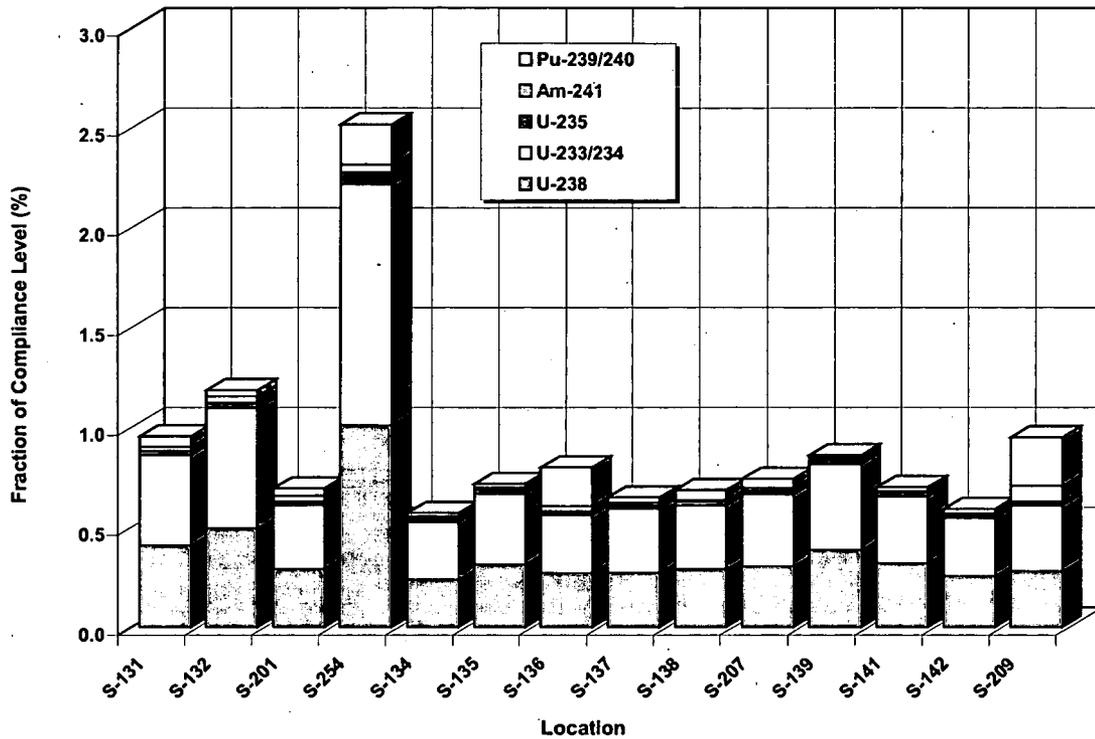


Figure 4-2. Environmental Measurements of Airborne Radionuclides in 2003

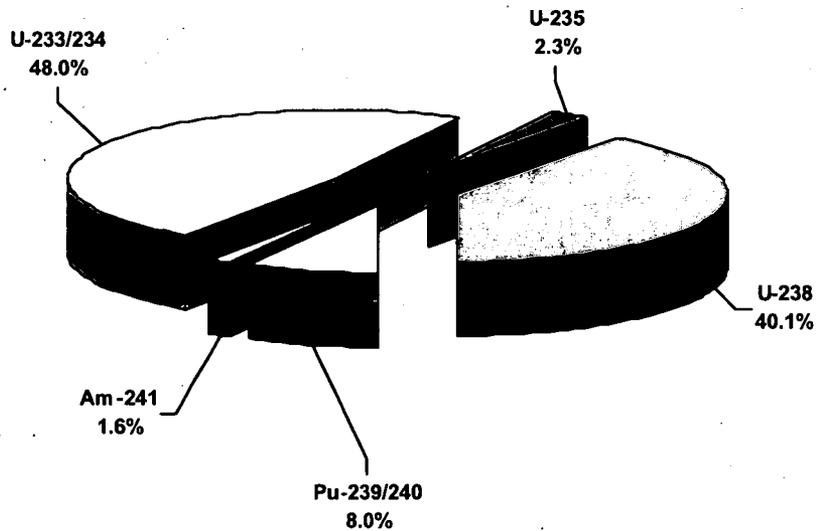


Figure 4-3. Isotopic Contribution to the Fractional Sum at the Critical Receptor

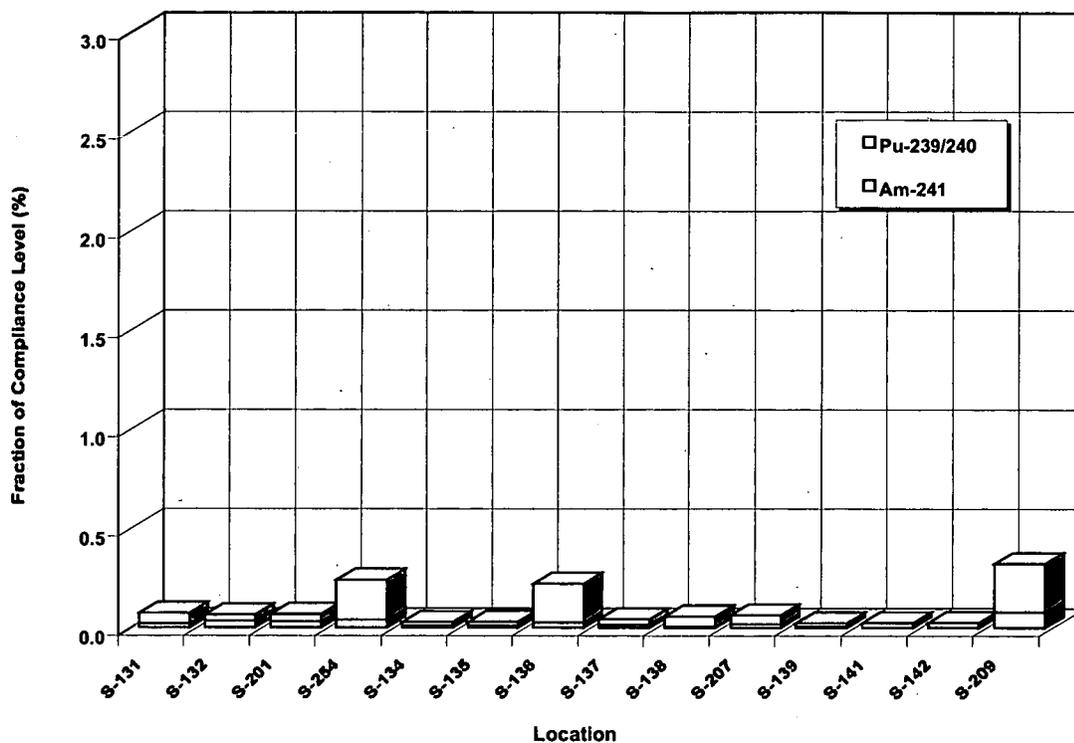
S-254 had the highest concentrations of U-233/234 and U-238 of any compliance sampler in 10 out of 12 months in 2003. S-254 also required extra, "off-cycle" exchanges once in July and twice in October due to excessive dust loading on the filters. Several perimeter samplers required mid-month exchanges due to dust loading in both July and October; however, an additional filter exchange was needed at S-254 between the routine exchange and the mid-month exchange. In October 2003, S-254 recorded the highest monthly U-233/234 and U-238 concentrations at any compliance sampler in the lifetime of the compliance sampling network (i.e., since January 1997). The U-233/234 to U-238 ratio for the October S-254 data strongly suggests naturally occurring uranium. Even if the October 2003 concentrations are excluded from annual average calculations, however, S-254 would still have the highest overall concentrations of U-233/234 and U-238 at any compliance sampler in 2003.

Naturally occurring uranium isotopes appear to have dominated the airborne radionuclide levels at the other compliance samplers as well in 2003. The sum of U-233/234 and U-238 activity ranged from 64% to 95% of the fractional sum at the compliance samplers in 2003.

Figure 4-4 shows the measured levels of Pu-239/240 and Am-241 at the compliance sampling network locations, also presented as percentages of the compliance level for each isotope. These two isotopes are characteristic of the weapons-grade plutonium that was used at the Site.

In previous years, elevated Pu-239/240 and Am-241 concentrations have been apparent at several of the samplers located along the eastern boundary of the Site (relative to concentrations at other compliance network samplers). Based on annual average wind patterns, these samplers are generally downwind of Site activities. In 2003, however, only a very slight increase in Pu-239/240 and Am-241 concentrations was apparent at samplers along the eastern fence line; instead, the patterns are dominated by higher concentrations of these radionuclides at three samplers, S-254, S-136, and S-209. The annual average concentrations of these two radionuclides at S-254 and S-136 are comparable to the maximum concentrations measured in 2002 at compliance network samplers (the maximum Pu-239/241 plus Am-241 concentrations were measured at sampler S-207 in 2002). The annual average 2003 Pu-239/240 plus Am-241 concentrations at S-209 are around 1.5 times last year's maximum concentrations across the network. Note that these concentrations still represent an annual dose rate two orders of magnitude below the 10 mrem standard.

In each case, the elevated annual average Pu-239/240 levels at these three samplers resulted primarily from a single high month. These three samples were investigated and the results were found to be somewhat anomalous (see additional discussion in Section 5.0). None of the three elevated Pu-239/240 concentrations could be correlated to particular activities or projects that were occurring on Site. To the extent the analytical results are representative of airborne concentrations during those months, they may simply reflect increased short-term emissions during periods when a large number of decommissioning, demolition, and environmental restoration activities took place.



**Figure 4-4. Environmental Measurements of Pu-239/240 and Am-241 in 2003**

The fractional sum information for calendar year 2003 for the critical receptor can be compared with the 10-mrem dose limit and with data from prior years. As noted previously, the fractional sum at the critical receptor location in 2003 was 0.0252. The fractional sum can be directly related to the allowable dose limit of 10 mrem in 40 CFR 61, Subpart H, the fractional-sum limit being 1. As a result, the maximum dose recorded at the compliance sampling network in 2003 was nearly two orders of magnitude below the 10-mrem limit and more than 88% of the dose was due to uranium isotopes that are largely naturally occurring in the Site environment. For comparison, the fractional sum at the critical receptor was 0.0156 in 2002, 0.0128 in 2001, 0.0130 in 2000, 0.0145 in 1999, 0.0141 in 1998, and 0.0128 in 1997.

#### 4.2.2 Statement of Compliance Status

Compliance with the 10-mrem standard has been determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when each measured radionuclide air concentration is less than its corresponding compliance level in Table 2 and when the fractional sum of all radionuclides is less than 1. For 2003, each measured radionuclide air concentration was less than 2% of its corresponding compliance level and the fractional sum of all radionuclides was less than 3% of the allowable level at the

critical receptor (the sampler with the highest fractional sum). The Site was in compliance with the 10-mrem standard during 2003.

#### 4.3 Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment. (See 18 USC 1001.)

Joseph A. Legare  
Director, Rocky Flats  
Project Office  
Rocky Flats Project  
Management Division  
Department of Energy

David C. Shelton  
Vice President  
of Environmental Systems and  
Stewardship  
Kaiser-Hill Company, LLC

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Signature

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Date

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Signature

\_\_\_\_\_  
Date

## 5.0 SUPPLEMENTAL INFORMATION

The following information is provided pursuant to DOE guidance or EPA request and is not required by 40 CFR 61, Subpart H, reporting requirements.

- **Calendar year 2003 collective dose:** DOE facilities such as the Site are required to estimate the collective dose to the surrounding population on an annual basis by DOE Order 5400.5, *Radiation Protection of the Public and the Environment*. While not a requirement of 40 CFR 61, Subpart H, the collective dose calculation for the air pathway has typically been reported in this annual report. Collective dose is defined as the sum of the EDEs of all individuals in an exposed population within an 80-km radius of the center of the Site (DOE, 1990).

For calendar year 2003, the population distributions that form the basis of the collective dose calculation were updated. Estimated population growth figures for 2000 to 2003 were obtained for the counties located within 80 km of the Site from the State of Colorado, Department of Local Affairs, Demography Section. Similar estimates were obtained for counties in the metropolitan Denver area from the Denver Regional Council of Governments (DRCOG). Where two growth projections were obtained for a single county, the projections were averaged. Percentage growth estimates were applied to 2000 census data for each census tract within 80 km of the Site to obtain 2003 population values for modeling.

The collective dose was calculated with CAP88-PC, as described in Appendix F. The collective dose for calendar year 2003 was 15.5 person-rem (0.155 person-Sv).

- **Other radionuclide regulations:** 40 CFR 61, Subparts T and Q (CAQCC Regulation No. 8, Part A, Subparts T and Q) are not applicable to this Site. Subparts T and Q contain standards for radon emissions from specific facilities.
- **Unplanned releases:** There were no unplanned releases of radionuclides to the atmosphere from the Site during 2003.
- **Coarse and fine particulate matter fractions:** As described previously, the compliance network samplers collect both fine and coarse particulate matter on filters and removable impactor surfaces. The fine fraction contains smaller particles that could reach and be retained in the lung, while the larger coarse fraction particles are more likely to be removed from the airstream before reaching the lungs. As a result, radionuclides in the fine fraction of measured particulate matter have a higher health risk than coarser particles.

To determine how much of the annual radionuclide activity measured at the compliance sampling network in 2003 is due to fine particles, the fine and coarse fraction data were examined for the critical receptor location, where the maximum calculated dose occurred (sampler S-254). Monthly concentrations at S-254 for all radionuclides measured (sum of Am-241, Pu-239/240, U-233/234, U-235, and U-238) ranged from 17% to 64% fine particles), with an average of 40% in the fine fraction. Am-241 and Pu-239/240 ranged from 0% to 100% each in the fine fraction, averaging 15% and 27% fine particles, respectively. U-233/234 and

U-238 were more consistent, with the fine fraction varying between 27% and 63% for U-233/234 (averaging 41%) and between 30% and 67% for U-238 (averaging 42%). No patterns were apparent by month.

Airborne radionuclide concentrations at S-209 were also examined. S-209 showed the highest concentrations of Am-241 and Pu-239/240 at any of the compliance sampling network locations in 2003. Am-241 concentrations ranged from 0% to 100% in the fine fraction by month (averaging 37%); Pu-239/240 concentrations ranged from 0% to 95% in the fine fraction by month (averaging 11%). U-233/234 concentrations ranged from 11% to 69% fine particles (averaging 39%), while U-238 concentrations ranged from 0% to 72% fine particles (averaging 37%). The sum of all measured radionuclides spanned the range from 5% to 69% in the fine fraction at S-209 in 2003, averaging 38% fine particles.

- **Elevated Plutonium Results:** As noted in Section 4.2.1, three of the compliance sampling locations showed somewhat elevated Pu-239/240 analytical results for one month each during 2003, when compared with other locations or other months. The three elevated results were at S-254 (north) in February 2003, and at S-136 (northeast) and S-209 (southwest) in November 2003.

The elevated results were examined for any apparent laboratory errors or problems. Ratios of plutonium to americium were calculated, as were the percentage of the Pu-239/240 concentration in the fine fraction. No laboratory deviations could be verified for any of these elevated concentrations, although tracer recovery was relatively low for the S-209 samples.

With respect to plutonium-to-americium ratios, two of the samples (S-254 and S-136) had virtually no americium present in the size fraction that showed elevated Pu-239/240 results. This casts doubt on the representativeness of the Pu-239/240 results for these two samples, since Am-241 is present in both Site weapons-grade plutonium and in fallout due to ingrowth from decay of Pu-241. Americium atoms would be "co-mingled" with Pu-239/240 atoms and would be expected to show up in the same size fraction from the compliance samplers. If the elevated Pu-239/240 results accurately represent airborne concentrations during the sampling period, readily measurable amounts of Am-241 should be present as well.

With respect to the S-209 samples from November 2003, relatively high levels of Am-241 were also present. Both Pu-239/240 and Am-241 appear predominantly in the coarse fraction in these samples. The coarse fraction also contains an unusually high proportion of the measured uranium isotopes as well, which may simply indicate that this sampler was collecting mostly larger particles from a localized source during this period (perhaps from traffic on nearby roads, or road sanding operations). The elevated Pu-239/240 and Am-241 results at this sampler could not be correlated with any specific Site activity or project, although a variety of dust-generating activities occurred on Site in November 2003. None of them occurred in close proximity to this sampler, however, and the wind blew

from the Site toward this location for only 8.2% of the hours during the sampling period.

In short, none of the results can be conclusively dismissed; however, the S-136 and S-254 samples are suspicious due to the lack of a measurable Am-241 component. The November sample from S-209 appears more credible but cannot be correlated with known Site activities. The size fraction information suggests a localized source of particles and the elevated Pu-239/240 and Am-241 concentrations may represent a random sampling event of the low levels of these radionuclides that are present in area soils due to fallout and past resuspension of contaminated dust from the Site. As noted previously, these relatively elevated results still represent Pu-239/240 and Am-241 annual dose rates that are two orders of magnitude below the 10 mrem standard.

- **March 2003 Snow Event:** The Site and the surrounding area experienced an unusually heavy snow event beginning March 17, 2003. Snow fell from March 17<sup>th</sup> through approximately March 20<sup>th</sup>, with accumulations around the Site totaling several feet of heavy, wet snow. Power went out to several of the compliance samplers for varying periods of time between March 18<sup>th</sup> and March 27<sup>th</sup>. A partial collapse of the T130C trailer roof also prevented access to the RAAMP network telemetry computer during a portion of this time.

Filters and impactor pads were exchanged at the compliance network samplers on March 21, 2003. The filters were saturated, wrinkled, and spotted due to the heavy snow, and the filter at S-135 was torn. The filters from the first portion of the month were analyzed separately from the replacement filters (the results presented in this report represent the sums of the measured isotopic concentrations from the two March sampling periods).

- **December 2001 Rejected Values:** Pu-239/240 and Am-241 concentrations at S-201 were flagged as estimated values by the laboratory because of poor tracer recoveries in the analytical process. For reporting purposes, these values have been conservatively replaced by the highest monthly values for each of these isotopes that have been measured at this location anytime between January 1997 (the beginning of the compliance sampling network) and November 2003.

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**APPENDIX A**  
**RADIOACTIVE MATERIALS ASSOCIATED WITH ROCKY FLATS**

## RADIOACTIVE MATERIALS ASSOCIATED WITH ROCKY FLATS

### A. RADIOACTIVE MATERIALS PRESENT IN KILOGRAM QUANTITIES

#### 1. Plutonium

##### Isotopic Composition of Rocky Flats Plutonium

<u>Isotope</u>	<u>Relative Weight (Percent)</u>	<u>Specific Alpha Activity (Curies/gram)</u>	<u>Specific Beta Activity (Curies/gram)</u>	<u>Relative Activity (Curies/gram)<sup>a</sup></u>
Pu-238	0.01	17.01	---	0.00171
Pu-239	93.79	0.0622	---	0.05834
Pu-240	5.80	0.228	---	0.01322
Pu-241	0.36	---	103.5	0.37260
Pu-242	0.03	0.00393	---	1.18x10 <sup>-6</sup>
Am-241	<sup>b</sup>	3.42	---	---

<sup>a</sup> Relative activity is obtained by multiplying the percent by weight by the specific activity. The total activity for the plutonium isotopes is: Alpha, 0.0732 curies/gram; and alpha plus beta, 0.446 curies/gram.

<sup>b</sup> Am-241 is a radioactive decay product of Pu-241.

#### 2. Enriched Uranium

Common Name: Oralloy

Normal Isotopic Composition: >90% U-235

#### 3. Depleted Uranium

Common Names: Tuballoy, D-38, U-238

Normal Isotopic Composition: <0.71% U-235

#### 4. Americium (Am-241)

Am-241 is a radioactive decay product of Pu-241.

#### 5. Natural Uranium (Thorium and Uranium-233)

Rocky Flats has historically had the capability to handle these in kilogram quantities and some of these materials have been handled in the past.

### B. RADIOACTIVE MATERIALS PRESENT IN GRAM QUANTITIES (<1Kg)

Curium-244

Neptunium-237

Uranium-233

Plutonium-238, -242

These radioisotopes have been used at Rocky Flats primarily for research and analytical activities.

**C. RADIOISOTOPES USED AT ROCKY FLATS AS ACCOUNTABLE AND/OR TRACEABLE/NONACCOUNTABLE SOURCES**

**1. Registered Sources (Twice-Yearly Leak Test and Physical Audit)**

Sealed solids > Appendix E values<sup>1</sup>  
Plated solids > Appendix E values  
Liquids > 10<sup>-3</sup> μCi

Plutonium (Pu-238,-239)

**2. Traceable (Nonaccountable) Sources**

Sealed solids < Appendix E values  
Plated solids < Appendix E values  
Liquids < 10<sup>-3</sup> μCi

Americium (Am-241, 243)  
Barium (Ba-133)  
Cadmium (Cd-109)  
Californium (Cf-252, -250)  
Cesium (Cs-137)  
Chlorine (Cl-36)  
Cobalt (Co-56, -57, -60)  
Europium (Eu-152)  
Iridium (Ir-192)  
Nickel (Ni-63)  
Plutonium (Pu-238, -239,240)  
Selenium (Se-75)  
Strontium (Sr-90)  
Uranium (U-232, -234, -235, -236, -238)

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<sup>1</sup> Accountability is determined by 10 CFR 835, Appendix E. Sealed radioactive sources with activities equal to or greater than Appendix E values are accountable. The activities are individual for each isotope and are not all equal in value.

**APPENDIX B**  
**EFFLUENT RELEASE POINTS**  
**CALENDAR YEAR 2003**

**Effluent Release Points  
Calendar Year 2003<sup>a</sup>**

<b>Building/ Location</b>	<b>Release Points</b>	<b>Subpart H Category</b>	<b>Notes</b>
<b>Release Points Sampled Throughout 2003</b>			
371-N01	1	Significant	
371-N02	1	Significant	
371-SSS	1	Significant	
374-MAI	1	Significant	
440-101	1	Significant	
559-561	1	Significant	
<b>Release Points Sampled During Part of 2003</b>			
771-MAI	1	Significant	Removed from service 4/29/03 due to active decommissioning
<b>Release Points Which Ceased Sampling at the End of 2002<sup>b</sup></b>			
707-102/104	1	Significant	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-105	1	Significant	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-106	1	Significant	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-107	1	Significant	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-108	1	Significant	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R21A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R22A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R23A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R25A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R45A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>
707-R46A/B	2	Significant <sup>c</sup>	Removed from service 1/07/03 due to active decommissioning <sup>b</sup>

<sup>a</sup> Formerly monitored release points where sampling has been permanently discontinued were listed in the calendar year 2000 report (DOE, 2001).

<sup>b</sup> Sampling ceased at these locations on the first day of the effluent sample year—no samples were collected during effluent sampling year 2003 (1/7/03 – 1/6/04). Data from these locations are not included in this report.

<sup>c</sup> These emission points were proactively upgraded to “significant” (and monitored accordingly) to support decommissioning work during 2002, though the actual material processing and holdup in the areas exhausted through these points may not have the potential to contribute a 0.1 mrem dose in any given year.

**APPENDIX C**  
**EFFLUENT INFORMATION SYSTEM (EIS) DATA**  
**2003**

**Summary Table For The EIS/ODIS Database<sup>a,b</sup>  
2003-Release (Ci)**

02_ODIS Location	ODIS Location Code	N	Effluent Volume (m <sup>3</sup> )	Plutonium 239/240	Americium 241	Uranium 233/234	Uranium 235	Uranium 238
371-N01		12	2.298E+08	2.747E-08	4.567E-09	5.190E-10	9.252E-10	-1.034E-09
371-N02		12	2.187E+08	8.831E-09	7.724E-10	-2.617E-11	-1.515E-09	2.517E-09
371-NNN	AFGHC371001	24	4.485E+08	3.630E-08	5.339E-09	4.928E-10	-5.895E-10	1.483E-09
371-SSS	AFGHC371002	12	4.194E+08	1.292E-08	1.670E-09	1.487E-09	-3.135E-10	-3.484E-10
374-MAI	AFGHJ374001	12	2.955E+08	5.835E-09	2.127E-09	6.297E-09	-2.855E-10	-4.241E-10
440-101		12	6.837E+07	5.129E-10	3.236E-10	7.891E-10	1.821E-10	-7.150E-11
559-561	AFGHA559001	12	5.775E+08	5.889E-09	3.655E-09	2.572E-09	9.190E-10	2.640E-09
771-MAI <sup>c</sup>	AFGHC771001	4	7.751E+08	2.490E-08	9.268E-09	1.451E-08	1.439E-09	4.335E-09
<b>RFETS</b>		<b>76</b>	<b>3.033E+09</b>	<b>8.636E-08</b>	<b>2.238E-08</b>	<b>2.614E-08</b>	<b>1.352E-09</b>	<b>7.614E-09</b>

<sup>a</sup> No longer report Pu-238.

<sup>b</sup> Many locations have been removed from this report, as sampling no longer was required or the building no longer exists.

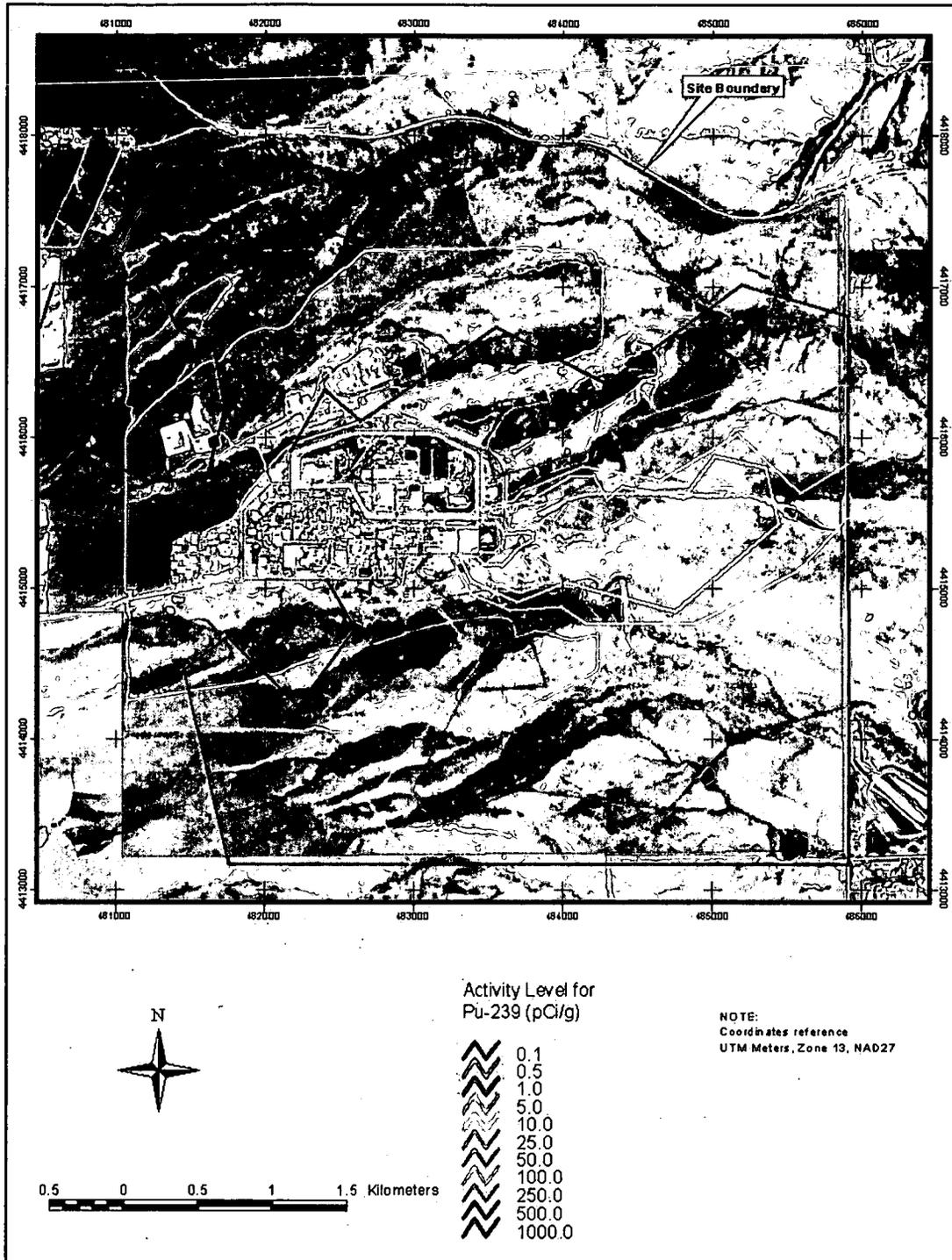
<sup>c</sup> Sampling terminated 4/29/03.

Notes:

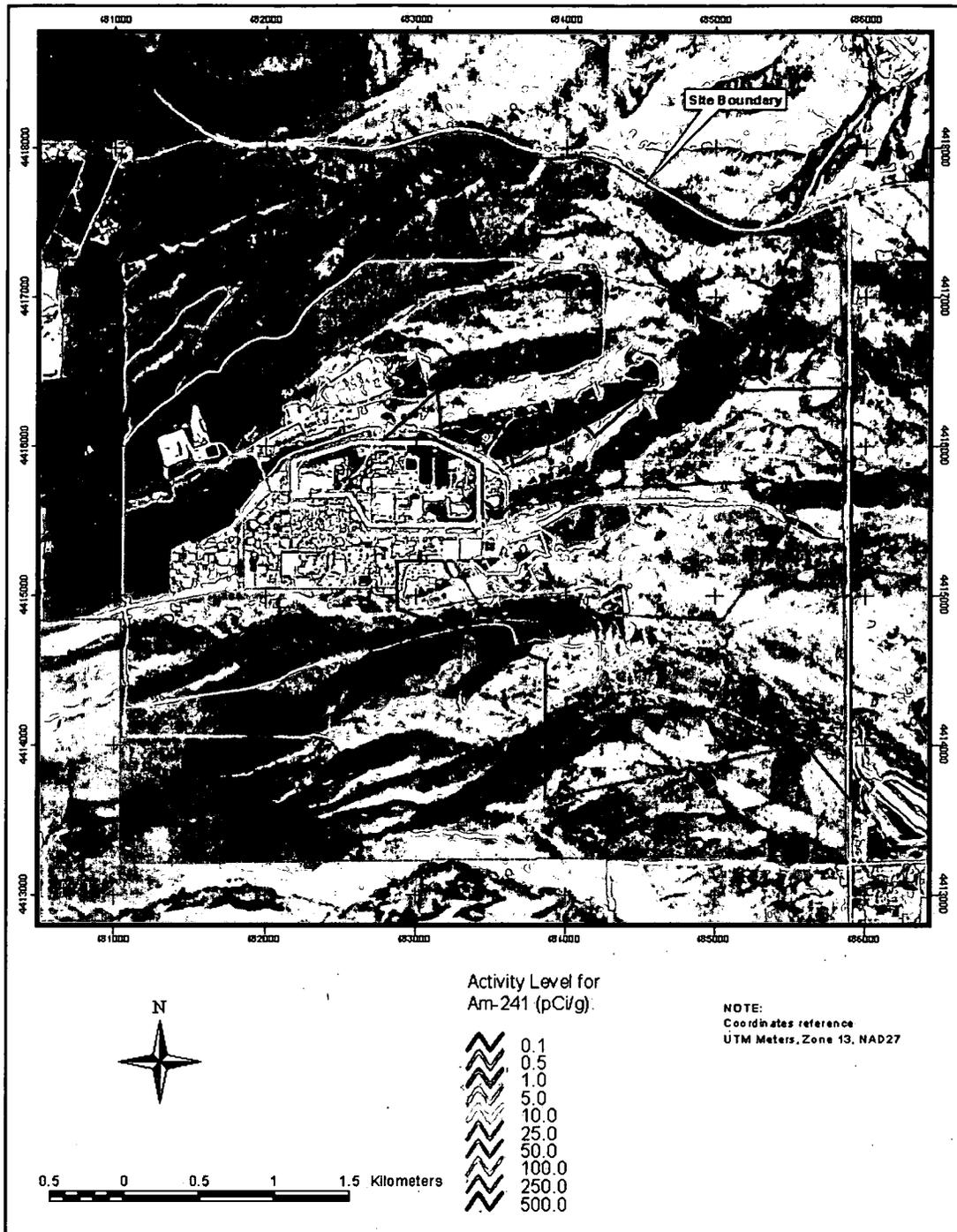
- Ci = Curies
- EIS = Effluent Information System
- m<sup>3</sup> = Cubic meters
- N = Number of samples analyzed
- ODIS = On-Site Discharge Information System
- RFETS = Rocky Flats Environmental Technology Site

**APPENDIX D**

**SOURCE AREAS FOR WIND EROSION  
OF RADIONUCLIDES**

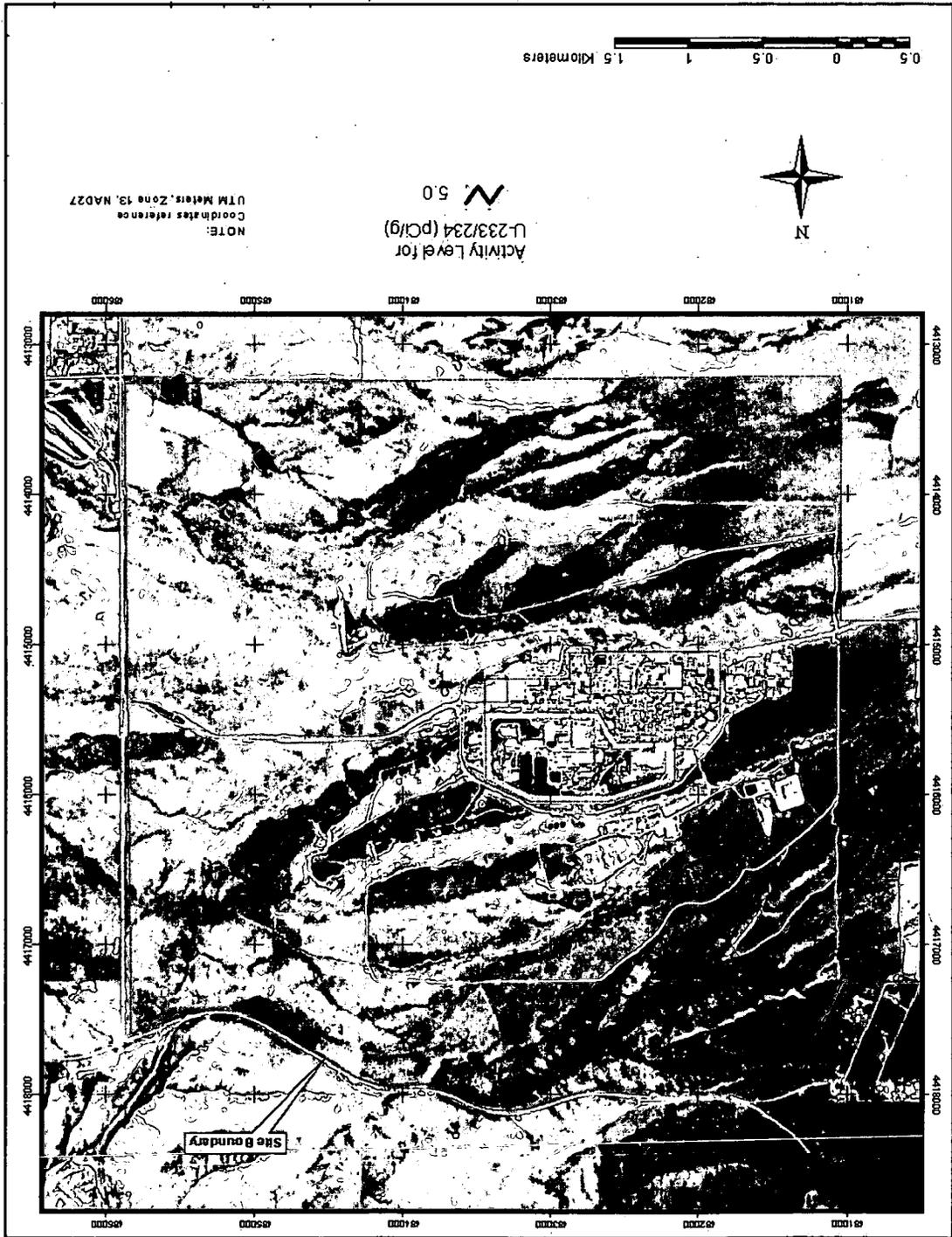


### Surface Soil Contamination Isoleths for Pu-239/240



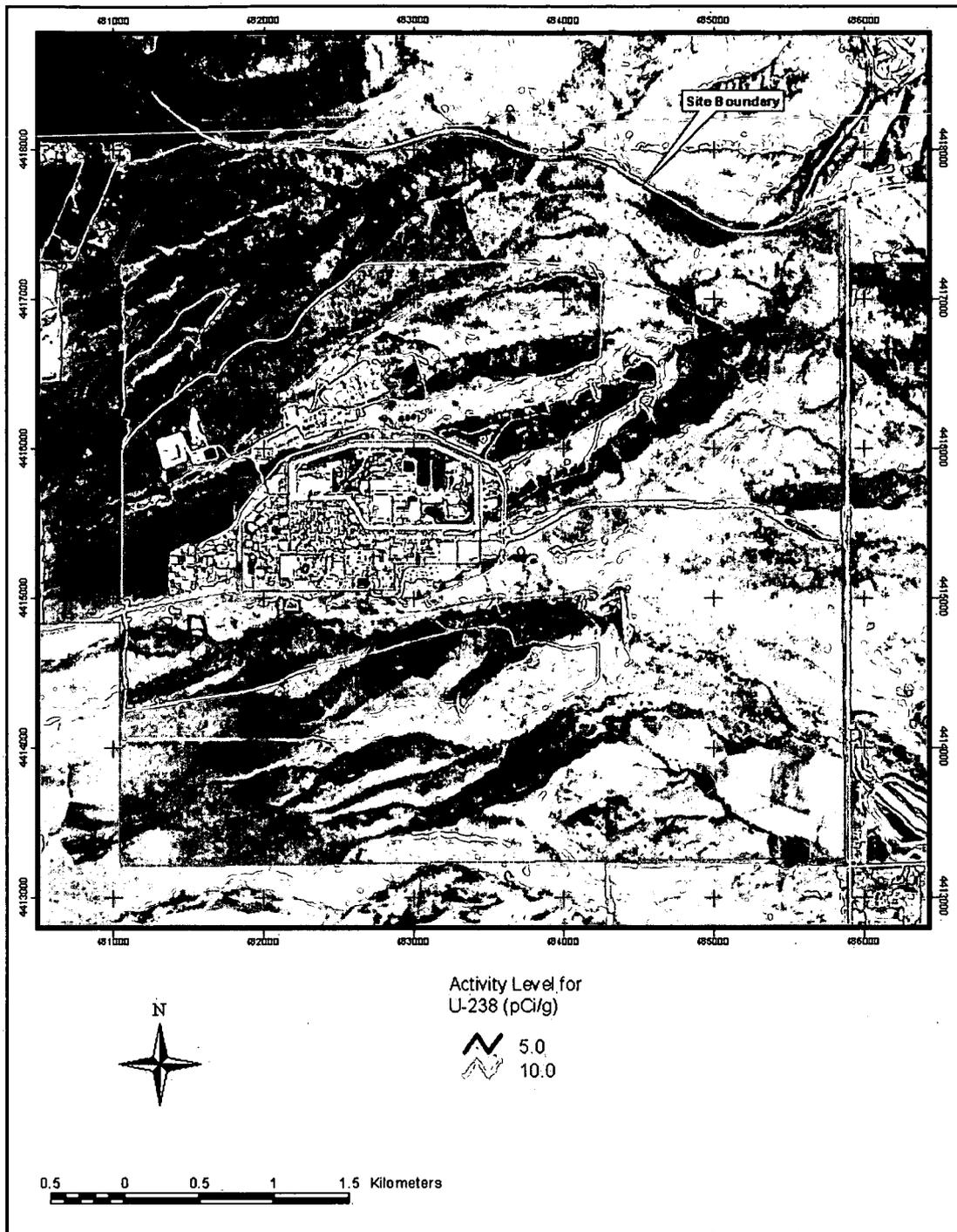
### Surface Soil Contamination Isopleths For Am-241

### Surface Soil Contamination Isopleths for U-233/234





### Surface Soil Contamination Isopleths for U-235



### Surface Soil Contamination Isopleths for U-238

**APPENDIX E**  
**WIND FREQUENCY DISTRIBUTION FOR 2003**

# WIND ROSE

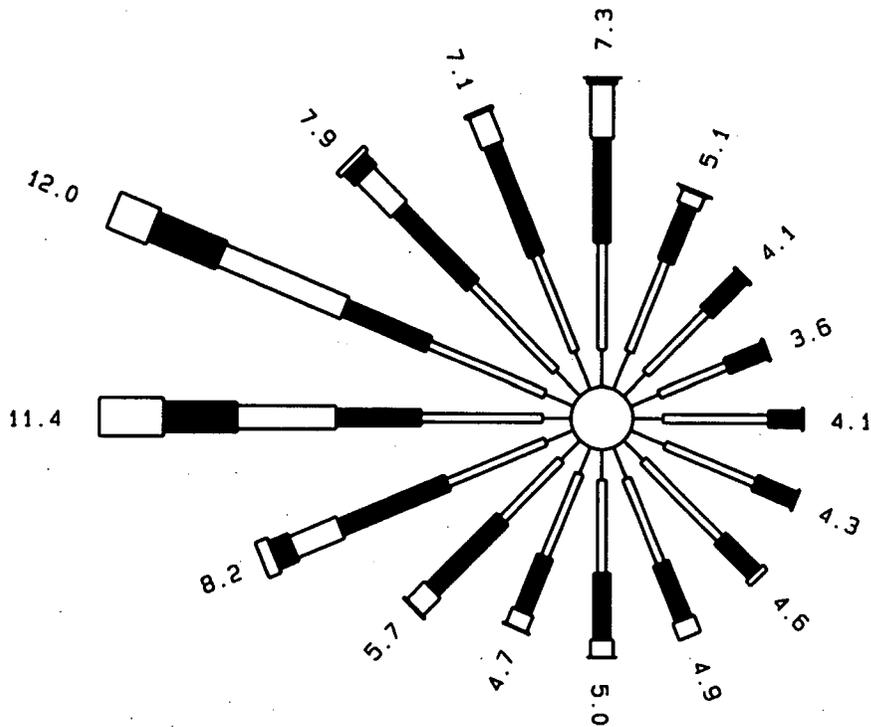
RFETS 61  
CY 2003



Wind Speed  
(m/s)



LE 1.8  
1.8 - 3.3  
3.3 - 5.4  
5.4 - 8.5  
8.5 - 11  
GT 11



Stability  
A 12.4% B 8.4% C 11.9% D 45.0% E 11.7% F 10.3%



Pct. Calms: N/A

**APPENDIX F**  
**MODELING SUMMARY**

## MODELING SUMMARY

### Model Description and Use

CAP88-PC is a dispersion and dose model that has historically been used at the Site for calculating EDE to both individual members of the public and to the surrounding population within 80 km. The model simulates the dispersion of airborne radionuclide emissions from point and nonpoint (termed "area") sources to user-specified receptor locations, then calculates an annual, multipathway EDE for a person living or working at each specified receptor location. When combined with population distribution information, CAP88 estimates the collective dose to the surrounding population.

### Summary of Model Input Data

The model accounts for dose received from Site emissions through inhalation and ingestion of radionuclides in air and deposited on the ground surface. To simulate pollutant dispersion and calculate dose, the model requires the following types of input data:

- Distance and direction from emission sources to receptor locations.
- Source release characteristics, including stack locations, stack heights, exhaust gas velocities and temperatures, the size of each stack or vent opening for point sources, and the size and location of each area source.
- The amount of each radioactive isotope released from each source.
- Meteorological data including the annual distribution of wind speed, wind direction, and atmospheric stability at the Site, and annual precipitation and temperature information. The model also requires information about the average height of regional temperature inversions (mixing height).
- Agricultural data used in calculating radionuclide ingestion rates including the location, distribution, and utilization of local and regional sources of meat, milk, and vegetables.
- Miscellaneous data regarding the size and solubility of the particles emitted.

To calculate the calendar year 2003 collective dose, Site emissions (sum of all emissions shown in Tables 3-1, 3-2, and 3-3, by isotope) were modeled from a single area source located at the center of the Site. The source was assumed to have an area of  $5.3 \times 10^6 \text{ m}^2$  (about 20% of the total Site area), release height of 0.0 m, and no momentum plume rise (exit velocity of 0.0 meters per second [m/s]). These release characteristics were appropriate for the major source of radionuclide emissions in calendar year 2003, which was resuspension of contaminated soil and dust from wind and from mechanical disturbance during demolition and remediation activities.

Meteorological data for calendar year 2003 were collected from a tower located in the western portion of the Site (the tower location is shown in Figure 4-1). A joint frequency distribution of wind speed, wind direction, and stability was processed for input to

CAP88-PC. A “wind rose” graphic representation of the meteorological data is shown in Appendix E.

Annual precipitation and temperature data collected on Site for 2003 show:

- Total precipitation in 2003: 35.18 cm; and
- Annual average temperature: 10.54°C.

An average mixing height for the Denver, Colorado, area of 1,405 m was used in the model (EPA, 1972).

The CAP88-PC model calculated EDEs over a polar coordinate receptor grid. The grid consisted of 16 compass sectors and 11 distances from the center of the Site: 3 km, 6 km, 10 km, 15 km, 20 km, 25 km, 30 km, 40 km, 50 km, 65 km, and 80 km. CAP88-PC estimates an EDE at the midpoint of each grid cell, then multiplies each EDE by the population within the grid cell to calculate collective dose. Population data for the 2000 census were obtained, organized by census tract, and each whole or partial census tract within 80 km of the Site was assigned to a grid cell. The 2000 census data were scaled up for 2003 using growth estimates by county obtained from the State of Colorado, Department of Local Affairs, Demography Section, and the Denver Regional Council of Governments.

Model default values were used for the median aerodynamic diameter (1.0 micrometers) and solubility class. Urban agricultural data were used in the model. Default values were also used cattle density and for the land fraction cultivated for vegetable crops.

The total collective dose was calculated as the sum of the contributions from Pu-239/240, Am-241, U-233/234, U-235, and U-238.