

U.S. Department of Energy

**Radionuclide Air Emissions
Annual Report**

Calendar Year 2002

**Rocky Flats Environmental
Technology Site**

REVIEWED FOR CLASSIFICATION/UCNI

By B. W. Hoffman

Date 6-13-03

u/nw

U.S. Department of Energy

Radionuclide Air Emissions Annual Report for Calendar Year 2002

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 Field Office

Address: U.S. Department of Energy
Rocky Flats Environmental Technology Site
10808 Hwy 93, Unit A
Golden, Colorado 80403-8200

Contact: Richard DiSalvo Phone: (303) 966-4765

Site Information

Site Operator: Kaiser-Hill Company, L.L.C.

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

Contact: Andrew Rosenman Phone: (303) 966-3687

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 2002.

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 2002, each measured radionuclide air concentration was less than 1% of the corresponding concentration level for environmental compliance and the fractional sum of all radionuclides was less than 2% of the allowable level at the sampler with the highest fractional sum (the critical receptor). The highest fractional sum measured in 2002 corresponds to an annual dose of 0.156 mrem or 1.56% of the 10-mrem standard.

Airborne radionuclides appear to have been dominated by naturally occurring uranium isotopes in 2002. For example, at the critical receptor, uranium isotopes characteristic of naturally occurring uranium contributed more than 92% of the fractional sum. In addition, the location where the highest total radionuclide levels were measured in 2002 (northwest of the Site) was influenced by off-Site activities that generated dust, such as traffic, sand and gravel removal operations, or quarrying operations. These patterns are consistent with sampling results from 1997, 1998, 1999, 2000, and 2001.

TABLE OF CONTENTS

EXECUTIVE SUMMARY	i
ABBREVIATIONS AND ACRONYMS	vi
1.0 INTRODUCTION	1-1
2.0 FACILITY INFORMATION	2-1
2.1 Site Description	2-1
2.2 Radionuclide Air Emissions Source Description.....	2-5
2.2.1 Radioactive Materials Handling and Processing in Calendar Year 2002.....	2-5
2.2.2 New Construction and Modifications in Calendar Year 2002.....	2-8
3.0 AIR EMISSIONS DATA	3-1
3.1 Emission Determination Process.....	3-1
3.2 Point Sources.....	3-2
3.2.1 Measured Point Source Emissions	3-2
3.2.2 Calculated Point Source Emissions.....	3-4
3.2.3 Control Technology for Point Sources.....	3-7
3.3 Nonpoint Sources	3-8
3.3.1 Nonpoint Source Descriptions	3-8
3.3.2 Control Technology for Nonpoint Sources	3-9
3.4 Release Locations.....	3-10
4.0 COMPLIANCE ASSESSMENT	4-1
4.1 Compliance Demonstration Based on Environmental Measurements	4-1
4.1.1 Description of Compliance Sampling Network	4-1
4.1.2 Compliance Sampling Network Measurements for 2002	4-3
4.2 Compliance Assessment Results	4-3
4.2.1 Compliance Demonstration.....	4-3
4.2.2 Statement of Compliance Status	4-7
4.3 Certification.....	4-8

TABLE OF CONTENTS (continued)

5.0 SUPPLEMENTAL INFORMATION..... 5-1

6.0 REFERENCES CITED..... 6-1

APPENDIX A: Radioactive Materials Associated with Rocky Flats

APPENDIX B: Effluent Release Points, Calendar Year 2002

APPENDIX C: Effluent Information System (EIS) Data 2002

APPENDIX D: Source Areas for Wind Erosion of Radionuclides

APPENDIX E: Wind Frequency Distribution for 2002

APPENDIX F: Modeling Summary

LIST OF FIGURES

2-1	Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities	2-2
2-2	Rocky Flats Environmental Technology Site Location Map.....	2-3
2-3	Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area).....	2-4
3-1	Industrial Area Source Locations.....	3-11
4-1	Receptor Locations and Nearby Samplers	4-2
4-2	Environmental Measurements of Airborne Radionuclides in 2002.....	4-5
4-3	Isotopic Contribution to the Fractional Sum at the Critical Receptor.....	4-5
4-4	Environmental Measurements of Pu-239/240 and Am-241 in 2002.....	4-6

LIST OF TABLES

3-1	Measured Point Source Radionuclide Emissions.....	3-5
3-2	Calculated Point Source Radionuclide Emissions	3-6
3-3	Nonpoint Source Radionuclide Emissions.....	3-9
4-1	Annual Average Isotopic Concentrations at Compliance Sampling Network Locations	4-4

ABBREVIATIONS AND ACRONYMS

Am	Americium
ANSI	American National Standards Institute
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 ³	Curies per cubic meter
Ci/yr	Curies per year
cm	Centimeter(s)
cm ²	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)
I&M	Inspection and maintenance
km	Kilometer(s)
km ²	Square kilometer(s)
l	Liter
m	Meter(s)
m ²	Square meter(s)
m ³	Cubic meters(s)
m ³ /s	Cubic meters per second
mrem	Millirem(s)
m/s	Meters per second
mSv	MilliSievert(s)
ODIS	Off-Site Discharge Information System
Pu	Plutonium
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
FFO	Rocky Flats Field Office
Site	Rocky Flats Environmental Technology Site
SNM	Special nuclear material
Sv	Sievert(s)
TRU	Transuranic
TRM	Mixed TRU (waste)

U Uranium
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 2002 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 used at the Site, and describes the handling and processing that the radioactive materials undergo. New construction or modifications in calendar year 2002 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 2002.

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 Field Office (RFFO) 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. The Site is now undergoing decommissioning and cleanup, and is moving toward final closure.

The Site occupies an area of 26.5 square kilometers (km²) 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 2.9 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 city of Boulder 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 contains support facilities and serves as a buffer zone for former production facilities. 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.

The central portion of the Site, which houses the former production facilities, can be roughly divided into halves. The northern half of the central area historically housed plutonium processing operations. The rest of the industrial area (south side) housed uranium, beryllium, and stainless steel operations. A portion of the northern half of the industrial area is surrounded by a security perimeter.

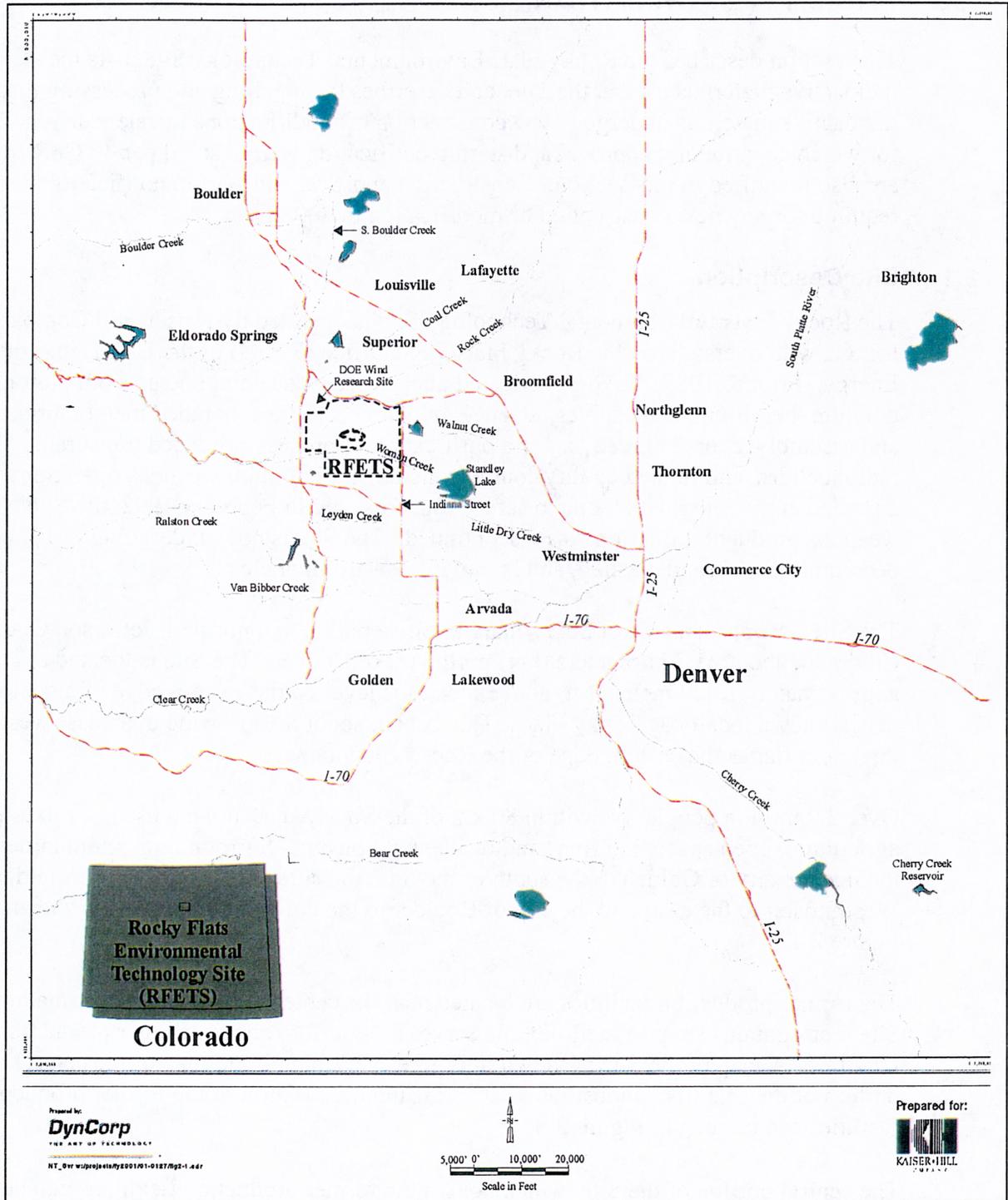


Figure 2-1. Area Map of the Rocky Flats Environmental Technology Site and Surrounding Communities

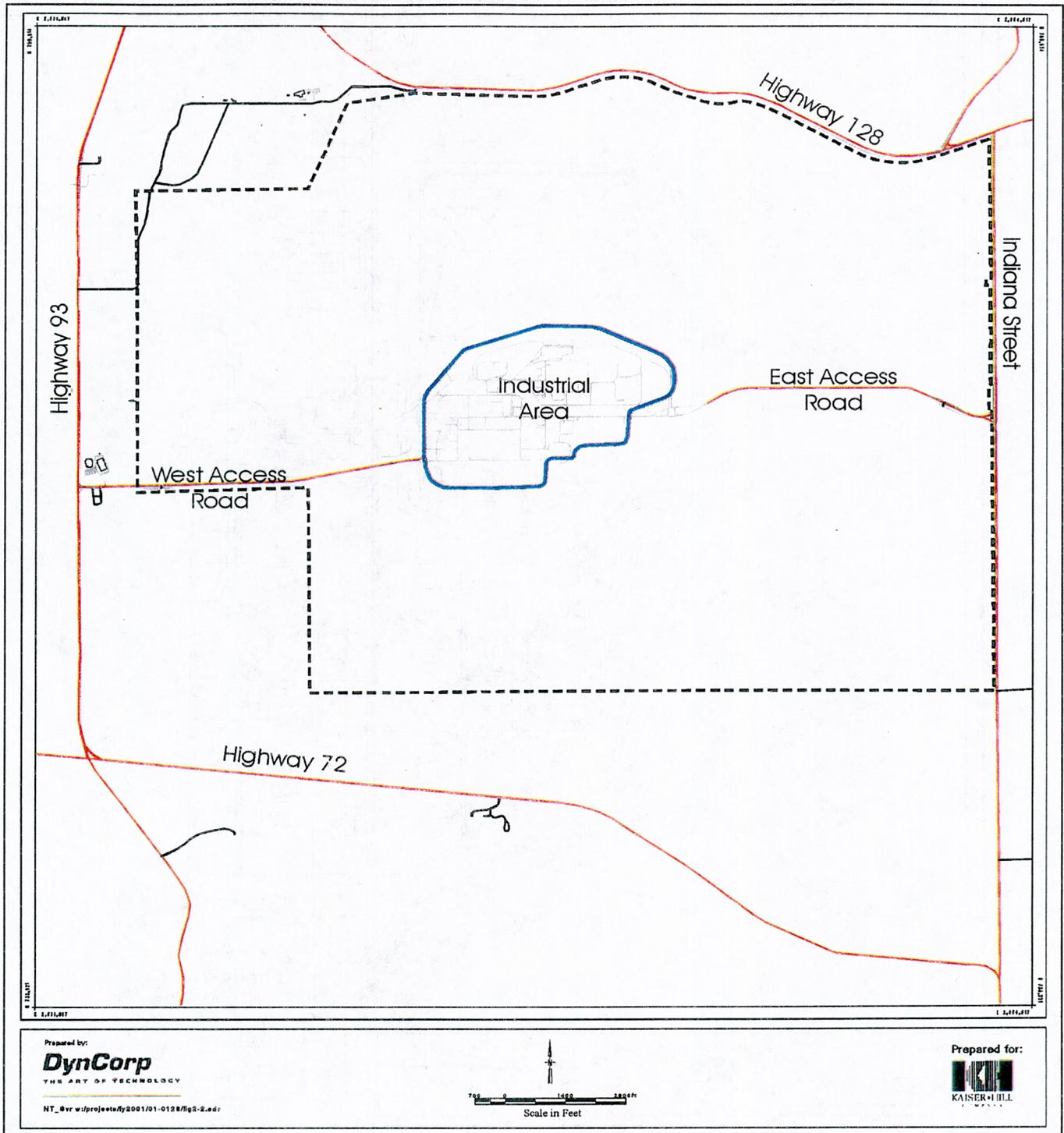


Figure 2-2. Rocky Flats Environmental Technology Site Location Map

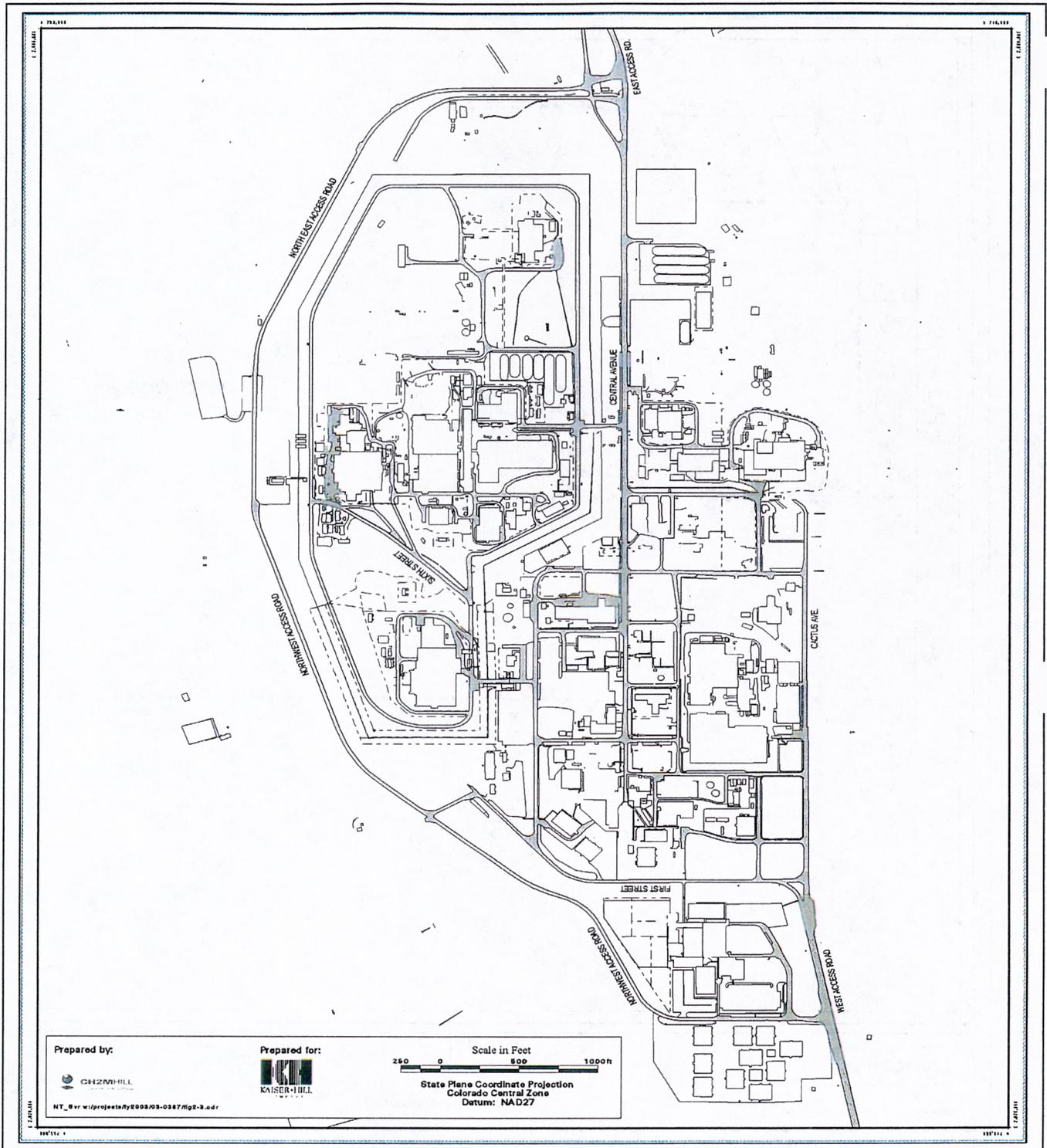


Figure 2-3. Central Portion of the Rocky Flats Environmental Technology Site (Industrial Area)

2.2 Radionuclide Air Emissions Source Description

Radioactive material handling at the Site in 2002 was focused on material consolidation, environmental restoration, building decommissioning and demolition, waste processing, and analytical operations. Most of the radionuclide air emissions from the Site resulted from nonpoint (diffuse) sources, primarily 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.

Radioactive material processing can result in radionuclides becoming entrained in ventilation air (effluent) that is released through vents or stacks (point sources). However, because no routine nuclear weapons-related processing has occurred at the Site since 1989, most radionuclide point source emissions in 2002 resulted from the resuspension of residual radioactive material in ventilation systems and from decontamination and deactivation activities taking place in process buildings.

Air exhausted from process buildings was 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 2002.

2.2.1 Radioactive Materials Handling and Processing in Calendar Year 2002

In 2002, 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 Site activities and sources that handled or processed radionuclides in calendar year 2002, with resulting radionuclide emissions, 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 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 2002, resulting in additional emissions to the atmosphere. Ducts containing hold-up were vented through multiple stages of HEPA filters.

Resident Contamination

In some process areas, contamination may be found on glovebox surfaces and floors, and, in limited cases, in the rooms themselves. This contamination has been surveyed and estimated using surface swipes in the areas. As with hold-up, resident contamination was emitted in 2002 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 2002 and included metal brushing, size reduction of metal, thermal stabilization of oxide, and packaging and interim storage of SNM. These consolidation activities are defined as follows:

- Metal brushing: Mechanical removal of metal oxide from metal surfaces.
- Size reduction: Reduction of material size by breaking, cutting, sawing, or pressing to accommodate storage container requirements.
- Thermal stabilization of oxide: Treatment of unstable forms of metal oxides in furnaces operating in the range of 800 to 1,200 degrees Celsius (°C) to remove moisture and to fully oxidize the metal to stable form.
- 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 2002 through exposure of SNM to ventilation air, as well as through mechanical and thermal disturbance of SNM. Consolidation was performed in areas where ventilation air was exhausted through HEPA filters.

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 2002, 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 in several buildings contributed to emissions during 2002. These activities took place in areas that vented through HEPA filters.

Waste Storage

Packaged low-level and TRU wastes are commonly stored in drums at various locations on the Site. 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 2002 from waste characterization and repackaging activities that support waste shipment activities. Shipment plans required the characterization and repackaging of various radionuclide-contaminated wastes and residues in preparation for shipment to the Nevada Test Site, Savannah River Site, the Waste Isolation Pilot Plant (WIPP), or other off-Site facilities. All of the waste repackaging activities that occurred in 2002 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 2002:

- Buildings 125, S125, 280, 381, 442L, 442W, 452, 662, 663, 709A, 828, 850, 864, 875, 880, 886, 932, 331A, 335, 367, S452, 666, 884, and 910;
- Trailers T452A-G, T760B, T886A-C, T891D-E, T891G, T891P-Q, T891V, T891T, T893A-B, T334B, T334D, and T760A; and
- Tents 07, 08, 09, and 14.

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 in 2002. Radionuclide emissions from the handling of contaminated media (such as filters) were negligible.

Two point sources were initiated in 2002: 1) installation and use of decontamination showers in Building 778, and 2) visual examination and repackaging of rejected TRU, and mixed hazardous and TRU (TRM), waste drums in Building 440, Room 123A. 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 2002; operation of the spray dryer in Building 374 during the early part of 2002; repackaging of waste chemicals at the 904 Pad, Tent 11; and repackaging of ash and dry residues in Building 371 during the early portions of 2002.

Miscellaneous Nonpoint Sources

Another contributor to Site radionuclide emissions in 2002 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 2002 included the 750 Pad Solar Pond sludge removal project, the Solar Ponds closure, 903 Pad remediation, Building 886 slab removal, Building 123 slab removal, Building 442 slab removal, Building 889 slab removal, Building 662/663 slab removal, 231 Tank System sludge removal, Building 707 loading dock modifications, and the Building 707 cargo pad construction (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 2002

Thirteen new or modified activities that contributed to the Site air pathway dose in calendar year 2002 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.

Building 440 Waste Repackaging and Visual Examination Activities: In 2002, rejected TRU/TRM waste drums were visually examined and repackaged in Building 440, Room 123A. The maximum process rate assumed was four drums per day, 5 days per week, 50 weeks per year (repackaging operations were actually initiated in September 2002).

Both visual examination and repackaging activities took place in a C-Cell and gloveboxes that exhausted through two stages of HEPA filters, and through a vent that was continuously sampled for radionuclide emissions. The off-Site EDE was calculated based on the maximum plutonium content in each drum (200 grams), the maximum process rate, 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 3.6×10^{-5} mrem (3.6×10^{-7} mSv).

Building 778 Decontamination Shower Installation: In 2002, temporary decontamination showers were installed in Building 778, Room 112. Each shower had a 114-liter (l) sump/reservoir and a directly piped sink. When a worker was decontaminated, a pump was activated, along with a 0.47 cubic meter per second (m^3/s) 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. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 2.1×10^{-7} mrem (2.1×10^{-9} mSv).

750 Pad Solar Pond Sludge Removal: In 2002, the Site initiated a project to remove approximately 723,000 gallons of Solar Pond sludge and water mixture currently stored at the 750 Pad in Tents 3, 4, and 6. Removal operations included mixing stratified layers of pond sludge and water to form a homogenous mixture, pumping the mixture

through a conditioning process for absorption of water, and pumping the conditioned sludge into approved containers for shipment to an off-Site treatment/disposal facility.

The off-Site EDE was calculated based on the maximum radionuclide activity measured in sludge samples, the total amount of sludge to be pumped and dewatered, and emission factors for tank cleaning and from Appendix D to 40 CFR 61. The maximum annual (controlled) off-Site EDE from this activity was estimated to be 5.5×10^{-2} mrem (5.5×10^{-4} mSv).

Solar Ponds Closure: The Solar Ponds consisted of five surface impoundments. Closure involved removing standing water within the ponds, pushing the surrounding berms into the ponds, adding clean fill to create a level area, and grading and vegetating the area. Soils in the berms surrounding the ponds were slightly contaminated with americium, plutonium, and uranium.

Dose calculations from bulldozer activities associated with pushing in the berms were based on maximum measured radionuclide concentrations in the soil from surface soil screening, the volume of soil pushed into the berms, and 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 2.9×10^{-3} mrem (2.9×10^{-5} mSv).

903 Pad Remediation: In November 2002, excavation began on the 903 Pad Remediation project. Soil excavation was conducted within a 27.4 m by 33.5 m tent that was used to protect the excavation from weather conditions. Three 2.83-m³/s air movers were used to exhaust the air through HEPA filtration. The 903 Pad dimensions are 114 m by 120 m. The total volume of material to be excavated is approximately 9,939 cubic meters (m³).

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the maximum soil excavation rate (82 m³ per day); a radionuclide emission factor from Appendix D to 40 CFR 61; and the average isotopic contamination levels in the soil (Tier I soil footprint contamination data). RFCA defines Tier I and Tier II soil action levels based on concentrations of various contaminants in the soil, where contamination above the higher Tier I action levels suggests cleanup may be necessary, while contamination above Tier II represents contaminant concentrations that require further evaluation. (Contamination below Tier II soil action levels does not require further action.) The maximum annual off-Site EDE from the project was estimated to be 2.5×10^{-5} mrem (2.5×10^{-7} mSv).

Building 886 Slab Remediation: In 2002, Building 886 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 volumes of soil excavated and concrete size-reduced; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be 8.5×10^{-6} mrem (8.5×10^{-8} mSv).

Building 123 Slab Remediation: In 2002, Building 123 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 volumes of soil excavated and concrete size-reduced; and maximum radionuclide contamination levels from data summaries. The maximum annual off-Site EDE from the project was estimated to be 2.0×10^{-5} mrem (2.0×10^{-7} mSv).

Building 442 Slab Remediation: In 2002, Building 442 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 volumes of soil excavated and concrete size-reduced; and conservative isotopic contamination levels in the soil (assumed maximum Tier II soil action levels). The maximum annual off-Site EDE from the project was estimated to be 4.3×10^{-5} mrem (4.3×10^{-7} mSv).

Building 889 Slab Remediation: In 2002, the Building 899 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 volumes of soil excavated and concrete size-reduced; and maximum under-building contamination data. The maximum annual off-Site EDE from the project was estimated to be 1.1×10^{-6} mrem (1.1×10^{-8} mSv).

Building 662/663 Slab Remediation: In 2002, the Building 662/663 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 volumes of soil excavated and concrete size-reduced; and the maximum allowable radionuclide contamination value for low-level waste (100 nanocuries per gram). The maximum annual off-Site EDE from the project was estimated to be 3.7×10^{-3} mrem (3.7×10^{-5} mSv).

231 Tank System Sludge Removal: The 231 Tank System consists of two storage tanks and associated transfer pumps. The tanks are designed to store low-level mixed waste prior to shipping off Site for treatment and disposal. In 2002, sludge from the tanks was pumped out of the tanks and into drums. The sludge was dewatered, and the water pumped back into the tanks. Approximately 200 drums were processed in January and February 2002.

The off-Site EDE was calculated based on the maximum plutonium and americium activity measured in sludge samples, the total amount of sludge to be pumped and dewatered, 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 3.8×10^{-4} mrem (3.8×10^{-6} mSv).

Building 707 Loading Dock Modifications: In 2002, the loading dock area at the southeast corner of Building 707 was lowered approximately 0.33 m. Existing asphalt and underlying soil were removed to a depth of 0.55 m; the area was then backfilled and capped with 0.2 m of concrete.

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volumes of soil excavated; and conservative isotopic contamination levels in the soil (assumed maximum Tier II soil action levels). The maximum annual off-Site EDE from the project was estimated to be 1.9×10^{-5} mrem (1.9×10^{-7} mSv).

Building 707 Cargo Storage Pad Construction: In 2002, three concrete storage areas were constructed at Building 707. The top 18 centimeters (cm) of soil was removed from the areas and covered with the equivalent thickness of concrete. The maximum volume of soil excavated during the project was 336 m^3 .

The EDE estimation used emission factors from EPA's *Compilation of Air Pollutant Emission Factors*, AP-42; the volume of soil excavated; and conservative isotopic contamination levels in the soil (assumed maximum Tier II soil action levels). The maximum annual off-Site EDE from the project was estimated to be 5.8×10^{-5} mrem (5.8×10^{-7} mSv).

3.0 AIR EMISSIONS DATA

This section discusses and quantifies radionuclide emissions from the Site for calendar year 2002. The stacks, vents, and other points where radioactive materials were released to the atmosphere are described, and the effluent controls employed by the Site to minimize emissions are discussed.

3.1 Emission Determination Process

The emission data presented in this section represent an estimate of Site radionuclide air emissions in calendar year 2002. In many cases, air effluent exiting buildings through stacks or vents was continuously sampled and radionuclide emissions measured. Where such data were available, they are presented here. In other cases, emissions from activities that generated airborne radionuclides were not measured. For these activities, emissions were estimated based on project- or process-specific information, combined with emission factors from various sources. Emission sources that were clearly negligible were not quantified.

Where emissions reported in this section were estimated, rather than directly measured, the emission estimates were based on:

- The radionuclide content of materials handled or processed;
- The form of the radioactive material (gas, liquid, solid, or particulate);
- 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 (a maximum of two stages of HEPA filters were credited, even if additional stages were actually employed); and
- Emission factors appropriate to a given process or 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). Where appropriate, emission data from a DOE publication, *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities* (DOE, 1994), were also used. The appropriate emission factors were combined with project- or process-specific information to yield estimated radionuclide emissions.

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. The development of the Site-specific soil resuspension factor used in emission calculations was discussed in detail in a previous annual report (DOE, 1996).

Historical surface soil radionuclide concentration data from a Site-specific soil sampling database were used to develop a set of radionuclide concentration isopleths spanning the entire Site. The soil resuspension emissions reflect information based on plutonium and americium concentration isopleths that were updated in 1999 and uranium concentration isopleths that were updated in 1998.

The emissions discussed in this section include the 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.

Prior to 2001, tritium emissions from the Site were also reported. However, because potential tritium emissions from the Site have decreased to negligible levels in recent years, tritium is no longer reported.

3.2 Point Sources

Radionuclide emissions released through stacks and vents are termed "point" sources. In 2002, 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 2002 and the control technology used at each point source are described in this section.

3.2.1 Measured Point Source Emissions

During calendar year 2002, radionuclide emissions were collected and measured only at significant release points, or at release points that had the potential to become significant due to scheduled decommissioning activities. 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. 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.

Effluent Sampling Methods

Point source emissions are measured at the Site with a sampling system that continuously draws a portion of the duct or vent airstream through a filter. Radioactive particles collect on the filters, which were generally exchanged weekly in 2002. Following collection, the filters were screened for long-lived alpha and beta radiation to check for elevated radionuclide emissions.

Following alpha/beta screening, the samples were 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 2002.

Calendar Year 2002 Effluent Sampling

Due to the complexity of the building ventilation systems at the Site, the number of sampling locations is not a one-to-one match with the number of release or emission points. In most cases, a sampling location corresponds to a single release point. In some cases, however, a single sampling location monitors an effluent stream that is released through multiple stacks or vents.

In calendar year 2002, particulate matter samples were collected at 28 air effluent sampling locations, representing 35 release points. Sixteen of these locations were sampled all year. An additional 12 locations, representing 16 release points, were sampled during a portion of the year. Appendix B lists the sampling locations monitored in calendar year 2002.

Historically, particulate matter samples were collected at many effluent release points that were identified as insignificant. These locations, while not currently sampled, are still considered release points. However, the quantities of radionuclides emitted from these locations in 2002 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.

During 2002, several changes in point source emission measurements took place. Samplers at three locations were reactivated to support decommissioning activities: 707-R22A/B, -R45A/B, and -R46A/B. During decommissioning, these locations may have

the potential to emit radionuclides into the air in quantities that could result in an annual EDE to the public greater than 1% of the 10-mrem standard, based on uncontrolled emissions (without considering HEPA filtration).

Sampling was discontinued during 2002 at nine locations, representing 10 release points, because the buildings were undergoing active decommissioning. During active decommissioning, the air flow through the ventilation system 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 that location will be accounted for through the compliance sampling network.

Sampling continued throughout much of 2002 at Building 440 in anticipation of planned waste repackaging activities. Sampling was discontinued during a portion of the year due to sample pump failure and equipment repairs. 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. Waste repackaging was initiated in September 2002 and continued through the rest of the year.

Measured calendar year 2002 emissions of plutonium, americium, and uranium are shown in Table 3-1.

Appendix C shows calendar year 2002 measured point source emissions data that would historically have been contained in DOE's Effluent Information System (EIS)/Off-Site Discharge Information System (ODIS). DOE did not publish an EIS/ODIS report for 2002.

3.2.2 Calculated Point Source Emissions

During 2002, 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. These sources included a drum crusher in Tent 5 at the 750 Pad, repackaging of waste chemicals in Tent 11 at the 904 Pad, the Building 374 spray dryer, and the installation and operation of decontamination showers in Building 778, which was described in Section 2.2.2. Point sources with calculated emissions that continued operation from 2001 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 2002.

Table 3-1. Measured Point Source Radionuclide Emissions

Building/ Location ^a	Isotope Emissions (Ci/yr) ^{b,c,d}				
	Pu-239/240	Am-241	U-233/234	U-235	U-238
371-N01	1.09E-08	3.89E-09	3.34E-09	0	2.68E-10
371-N02	1.27E-08	2.14E-09	5.03E-09	0	3.65E-09
371-SSS	4.58E-09	3.68E-10	2.00E-09	3.23E-11	1.36E-10
374-MAI	2.12E-09	8.38E-10	9.03E-09	0	4.37E-09
440-101 ^e	5.64E-10	2.34E-11	3.78E-09	1.44E-09	0
559-561	2.48E-09	1.49E-09	7.65E-09	6.44E-10	5.25E-09
707-101/103	7.22E-11	2.93E-11	3.37E-10	1.64E-11	1.69E-10
707-102/104	1.26E-10	1.63E-10	5.70E-10	2.75E-10	9.58E-11
707-105	4.52E-10	3.73E-10	1.26E-09	5.28E-10	1.37E-09
707-106	8.52E-11	6.91E-11	7.51E-10	2.09E-11	2.50E-10
707-107	5.31E-10	2.55E-10	7.02E-10	4.32E-11	4.57E-10
707-108	1.38E-09	6.71E-10	8.90E-10	7.86E-11	4.72E-10
707-R21A/B	7.80E-09	1.54E-09	1.88E-09	0	3.55E-09
707-R22A/B ^f	4.34E-09	1.02E-09	4.77E-09	1.02E-09	4.66E-09
707-R23A/B	3.38E-09	7.73E-10	4.47E-09	2.83E-10	6.46E-10
707-R24A/B ^g	1.46E-09	1.69E-09	4.29E-09	0	6.16E-10
707-R25A/B	2.08E-09	1.11E-09	2.28E-09	0	5.02E-10
707-R45A/B ^f	5.31E-09	5.09E-10	2.41E-09	0	2.68E-10
707-R46A/B ^f	5.25E-09	5.44E-10	5.36E-09	0	9.77E-10
771-MAI	4.78E-08	2.46E-08	5.21E-08	4.13E-09	7.24E-08
774-202 ^h	5.24E-10	6.04E-11	2.39E-09	1.16E-10	3.84E-11
776-201 ⁱ	9.05E-11	3.04E-11	0	3.49E-12	3.07E-11
776-202 ⁱ	6.01E-09	1.53E-09	4.23E-10	2.17E-10	0
776-204 ⁱ	8.73E-10	2.71E-10	9.10E-10	0	3.95E-10
776-205 ⁱ	1.33E-09	2.00E-10	4.78E-09	0	2.88E-09
776-250 ⁱ	2.75E-08	1.24E-08	2.58E-09	9.93E-11	6.64E-09
776-251 ⁱ	1.29E-09	8.96E-10	0	3.57E-10	8.23E-10
776-252 ⁱ	1.72E-09	2.69E-10	6.26E-10	8.10E-11	3.21E-10

^a 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.

^b Values were corrected for filter blanks.

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

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

^e Release point 440-101 was inactive during a portion of the year (see discussion in Section 3.2.1).

^f Samplers reactivated on 1/7/02 to support decommissioning.

^g Sampler removed from service on 10/7/02 due to active decommissioning.

^h Sampler removed from service on 9/30/02 due to active decommissioning.

ⁱ Samplers removed from service on 7/1/02 due to active decommissioning.

Notes:

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

Table 3-2. Calculated Point Source Radionuclide Emissions

Activity or Building	Isotope Emissions (Ci/yr) ^a				
	Pu-239/ 240	Am-241	U-233/234	U-235	U-238
750 Pad, Tent 5 Drum Crusher ^b	4.7E-08	4.2E-09	--	--	--
Building 374 Spray Dryer ^b	3.3E-08	3.8E-09	--	--	--
Building 778 Decontamination Showers ^b	8.3E-09	7.4E-10	--	--	--
904 Pad, Tent 11 Waste Chemical Repackaging ^b	2.2E-06	2.3E-07	--	--	--

^aEmissions 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.

^bHEPA 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 10¹⁰ Becquerel (Bq)
- E# = x 10[#]
- EDE = Effective dose equivalent
- HEPA = High efficiency particulate air
- Pu = Plutonium
- U = Uranium
- = Not estimated/negligible

904 Pad, Tent 11 Repackaging of Waste Chemicals: In 1999, 2000, 2001, and 2002, drums of waste chemicals were repackaged in the Tent 11 containment structure 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. Emission estimates 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 structure open to the atmosphere at all times.

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 (cm²). 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 cm².

The containment structure air exhausted through a single-stage HEPA filter. For 2002, 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 cm² over the entire surface area. In fact, the drum crusher operated only intermittently during 2002, so the actual emissions would have been substantially less than estimated here.

Building 374 Spray Dryer Operation: The spray dryer in Building 374 was revitalized in 2001 to treat the backlog of liquid radioactive concentrate stored at the Site. Concentrated liquid was fed into the spray dryer chamber where it was dried into salt, which was filtered and loaded into drums for shipment. Dose calculations were based on the conservative assumptions that the spray dryer operated at the maximum design rate 24 hours per day, 5 days per week, 52 weeks per year, although the spray dryer actually operated only in January and February 2002, then was shut down in March.

The process air exhausted through two stages of HEPA filters. The off-Site EDE was calculated based on the maximum radionuclide content of the influent; the maximum design process rate operating 24 hours per day, 5 days per week, 52 weeks per year; and an emission factor from Appendix D to 40 CFR 61.

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 2002 (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 2002. 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.

Waste repackaging activities at the 904 Pad, Tent 11, and the Building 374 spray dryer were controlled by two stages of HEPA filters. The drum crushing activities at the 750 Pad, Tent 5, and the Building 778 decontamination showers were controlled by a single-stage 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 2002.

3.3.1 Nonpoint Source Descriptions

In calendar year 2002, 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:

- Solar Ponds Closure,
- 903 Pad remediation,
- Building 886 slab removal,
- Building 123 slab removal,
- Building 442 slab removal,
- Building 889 slab removal,
- Building 662/663 slab removal,
- Building 707 loading dock modifications, and
- Building 707 cargo storage pad construction.

Calendar year 2002 nonpoint sources also included the Building 886 demolition project. Radionuclide emissions were measured by an ambient network activated for the Building 886 demolition and were found to be negligible.

Several other structures were demolished during 2002, including:

- Buildings 125, S125, 280, 381, 442L, 442W, 452, 662, 663, 709A, 828, 850, 864, 875, 880, 932, 331A, 335, 367, S452, 666, 884, 910;
- Trailers T452A-G, T760B, T886A-C, T891D-E, T891G, T891P-Q, T891V, T891T, T893A-B, T334B-D, T760A; and
- Tents 07, 08, 09, and 14.

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

Calendar year 2002 nonpoint sources also included emissions from sludge dewatering activities at the 231 Tank System, the removal of Solar Pond sludge from the 750 Pad, and, as described in Section 3, the resuspension of contaminated soil.

Table 3-3. Nonpoint Source Radionuclide Emissions

Source or Project ^b	Isotope Emissions (Ci/yr) ^a				
	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
Solar Ponds Closure	2.1E-05	4.9E-05	2.4E-05	8.7E-07	1.0E-05
903 Pad Remediation	4.9E-06	1.1E-06	6.5E-09	9.4E-10	2.7E-08
Building 886 Slab Remediation	3.1E-07	8.3E-10	7.9E-09	3.0E-10	2.8E-09
Building 123 Slab Remediation	1.1E-07	2.9E-07	4.8E-07		3.9E-07
Building 442 Slab Remediation	4.8E-07	7.2E-08	5.9E-7	4.6E-08	2.0E-07
Building 889 Slab Remediation	1.8E-06	1.4E-07	1.1E-06	8.6E-08	3.7E-07
Building 662/663 Slab Remediation	1.1E-04	9.4E-06	--	--	--
231 Tank System Sludge Removal	8.2E-06	6.7E-06	--	--	--
750 Pad Solar Pond Sludge Removal	2.6E-04	6.3E-04	1.8E-05	1.2E-06	2.7E-05
Building 707 Loading Dock Modifications	1.6E-07	2.3E-08	1.9E-07	1.5E-08	6.3E-08
Building 707 Cargo Storage Pad Construction	4.8E-07	7.2E-08	5.8E-07	4.5E-08	1.9E-07

^a 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 Figures 3-1 through 3-6 of this report.

^b Emissions assumed to be uncontrolled.

Notes:

- Am = Americium
- Ci/yr = Curies per year, 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq)
- E# = x10[#]
- EDE = Effective dose equivalent
- Pu = Plutonium
- U = Uranium

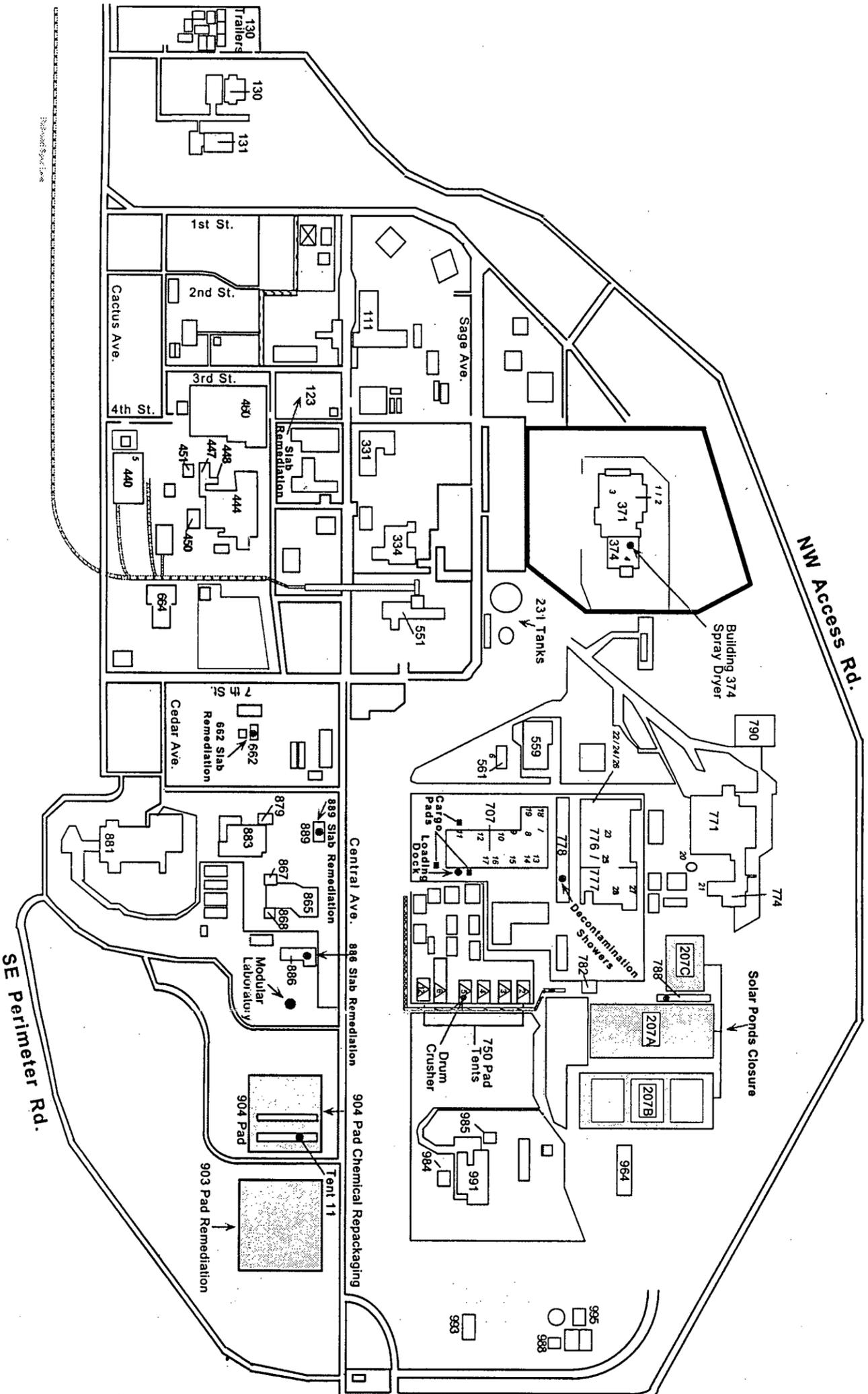
3.3.2 Control Technology for Nonpoint Sources

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.



not to scale
Revision 7, April 2003

Map Identifier	Monitored Emission Point ID	Calculated Point Sources
1	371-NO1	● Building 374 Spray Dryer Operation
2	371-NC2	● 904 Pad, Tent 11 Waste Chemical Repackaging
3	371-SSS	● Drum Crusher 750 Pad, Tent 5
4	374-MA1	● Building 778 Decontamination Showers
5	440-101	
6	559-561	
7	707-101/103	
8	707-102/104	
9	707-105	
10	707-106	
11	707-107	
12	707-108	
13	707-R21A/B	● Solar Ponds Closure
14	707-R22A/B	● 903 Pad Remediation
15	707-R23A/B	● Building 886 Slab Remediation
16	707-R24A/B	● Building 123 Slab Remediation
17	707-R25A/B	● Building 889 Slab Remediation
18	707-R45A/B	● Building 662/663 Slab Remediation
19	707-R46A/B	● Building 662/663 Slab Remediation
20	771-MA1	● 231 Tank System Sludge Removal
21	776-202	● Building 707 Loading Dock Modifications
22	776-201	● Building 707 Cargo Storage Pads
23	776-202	
24	776-204	
25	776-205	
26	776-250	
27	776-251	
28	776-252	

Figure 3-1. Industrial Area Source Locations

4.0 COMPLIANCE ASSESSMENT

This section describes the compliance assessment performed for the Site for the 2002 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 2002 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. Eleven of these samplers have operated for several years in their current locations. A 12th sampler located at the intersection of Highway 72 and Indiana Street ceased operation and a new sampler began operation to the north along Indiana Street during 1999. In addition, two new samplers were installed during 1999 to complete the compliance sampling network, one at the northeast corner of the Site fence line near the intersection of Highway 128 and Indiana Street and the other due north of the center of the Site, on South 66th Street. 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 2002.

Following the transition to the alternative compliance demonstration method, effluent collection and measurement were discontinued for insignificant release points on Site and

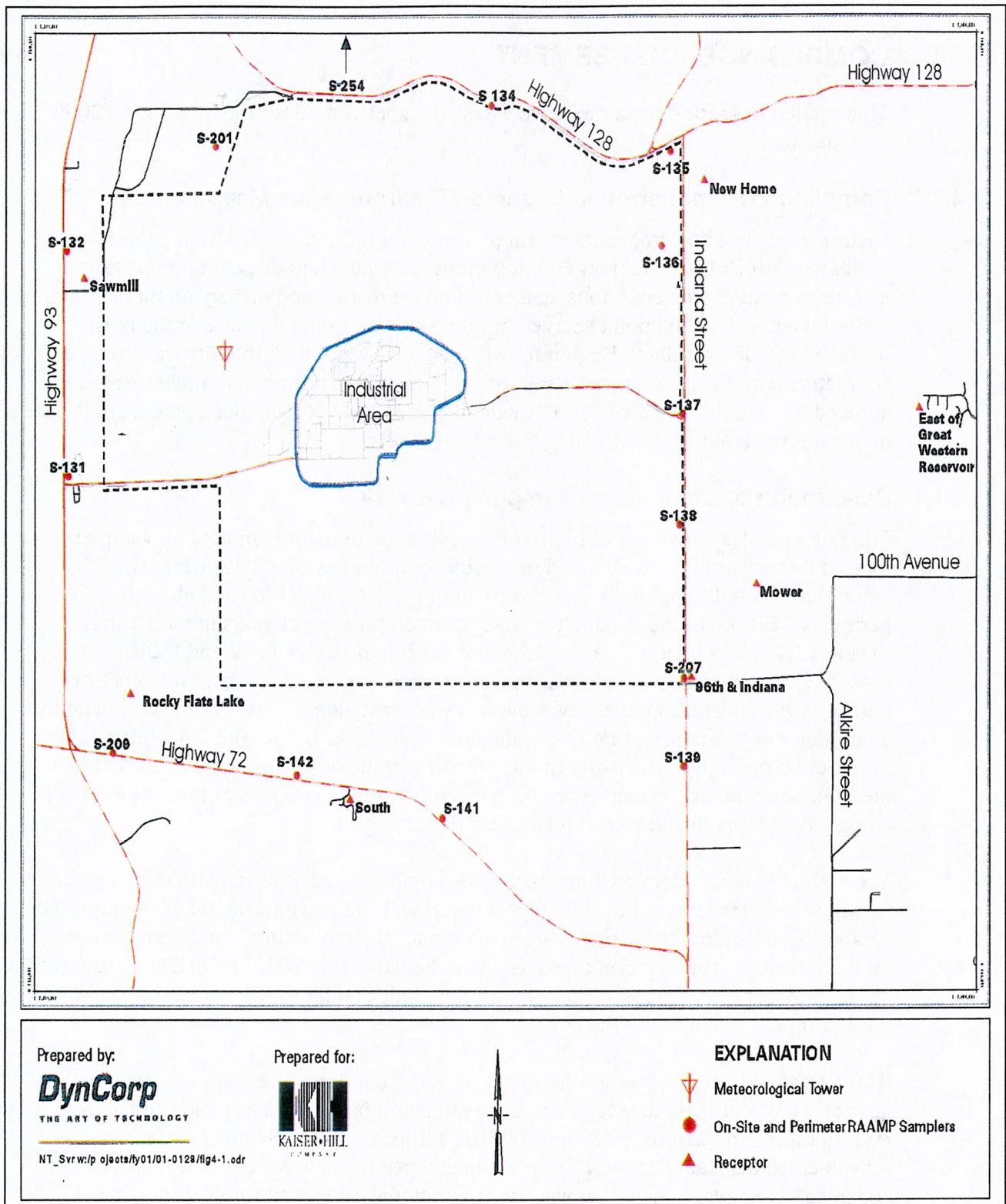


Figure 4-1. Receptor Locations and Nearby Samplers

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 2002

Filters from the compliance sampling network were exchanged monthly during 2002, then analyzed for Pu-239/240, Am-241, U-233/234, U-235, and U-238. 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 demonstration 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 2002.

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 1% 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 2002) was determined to be 0.0156. 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 2002 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.

The maximum measured radionuclide levels occurred to the northwest of the Site, at sampler S-132. This location also showed the highest radionuclide levels measured at the perimeter samplers during calendar years 1997, 1998, 1999, 2000, and 2001.

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

Sampler	Pu-239/240 (Ci/m ³)	Am-241 (Ci/m ³)	U-233/234 (Ci/m ³)	U-235 (Ci/m ³)	U-238 (Ci/m ³)	Fractional Sum
S-131	8.75E-19	4.03E-19	3.85E-17	1.80E-18	3.69E-17	0.0108
S-132	8.56E-19	5.68E-19	5.51E-17	3.22E-18	5.55E-17	0.0156
S-134	3.17E-19	3.39E-19	2.82E-17	1.42E-18	2.88E-17	0.0080
S-135	7.98E-19	3.07E-19	3.03E-17	1.91E-18	3.12E-17	0.0089
S-136	1.41E-18	2.73E-19	2.55E-17	1.39E-18	2.62E-17	0.0078
S-137	2.54E-18	3.15E-19	2.84E-17	1.59E-18	2.84E-17	0.0091
S-138	3.08E-18	4.45E-19	2.79E-17	1.52E-18	2.89E-17	0.0094
S-139	7.43E-19	1.11E-19	3.97E-17	2.15E-18	4.01E-17	0.0112
S-141	4.92E-19	1.71E-19	3.35E-17	2.08E-18	3.17E-17	0.0092
S-142	5.05E-19	6.79E-20	3.06E-17	2.06E-18	3.18E-17	0.0087
S-201	4.59E-19	1.93E-19	4.01E-17	1.66E-18	3.82E-17	0.0108
S-207	3.69E-18	6.01E-19	3.76E-17	1.96E-18	3.61E-17	0.0121
S-209	6.66E-19	1.61E-19	3.34E-17	1.71E-18	3.40E-17	0.0095
S-254	8.29E-19	3.60E-19	4.51E-17	2.27E-18	4.62E-17	0.0128
Compliance Level (Ci/m³)^a	2.0E-15	1.9E-15	7.1/7.7E-15	7.1E-15	8.3E-15	1

^a Compliance levels are listed for each isotope in Table 2 of Appendix E to 40 CFR 61.

Notes:

- Am = Americium
- Ci/m³ = Curies per cubic meter; 1 Ci = 3.7 x 10¹⁰ Becquerel (Bq)
- E# = x 10[#]
- Pu = Plutonium
- U = Uranium

Examination of the isotopic data presented in Table 4-1 and Figure 4-2 shows that the higher overall radionuclide level (fractional sum) at S-132, relative to other samplers in the compliance sampling network, was primarily due to higher levels of U-233/234 and U-238. The ratio of U-233/234 to U-238 activities at S-132 (and at other compliance samplers as well) 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.) S-132 is located in an area that has elevated dust levels due to quarrying activities, sand and gravel removal, and turbulence caused by nearby traffic, and 2002 was a particularly dry year, which may have enhanced dust emissions. The soils surrounding Rocky Flats contain naturally occurring uranium, which may explain the elevated activities at this sampler. Figure 4-3 shows the isotopic breakdown at S-132 as a percentage of the total fractional sum at that location; over 92% of the fractional sum is due to U-233/234 and U-238.

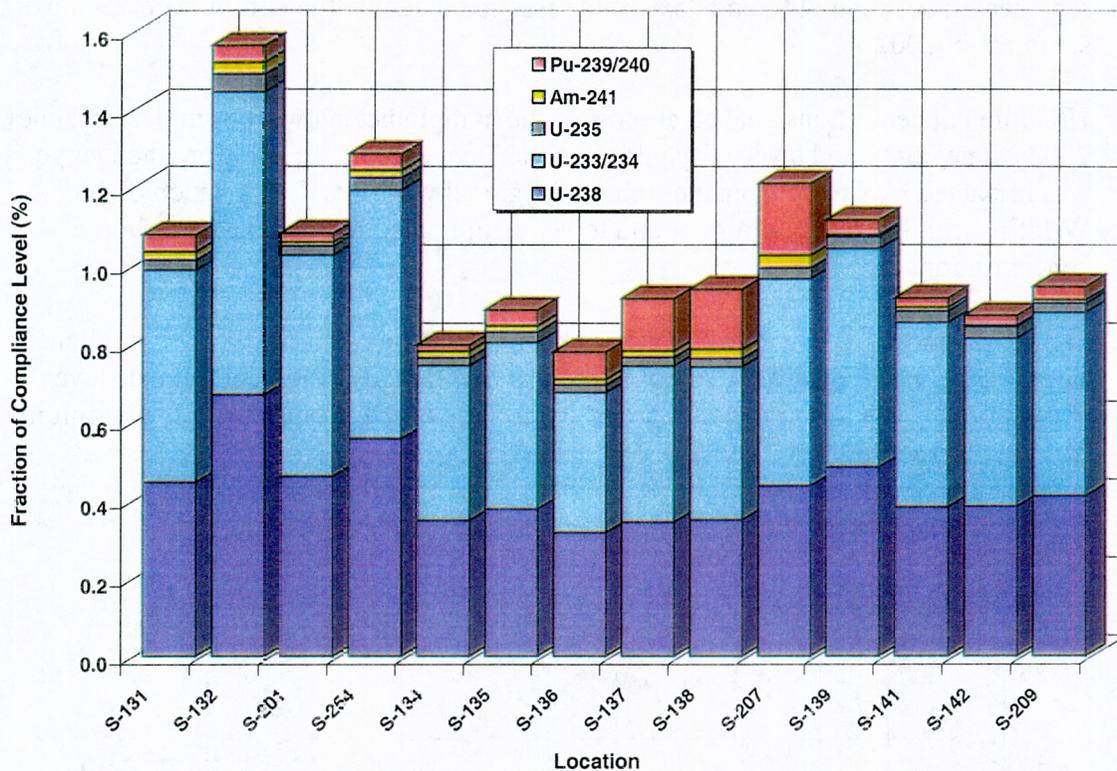


Figure 4-2. Environmental Measurements of Airborne Radionuclides in 2002

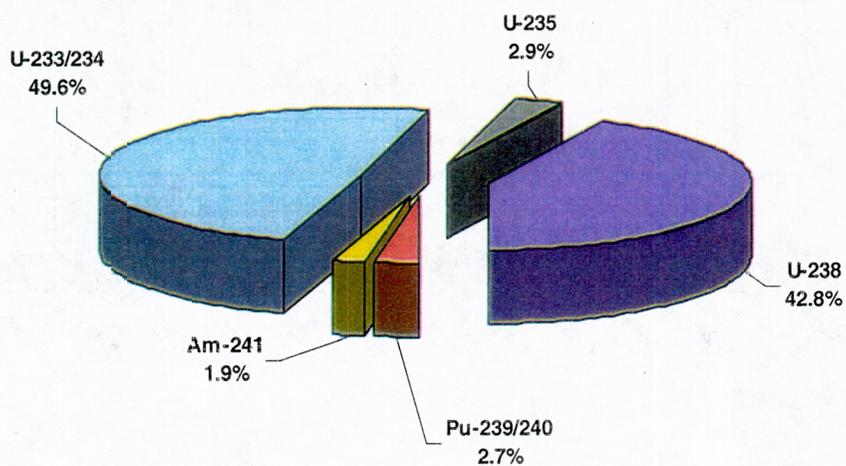


Figure 4-3. Isotopic Contribution to the Fractional Sum at the Critical Receptor

Naturally occurring uranium isotopes appear to have dominated the airborne radionuclide levels at all the compliance samplers in 2002. The sum of U-233/234 and U-238 activity represented between 79% and 95% of the fractional sum at the compliance demonstration samplers in 2002.

Uranium concentrations peaked at most of the compliance network samplers in June 2002. June continued a very dry period in the Denver area. In addition, the Denver area was impacted by smoke from a number of regional wildfires during much of June. Wildfires can liberate uranium bound to vegetation, leading to elevated airborne concentrations.

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.

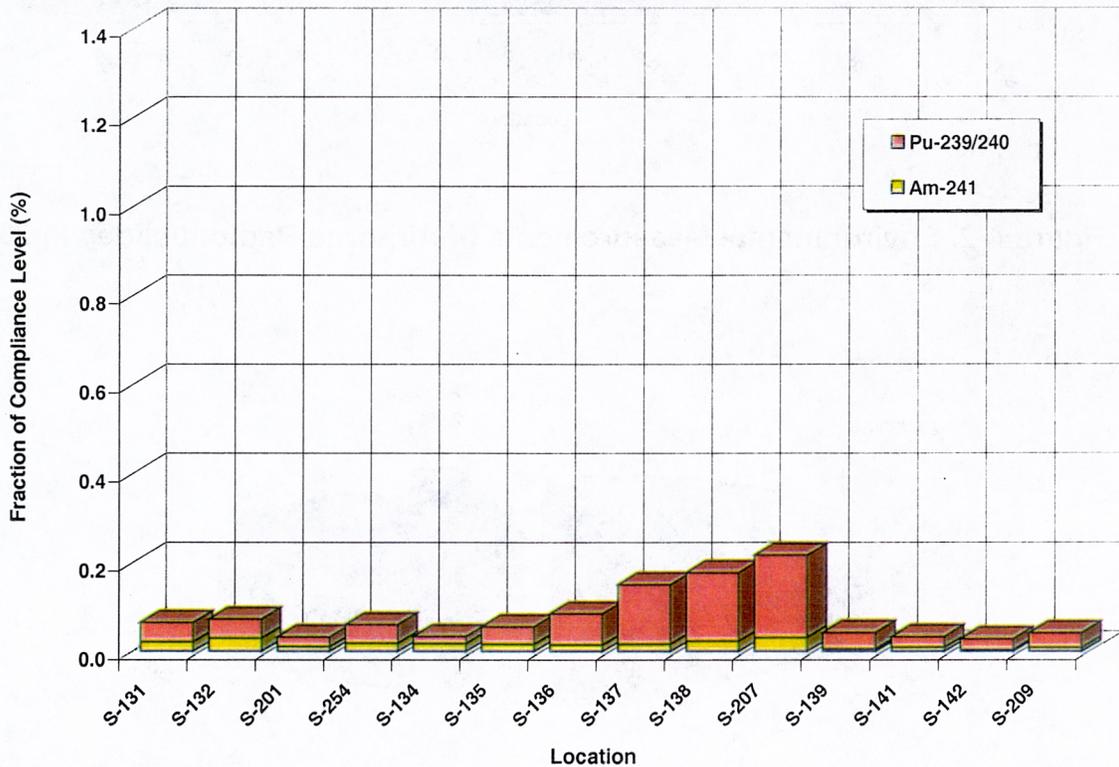


Figure 4-4. Environmental Measurements of Pu-239/240 and Am-241 in 2002

As has been seen in past years, Pu-239/240 and Am-241 present a different pattern than U-233/234 and U-238. An increase in concentrations is apparent at several of the samplers located along the eastern boundary of the Site relative to the other compliance network samplers. Based on annual average wind patterns (see Appendix E), these samplers are generally downwind of Site activities, including wind-blown dust from the 903 Pad, decommissioning and demolition activities in the industrial area, and other soil disturbance activities in the Buffer Zone.

Most of the increased Pu-239/240 and Am-241 activity measured along the eastern fenceline occurred in March, May, and June 2002. A number of demolition and slab removal projects occurred in the industrial area during this period, which may have disturbed contaminated dust. Also, between March and May, installation of a power line in the eastern Buffer Zone may have disturbed the slightly contaminated soils west of these fenceline samplers. Note that although the Pu-239/240 and Am-241 activity levels recorded at the eastern compliance network samplers were higher than those seen at most other samplers during 2002, they still represent an annual dose rate two orders of magnitude below the 10 mrem standard.

The fractional sum information for calendar year 2002 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 2002 was 0.0156, which is nearly two orders of magnitude below the allowable level (fractional sum of 1). The fractional sum can be directly related to the allowable dose limit of 10 mrem in 40 CFR 61, Subpart H. As a result, the maximum dose recorded at the compliance sampling network in 2002 was nearly two orders of magnitude below the 10-mrem limit and more than 92% 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 0.0128 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

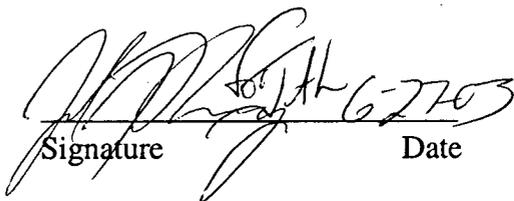
Compliance with the 10-mrem standard has been determined by comparing environmental radionuclide air concentration measurements at the critical receptor location with the "Concentration Levels for Environmental Compliance" listed in Table 2 of Appendix E to 40 CFR 61. Compliance is demonstrated when 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 2002, each measured radionuclide air concentration was less than 1% of its corresponding compliance level and the fractional sum of all radionuclides was less than 2% 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 2002.

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
Assistant Manager
of Environment and
Infrastructure
Department of Energy

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


Signature Date


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 2002 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 2002, the population distributions that form the basis of the collective dose calculation were updated. Estimated population growth figures for 2000 to 2002 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 comprising 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 2002 population values for modeling.

The collective dose was calculated with CAP88-PC, as described in Appendix F. The collective dose for calendar year 2002 was 5.2 person-rem (0.052 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 2002.
- **Revisions to 40 CFR 61, Subpart H:** On September 9, 2002, EPA finalized revisions to 40 CFR 61, Subpart H, that incorporated American National Standards Institute's *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, ANSI N13.1-1999, for new and modified sources. Appendix B to 40 CFR 61, Reference Method 114, which further specifies analytical and quality assurance requirements for radiological sampling, was also revised to correspond to the changes in the underlying regulation. These revisions do not apply to the existing effluent sampling systems at the Site but would apply if a new effluent sampling system was installed. At this point, no additional effluent sampling systems are expected to be installed prior to Site closure.

The revisions also added new inspection and maintenance (I&M) requirements for both new and existing effluent sampling systems. However, DOE contends that the new I&M requirements will not apply to the remaining effluent sampling systems at the Site since these systems are no longer used to demonstrate

compliance with 40 CFR 61, Subpart H. Both CDPHE and EPA Region VIII concurred with this interpretation during conversations that took place in October 2002. This understanding was memorialized in a letter from DOE to CDPHE and EPA Region VIII dated January 15, 2003.

To assure quality environmental sampling, an enhanced I&M program was instituted during 2002 for the RAAMP sampler network. The RAAMP I&M program was developed to ensure the continued quality operation of an ambient sampling network that has been in reliable service for over 5 years. Though the September 9, 2002 changes which compel the adoption of an I&M program for effluent sampling systems do not apply to ambient monitoring systems, the RAAMP I&M program adopted at the Site is consistent with the new I&M requirements of Method 114. Each RAAMP sampler undergoes a thorough inspection and preventative maintenance procedure on an annual basis; additionally, sample flow rate verifications and similar quality control functions continue on a quarterly calendar basis.

- **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 represents particles that could reach and be retained in the lung, while the coarse fraction particles are more likely to be screened out 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 dose in 2002 was due to fine particles, the fine and coarse fraction data were examined for the critical receptor location, where the maximum measured dose occurred (sampler S-132). Monthly concentrations at S-132 for all radionuclides measured (sum of Am-241, Pu-239/240, U-233/234, U-235, and U-238) ranged from 37% to 59% fine particles. Am-241 and Pu-239/240 covered a broader range, from 0% to 100% each in the fine fraction. No patterns were apparent by month.

Airborne radionuclide concentrations at S-207 were also examined. S-207 showed the highest concentrations of Am-241 and Pu-239/240 at any of the compliance sampling network locations in 2002. Again, both Am-241 and Pu-239/240 concentrations ranged from 0% to 100% in the fine fraction by month. The sum of all measured radionuclides spanned the range from 35% to 71% in the fine fraction at S-207 in 2002.

Finally, because the various measured isotopes have greater or lesser dose potential, weighted average fine particle fractions were calculated at S-132 and S-207 for 2002, where the average fine fraction for each isotope was weighted according to its compliance level from Table 2 of Appendix E to 40 CFR 61. The weighted average fine fraction of dose at S-132 was 40.9% in 2002; the weighted average fine fraction of dose at S-207 was 47.5%.

- **Americium concentration at S-132:** During December 2002, sampler S-132 recorded a relatively high Am-241 concentration compared with the other compliance network samplers. No laboratory errors were apparent from the data, nor were there any known project emissions that would have produced the elevated Am-241 concentration for this month and location. The ratio of Am-241 to Pu-239/240 in this sample is considerably higher than would be expected for emissions from the Site (or from resuspension of fallout particles). Also, the elevated Am-241 is only apparent in the fine fraction; the coarse fraction indicates a much lower concentration. This anomalous result remains unexplained, although the coarse fraction results and the Am-241 to Pu-239/240 ratio cast doubt on the representativeness of the reported value. Of interest is that fact that sampler S-132 and, to a lesser extent the sampler immediately to the south, S-131, have shown similarly anomalous Am-241 concentrations on occasion in the past (see the 1999 and 2000 *Radionuclide Air Emissions Annual Reports*, DOE 2000 and 2001).
- **Project monitoring:** The compliance sampling network described in Section 4.1.1 is used to verify low emissions from Site insignificant release points and to demonstrate compliance with the 10 mrem annual limit in 40 CFR 61.92. However, ambient monitoring is also implemented at the Site for purposes that go beyond the specific requirements of 40 CFR 61, Subpart H. The RAAMP program is used to detect and track the impacts of Site operations on air quality to both protect and inform the public. Data are used to plan, implement, and assess the effects of on-Site activities. To supplement routine RAAMP network operation in tracking emissions from decommissioning or remediation activities, the Site has established a project monitoring program, as described below.

During execution of those portions of decommissioning and environmental restoration projects that have a significant potential to release fugitive radionuclide emissions, routine RAAMP operations are augmented by more frequent sampling using selected RAAMP samplers surrounding the project or projects (rather than at the Site fenceline). Because several demolition and remediation projects may be conducted during the same time period, project monitoring now focuses on area-wide monitoring rather than monitoring for single, isolated projects. Under this plan, projects located within the industrial area are monitored with a 10-sampler area-specific RAAMP network, while projects involving the 903 Pad and adjacent lip area are monitored with a separate, but overlapping, 10-sampler network.

Filters from these interior samplers are generally exchanged weekly instead of monthly. The filters are screened through an expedited gross alpha/beta count and the results compared to two predefined action levels. The lower action level corresponds to a 1-mrem dose at the sampler location (assuming that emissions continue at those levels for a two-week period and that all activity is Pu-239/240). The higher action level corresponds to a 5-mrem dose at the sampler location using the same assumptions. The two-week exposure assumption is based on a one-week project monitoring period followed by a one-week period to allow analysis (actual analytical turnaround is expected to be four working days).

Air sampling and atmospheric modeling results indicate that airborne concentrations of radionuclides released from the industrial area decrease by a factor of between 10 and 1,000 over the distance between the industrial area and the Site fenceline due to dispersion and dilution. A two-week concentration measured at the area-wide project monitoring network would correspond to a fenceline concentration at least a factor of 10 lower (i.e., a 1-mrem dose at a project monitoring sampler would correspond to less than a 0.1-mrem dose at the fenceline). The two-week exposure assumption is therefore protective of public receptors and helps ensure compliance with the 10-mrem dose standard of 40 CFR 61, Subpart H.

If the lower action level is exceeded under these assumptions, filters will be submitted for expedited isotopic analyses. Project personnel will be contacted regarding possibly unexpected conditions and to determine whether additional sample collection and analysis may be warranted. If the higher action level is exceeded, the weekly filters from the project samplers will be submitted for expedited isotopic analyses. Project parameters will be reassessed for those activities thought likely to have contributed to the elevated concentrations and, if necessary, mitigative measures will be implemented to reduce future emissions. If sample isotopic results exceeding the higher action level indicate that the 10-mrem dose standard to the most impacted public receptor could occur, project operations will cease until appropriate controls are in place.

The project monitoring program for the Site is documented in an *Integrated Monitoring Plan* (Kaiser-Hill, 2002). The *Integrated Monitoring Plan* also describes monitoring of Site air emissions that is performed by CDPHE and additional monitoring that is coordinated by DOE.

6.0 REFERENCES CITED

- American National Standards Institute, 1999. *Guide to Sampling Airborne Radioactive Materials in Nuclear Facilities*, ANSI N13.1-1999. McLean, VA.
- Brockman, D. A. (U.S. Department of Energy), 1995. Letter. Rocky Flats Field Office, Golden, CO. February 27.
- Kaiser-Hill Company, L.L.C., 2002. *Integrated Monitoring Plan*. Golden, CO.
- Novick, V.J., P.J. Higgins, B. Dierkschiede, C. Abrahamsor, W.B. Richardson, P.R. Monson, and P.G. Ellison, 1985. "Efficiency and Mass Loading Characteristics of a Typical HEPA Filter Media Material" in *21st DOE/NRC Nuclear Air Cleaning Conference Proceedings*.
- Roberts, Rick (Kaiser-Hill Company, LLC.), 1998. Personal Communication. June 16.
- U.S. Department of Energy, 1990. Order 5400.5, *Radiation Protection of the Public and the Environment*.
- U.S. Department of Energy, 1994. *Airborne Release Fractions/Rates and Respirable Fractions for Nonreactor Nuclear Facilities*. Volumes I and II. Washington D.C. December.
- U.S. Department of Energy, 1996. *Radionuclide Air Emissions Annual Report for Calendar Year 1995*. Rocky Flats Field Office, Golden, CO. June.
- U.S. Department of Energy, 1997. *Proposal to Use Environmental Sampling for Demonstrating Compliance with 40 CFR 61, Subpart H*. Rocky Flats Field Office, Golden, CO. July.
- U.S. Department of Energy, 2000. *Radionuclide Air Emissions Annual Report for Calendar Year 1999*. Rocky Flats Field Office, Golden, CO. June.
- U.S. Department of Energy, 2001. *Radionuclide Air Emissions Annual Report for Calendar Year 2000*. Rocky Flats Field Office, Golden, CO. June.
- U.S. Environmental Protection Agency, 1972. *Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States*. Office of Air Programs, Research Triangle Park, NC. January.
- U.S. Environmental Protection Agency, 1991. *Guidance on Implementing the Radionuclide NESHAPS*. Office of Radiation Programs, Washington, D.C. July.

U.S. Environmental Protection Agency, 1995. *Compilation of Air Pollutant Emission Factors*. Volumes I and II. Office of Air Quality Planning and Standards, Research Triangle Park, NC. January.

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)^a</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 ⁻⁶
Am-241	^b	3.42	---	---

^a 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.

^b 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 UTILIZED 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.¹
Plated solids > Appendix E values.
Liquids > $10^{-3} \mu\text{Ci}$

Americium (Am-241)
Cesium (Cs-137)
Plutonium (Pu-238,-239)

¹ 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.

2. Traceable (Nonaccountable) Sources

Sealed solids < Appendix E values
Plated solids < Appendix E values
Liquids < $10^{-3} \mu\text{Ci}$

Americium	(Am-241, 243)
Barium	(Ba-133)
Cadmium	(Cd-109)
Californium	(Cf-252, -250)
Carbon	(C-14)
Cesium	(Cs-137)
Chlorine	(Cl-36)
Cobalt	(Co-56, -57, -60)
Gadolinium	(Gd-148)
Hydrogen (Tritium)	(H-3)
Iridium	(Ir-192)
Nickel	(Ni-63)
Plutonium	(Pu-238, -239, 240)
Promethium	(Pm-147)
Radium	(Ra-226)
Selenium	(Se-75)
Strontium	(Sr-85-90)
Thallium	(Tl-204)
Thorium	(Th-230)
Uranium	(U-232, -234, -235, -236, -238)

D. RADIUM SOURCES HANDLED AND STORED AT ROCKY FLATS

<u>Source*</u>	<u>RFETS ID</u>	<u>Nuclide</u>	<u>Location</u>	<u>Original Activity (μCi)</u>
TS	3938	Ra-226	T130B	0.0315
TS	3939	Ra-226	T130B	0.0135
LS	4305	Ra-226	126	0.9
LS	4306	Ra-226	126	0.9
LS	4307	Ra-226	126	0.9
LS	4308	Ra-226	126	0.9
LS	4309	Ra-226	126	0.9
LS	4310	Ra-226	126	0.9
LS	4311	Ra-226	126	0.9
LS	4312	Ra-226	126	0.9

Note -- The following Ra-226 source numbers, which have appeared in prior year reports, are no longer at RFETS: 138, 866, 1734.

*TS = Traceable Source

LS = Legacy Source, discovered 09/03/02

APPENDIX B
EFFLUENT RELEASE POINTS
CALENDAR YEAR 2002

**Effluent Release Points
Calendar Year 2002^a**

Building-Location	Release Points	Subpart H Category	Notes
Release Points Sampled Throughout 2002			
371-N01	1	Significant	
371-N02	1	Significant	
371-SSS	1	Significant	
374-MAI	1	Significant	
440-101	1	Significant	
559-561	1	Significant	
707-101/103	1	Significant	
707-102/104	1	Significant	
707-105	1	Significant	
707-106	1	Significant	
707-107	1	Significant	
707-108	1	Significant	
707-R21A/B	2	Significant ^b	Sampling to support decommissioning, effective 11/05/01.
707-R23A/B	2	Significant ^b	Sampling to support decommissioning, effective 11/05/01.
707-R25A/B	2	Significant ^b	Sampling to support decommissioning, effective 10/01/01.
771-MAI	1	Significant	
Release Points Sampled During Part of 2002			
707-R22A/B	2	Significant ^b	Sampling to support decommissioning, effective 1/07/02.
707-R24A/B	2	Significant ^b	Removed from service 10/07/02 due to active decommissioning.
707-R45A/B	2	Significant ^b	Sampling to support decommissioning, effective 1/07/02.
707-R46A/B	2	Significant ^b	Sampling to support decommissioning, effective 1/07/02.
774-202	1	Significant	Removed from service 9/30/02 due to active decommissioning.
776-201	1	Significant	Removed from service 7/01/02 due to active decommissioning.
776-202	1	Significant ^b	Removed from service 7/01/02 due to active decommissioning.
776-204	1	Significant	Removed from service 7/01/02 due to active decommissioning.
776-205	1	Significant	Removed from service 7/01/02 due to active decommissioning.
776-250	1	Significant ^b	Removed from service 7/01/02 due to active decommissioning.
776-251	1	Significant ^b	Removed from service 7/01/02 due to active decommissioning.
776-252	1	Significant ^b	Removed from service 7/01/02 due to active decommissioning.
Total	35		

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

^b These emission points were proactively upgraded to "significant" (and monitored accordingly) to support decommissioning work, 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
2002**

**Summary Table For The EIS/ODIS Report^{a,b}
2002-Release (Ci)**

02_ODIS Location	ODIS Location Code	N	Effluent Volume (m ³)	Plutonium 239/240	Americium 241	Uranium 233/234	Uranium 235	Uranium 238
707-101	AFGHB707005	12	8.98E+06	7.22E-11	2.93E-11	3.37E-10	1.64E-11	1.69E-10
707-102	AFGHB707006	12	2.94E+07	1.26E-10	1.63E-10	5.70E-10	2.75E-10	9.58E-11
707-105	AFGHB707003	12	6.83E+07	4.52E-10	3.73E-10	1.26E-09	5.28E-10	1.37E-09
707-106	AFGHB707001	12	3.29E+07	8.52E-11	6.91E-11	7.51E-10	2.09E-11	2.50E-10
707-107	AFGHB707004	12	6.79E+07	5.31E-10	2.55E-10	7.02E-10	4.32E-11	4.57E-10
707-108	AFGHB707002	12	9.70E+07	1.38E-09	6.71E-10	8.90E-10	7.86E-11	4.72E-10
707-R21	AFGHI707001	12	4.47E+08	7.80E-09	1.54E-09	1.88E-09	-7.20E-10	3.55E-09
707-R22 ^c	AFGHI707002	12	4.47E+08	4.34E-09	1.02E-09	4.77E-09	1.02E-09	4.66E-09
707-R23	AFGHI707003	12	4.47E+08	3.38E-09	7.73E-10	4.47E-09	2.83E-10	6.46E-10
707-R24 ^d	AFGHI707004	9	3.34E+08	1.46E-09	1.69E-09	4.29E-09	-9.30E-11	6.16E-10
707-R25	AFGHI707005	12	4.47E+08	2.08E-09	1.11E-09	2.28E-09	-2.80E-10	5.02E-10
707-R45 ^c	AFGHI707008	12	4.47E+08	5.31E-09	5.09E-10	2.41E-09	-2.90E-10	2.68E-10
707-R46 ^c	AFGHI707009	12	4.47E+08	5.25E-09	5.44E-10	5.36E-09	-8.90E-10	9.77E-10
776-201 ^c	AFGHE776003	6	3.64E+06	9.05E-11	3.04E-11	-2.20E-11	3.49E-12	3.07E-11
776-202 ^f	AFGHE776008	6	3.64E+07	6.01E-09	1.53E-09	4.23E-10	2.17E-10	-1.30E-10
776-204 ^f	AFGHE776005	6	7.55E+07	8.73E-10	2.71E-10	9.10E-10	-8.10E-11	3.95E-10
776-205 ^{f,g}	AFGHE776004	6	1.12E+08	1.33E-09	2.00E-10	4.78E-09	-8.00E-11	2.88E-09
776-250 ^f	AFGHE776001	6	1.44E+09	2.75E-08	1.24E-08	2.58E-09	9.93E-11	6.64E-09
776-251 ^f	AFGHE776006	6	1.34E+08	1.29E-09	8.96E-10	-7.00E-10	3.57E-10	8.23E-10
776-252 ^f	AFGHE776007	6	4.17E+07	1.72E-09	2.69E-10	6.26E-10	8.10E-11	3.21E-10
559-561	AFGHA559001	12	5.97E+08	2.48E-09	1.49E-09	7.65E-09	6.44E-10	5.25E-09
771-MAI	AFGHC771001	12	2.55E+09	4.78E-08	2.46E-08	5.21E-08	4.13E-09	7.24E-08
774-202 ^e	AFGHD774001	9	6.92E+07	5.24E-10	6.04E-11	2.39E-09	1.16E-10	3.84E-11
374-MAI	AFGHJ374001	12	3.03E+08	2.12E-09	8.38E-10	9.03E-09	-1.90E-10	4.37E-09
371-NNN	AFGHC371001	24	4.22E+08	2.36E-08	6.03E-09	8.37E-09	-1.21E-09	3.92E-09
371-SSS	AFGHC371002	12	4.43E+08	4.58E-09	3.68E-10	2.00E-09	3.23E-11	1.36E-10
440-101		12	7.47E+04	5.64E-10	2.34E-11	3.78E-09	1.44E-09	-4.70E-09
RFETS		288	9.62E+06	1.53E-07	5.77E-08	1.24E-07	5.55E-09	1.06E-07

^a No longer report Pu-238.

^b Several locations were removed from this report, as sampling no longer was required or the building no longer exists.

^c Locations reactivated to support building decommissioning 1/7/02.

^d Location removed from service 10/07/02.

^e Location removed from service 9/30/02.

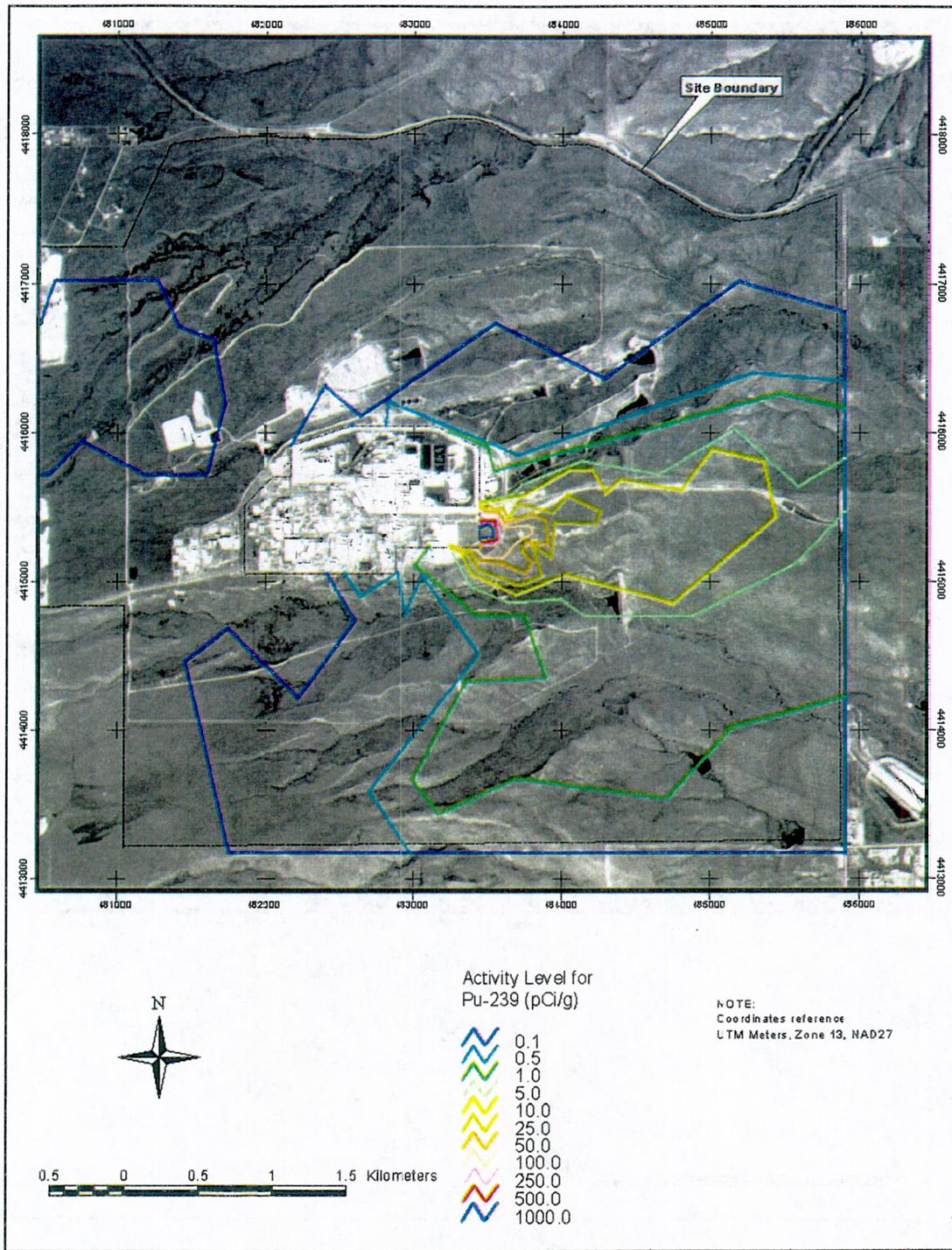
^f Locations removed from service 7/1/02.

^g Release points 776-205, -206, and -207 are combined through a mixing plenum and are sampled with one shrouded probe identified as 776-205.

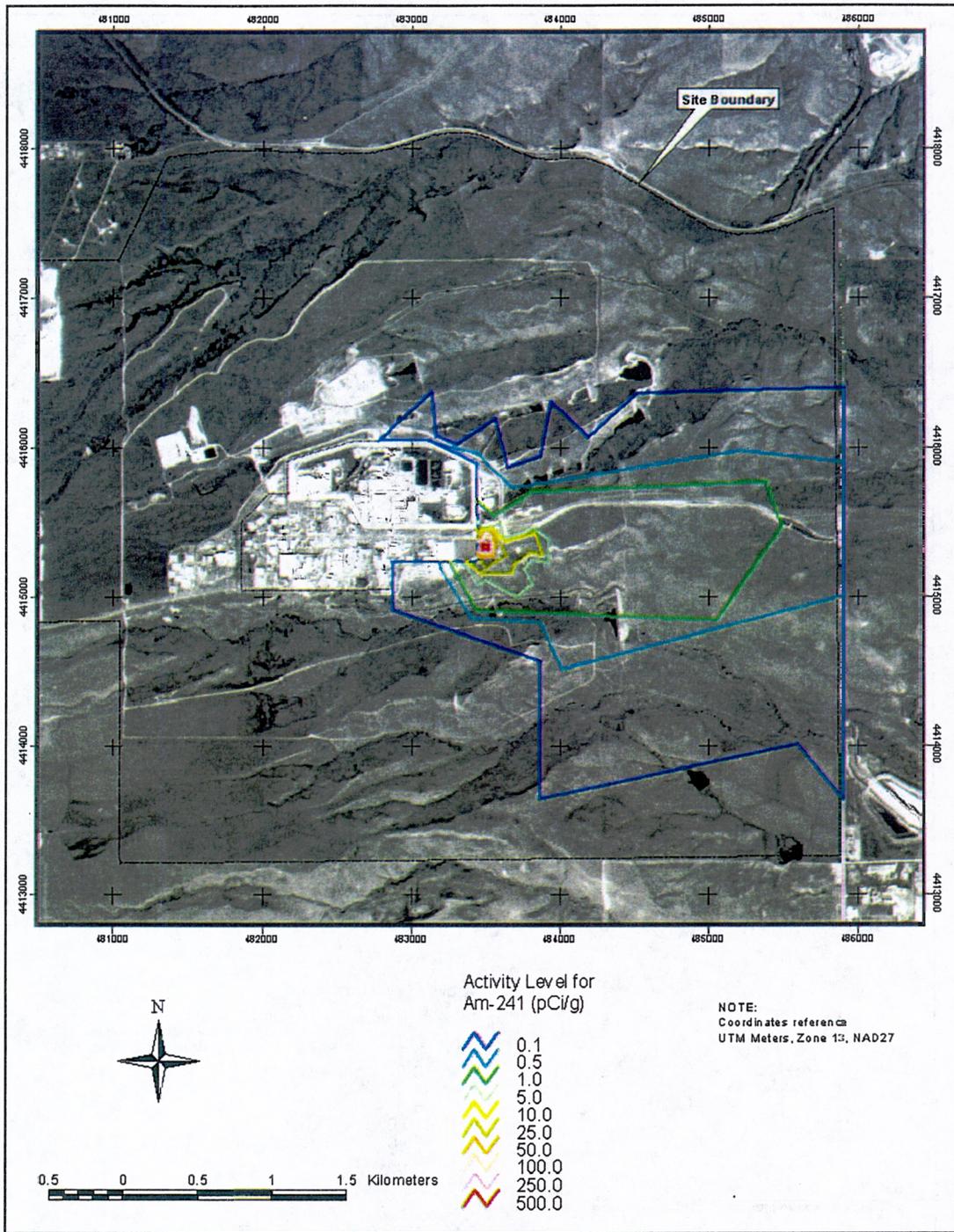
Notes:

- Ci = Curies
- EIS = Effluent Information System
- m³ = Cubic meters
- N = Number of samples analyzed
- ODIS = Off-Site Discharge Information System
- RFETS = Rocky Flats Environmental Technology Site

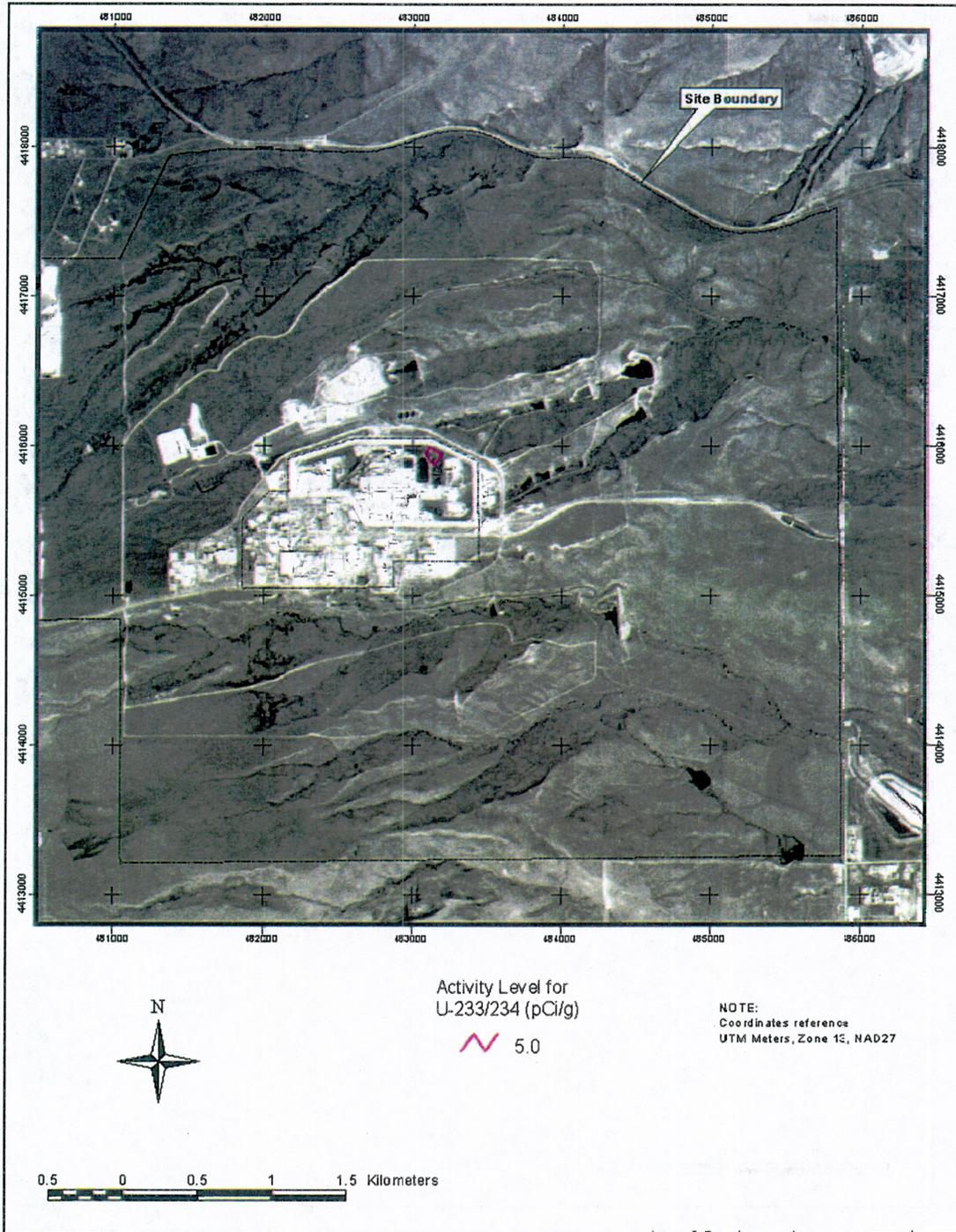
APPENDIX D
SOURCE AREAS FOR WIND EROSION
OF RADIONUCLIDES



Surface Soil Contamination Isopleths for Pu-239/240



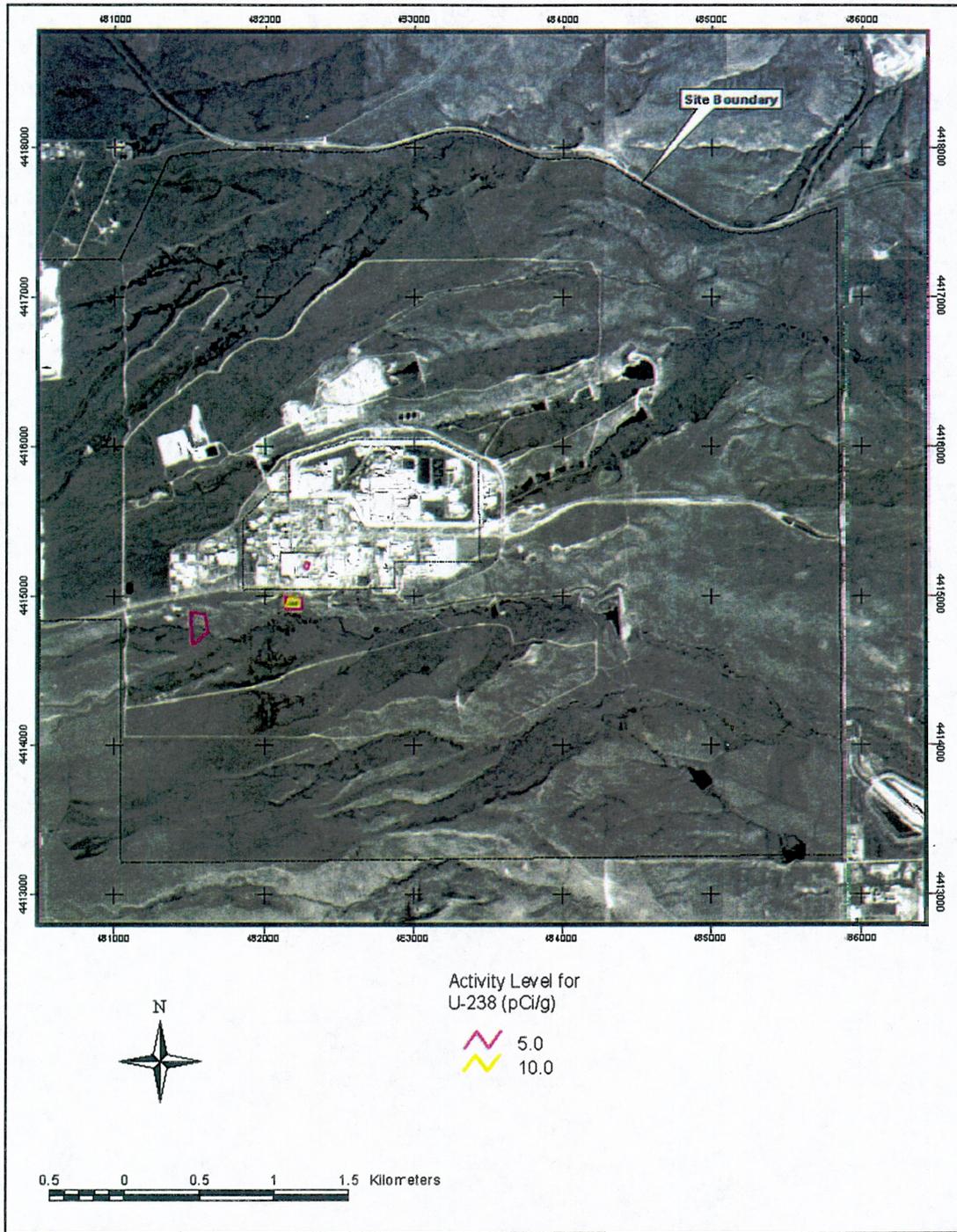
Surface Soil Contamination Isopleths For Am-241



Surface Soil Contamination Isopleths for U-233/234



Surface Soil Contamination Isopleths for U-235



Surface Soil Contamination Isopleths for U-238

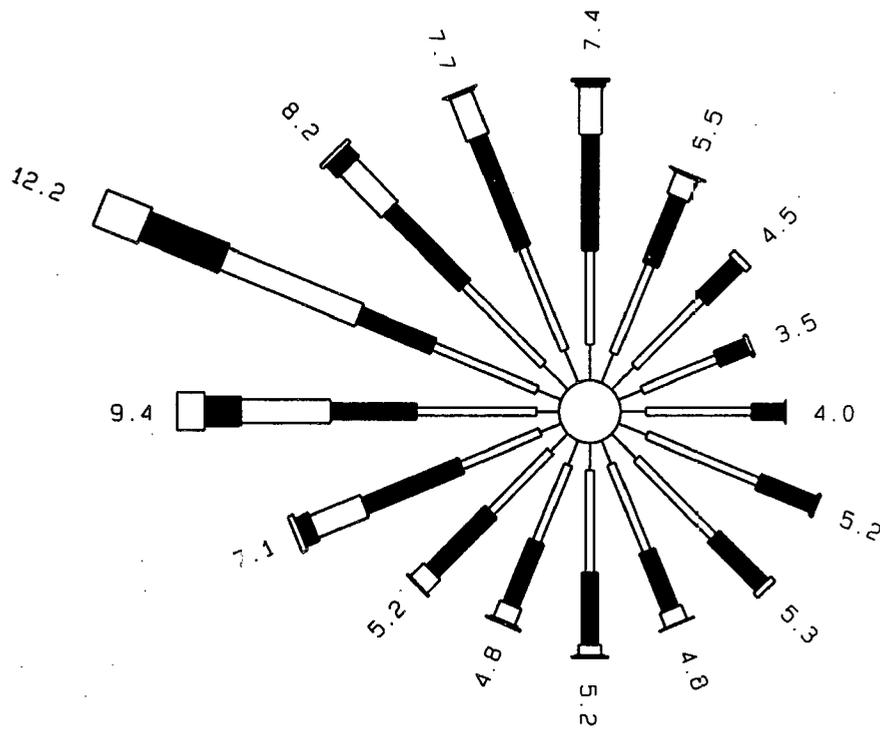
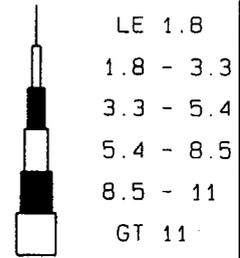
APPENDIX E

WIND FREQUENCY DISTRIBUTION FOR 2002

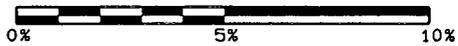
WIND ROSE

RFETS
CY 2002 (rev. 1)

Wind Speed
(m/s)



Stability
A 11.8% B 10.0% C 12.2% D 44.5% E 11.4% F 9.7%



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 2002 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 5.3×10^6 square meters (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 2002, which was resuspension of contaminated soil and dust from wind and from mechanical disturbance during demolition and remediation activities.

Meteorological data for calendar year 2002 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 D.

Annual precipitation and temperature data collected on Site for 2002 show:

- Total precipitation in 2002: 28.24 cm; and
- Annual average temperature: 10.05°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 2002 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 for 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.