RCRA Facility Investigation – Remedial Investigation/Corrective Measures Study – Feasibility Study Report for the Rocky Flats Environmental Technology Site

Section 6.0

Nature and Extent of Air Contamination

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6.0 NATURE AND EXTENT OF AIR CONTAMINATION

6.1 Introduction

The purpose of this section is to define the nature and extent of airborne contaminants at the Rocky Flats Environmental Technology Site (RFETS or site) after completion of Rocky Flats Cleanup Agreement (RFCA) accelerated actions. Information regarding ongoing sources of contaminant emissions to air will be considered in evaluating final remedy alternatives.

This section discusses historical airborne contamination sources, monitoring, and related studies. The following discussion is supported by and draws from the more detailed information in Section 3.0, Nature and Extent of Soil Contamination.

Monitoring programs and other studies were conducted during both the production era and cleanup phase at RFETS. Historical monitoring data are reviewed in Section 6.4. These data show that contaminant emissions and resulting ambient airborne concentrations during both the weapons production era and cleanup phase were always compliant with all regulatory requirements. In fact, compliance monitoring at the facility fenceline showed maximum airborne radionuclide concentrations of no more than 3 percent of the limiting standard during the entire cleanup phase. With completion of all accelerated actions at RFETS and the attendant removal of all historical air emissions sources except for wind erosion of the minor, remnant contamination in surface soils, future RFETS air emissions will be less than those in the past.

6.2 Historical Air Contaminant Emissions Sources

During the weapons production era at RFETS, the major sources of airborne contamination comprised releases of radionuclides, volatile organic compounds (VOCs), and metals from stacks venting building processes and operations; conventional pollutant sources such as fuel combustion in boilers and generators, street sanding, traffic, refrigerant leaks, and fugitive dust from soil disturbance; and resuspension of contaminants deposited on surface soil by prior events (such as fires or leakage of radioactively contaminated oils and VOCs from drums stored at the historical 903 Pad). During the cleanup phase, building decommissioning, and Environmental Restoration (ER) activities represented additional sources of emissions to air. These sources were eliminated or decreased as buildings were demolished and soil contamination was cleaned up.

RFETS released a variety of contaminants into the air from these sources. These contaminants included the six “criteria” pollutants, or their precursors, for which the U.S. Environmental Protection Agency (EPA) has established National Ambient Air Quality Standards in Title 40 of the Code of Federal Regulations (CFR), Part 50: sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM), VOCs (regulated as a precursor to ozone), carbon monoxide (CO), and lead. Radioactive particles and tritium, a gaseous pollutant, were also released, along with ozone-depleting substances (ODS) and a number of hazardous or toxic contaminants.

A summary of both past and ongoing air emissions sources at RFETS is provided in Table 6.1.

6.3 Data Sources

The data reviewed in this section were drawn from a number of sources. These include both ambient and effluent radionuclide monitoring conducted by the U.S. Department of Energy (DOE) and their contractors at RFETS, monitoring for VOCs conducted at the fenceline of RFETS by the Colorado Department of Public Health and Environment (CDPHE), a special purpose VOC monitoring program conducted by RFETS in the Industrial Area (IA) in 1995 and 1996, and project-specific beryllium monitoring conducted by RFETS during decommissioning of specific on-site buildings that had historical beryllium usage. In addition, modeling has been performed for landfill emissions using EPA methods to determine probable landfill gas emissions.

6.3.1 Data Quality Objectives

The EPA data quality objective (DQO) process is used to ensure that the type, quantity, and quality of environmental data used in the decision-making process are appropriate for the intended purpose (EPA 2000). The DQO process is used to demonstrate whether data collected at RFETS are of adequate quality and quantity to define the nature and extent of air contamination at the site following completion of accelerated actions.

6.3.1.1 Step 1: State the Problem

As described in Section 6.2 and Table 6.1, RFETS has historically released a number of different air pollutants from various sources. Historical air monitoring data show that contaminant emissions and resulting ambient airborne concentrations during both the weapons production era and cleanup phase were always compliant with all regulatory requirements. Over time, as buildings have been decommissioned and environmental contamination has been cleaned up, the sources of airborne emissions have declined or been removed, and future RFETS air emissions will be less than those in the past.

Analytes historically monitored by DOE, either in stack effluent or in ambient air, were:

- Radionuclides (plutonium-239/240; americium-241; uranium-233/234, -235, and -238; and tritium);
- Beryllium; and
- Selected VOCs/hazardous air pollutants (HAPs) and PM (special studies).

In addition, CDPHE, at various times, has measured a variety of pollutants at RFETS or in areas adjacent to RFETS, including radionuclides, ozone, selected VOCs and HAPs, NO_2, and PM.

Based on historical monitoring data and air emissions estimates, the problem to be addressed by the nature and extent of air evaluation is:

> *Define the nature and extent of remaining airborne contamination from RFETS following completion of accelerated actions.*

6.3.1.2 Step 2: Identify the Decision

The primary decisions for air are as follows:

- *Which pollutants and sources represent ongoing sources of airborne contamination following completion of accelerated actions?*
- *Of the ongoing sources, which, if any, present potential issues because they are near or above a standard or limitation, or otherwise merit additional evaluation because of persistence or other factors?*

6.3.1.3 Step 3: Identify the Inputs to the Decision

Inputs necessary to address the decisions are:

- A list of the pollutants emitted by RFETS historically and their sources;
- A list of historical sources of airborne contamination from RFETS and their final disposition (that is, have they been eliminated?);
- Historical monitoring data that quantify past airborne pollutant concentrations, particularly for sources/pollutants that will persist following completion of accelerated actions, to determine whether they should be further analyzed;
- Information necessary to quantify future airborne concentrations of any pollutants that may be present in sufficient concentrations following completion of accelerated actions to warrant consideration in evaluating final remedy alternatives, including information regarding remaining surface soil radionuclide contamination; and
- A list of the applicable standards, limitations, or guidelines that data will be evaluated against (such as radionuclide emissions standards in 40 CFR 61, Subpart H and Colorado Air Quality Control Commission [CAQCC] Regulation No. 8, landfill emission guidelines in 40 CFR 60, Subpart Cc).

6.3.1.4 Step 4: Define the Study Boundary

The airborne contamination of interest is due to RFETS ongoing sources.

Spatial Boundary: *The nature and extent of RFETS airborne contamination depends on ongoing source areas or activities generally within (or in close proximity to) the RFETS fenceline and are referenced to monitoring data within site boundaries* *and close to the site fenceline. The RFETS fenced property boundary is the line where publicly accessible “ambient air” begins.*

Temporal Boundary: *Monitoring data for various airborne substances collected from 1995 through September 2005 has been considered in this assessment.*

6.3.1.5 Step 5: Develop a Decision Rule

The decision rules are as follows:

- If sources of airborne contamination have been eliminated, then those sources and pollutants need not be considered further in evaluating the nature and extent of air contamination following completion of accelerated actions.
- For sources that have not been completely eliminated, if adequate historic monitoring data (or other analyses) exist to show that concentrations of pollutants from these sources have not been present in air at levels of concern in the past, and emissions and/or concentrations are expected to be decreasing, then these sources and pollutants need not be considered further in evaluating the nature and extent of air contamination following completion of accelerated actions.
- For sources that have not been completely eliminated, if either past historic monitoring data or other analyses show that concentrations of pollutants from these sources have previously approached levels of concern, or there is reason to believe that emissions and/or concentrations of these pollutants in air may be increasing, or there are other reasons such as persistence in the environment that makes the sources or pollutants of special concern, then the nature and extent of air contamination from these sources/pollutants following completion of accelerated actions should be further evaluated (See Section 8.0).
- For sources and pollutants that have not been eliminated from further consideration, if further analyses (see Section 8.0) indicate that future airborne concentrations outside of the RFETS (future) fenced property boundary would approach any regulatory limit or appropriate regulatory guideline level, then the nature and extent of this future air contamination should be considered in determining final remedy alternatives and additional mitigation may be warranted.

6.3.1.6 Step 6: Specify Tolerable Limits on Decision Errors

Decision errors represent the acceptable degree of uncertainty based on the consequences of making an incorrect decision. Decision errors can be evaluated through the use of a formal statistical procedure, known as hypothesis testing. Formal statistical approaches typically express numerically as probabilities the potential error in decision making. Because a formal statistical hypothesis cannot be applied to define extent of contamination decisions, decision errors have been controlled using other methods, as described below.

Although the possibility of decision errors cannot be eliminated, they can be minimized by increasing the number of samples collected and ensuring that methods used to evaluate data are suitably appropriate and conservative.

The decisions listed above rely on information concerning historical sources of air contamination and their fate, past monitoring data, and, in some cases, computer modeling of airborne emissions and their behavior in the RFETS environment. With respect to ambient concentrations of radionuclides in air, monitoring has been conducted at the site continuously since 1971, resulting in a robust data set that is adequate to define expected levels of airborne radionuclides in the RFETS environment. IA radionuclide monitoring was also conducted around demolition and ER projects that had the potential to generate substantial airborne emissions of radionuclides. Data collected since the mid-1990s have been governed by Quality Assurance Project Plans/Sampling and Analysis Plans (QAPPs/SAPs) and/or a Quality Assurance (QA) Plan that met the requirements of 40 CFR 61, Method 114. DQOs appropriate to these data collection programs were detailed in the latest revision of the RFETS Integrated Monitoring Plan (IMP) (K-H 2005).

Similarly, CDPHE monitored both radionuclide and VOC concentrations at RFETS for many years, again resulting in an extensive database of information regarding expected airborne concentrations. DQOs appropriate to CDPHE data collection are also detailed in the most recent and prior versions of the RFETS IMP (see, for example, K-H 2005). Targeted data collection of IA VOC concentrations collected in the mid-1990s supplemented the CDPHE data.

For beryllium, activities expected to generate emissions were monitored (that is, demolition of certain buildings) and showed no elevated emissions that would result in ongoing contamination. Again, the monitoring efforts were governed by a QAPP/SAP (URS 2001).

Landfill emissions and wind erosion of surface soils contaminated by radionuclides were evaluated using computer models. The models used were developed by EPA and are approved for modeling these types of sources and emissions. Conservative assumptions were applied to each modeling analysis. (The assumptions and methods used to model emissions of windblown radioactive dust are detailed in Section 8.0.)

6.3.1.7 Step 7: Optimize the Design

This step of the DQO process has been omitted because existing data collected at RFETS are used in this analysis and a sampling program is not being developed.

6.3.2 Data Adequacy and Data Quality

Data adequacy and quality have been reviewed for the RFETS radionuclide and beryllium monitoring and this discussion is contained in Attachment 1 to this section. Other data used to determine analytes of interest (AOIs) for air were derived from published sources and the data adequacy/quality of those investigations is not reviewed here. Attachment 2 to this section contains the RFETS data used to determine the nature and extent of air contamination.

6.4 Identification of Ongoing Air Contaminant Emission Sources

This section discusses the air pollutant sources that have historically operated at RFETS and the pollutants that have been emitted. The information provided serves as a screening process to determine which sources and analytes, if any, should be evaluated further to quantify their nature and extent following completion of accelerated actions.

6.4.1 Radionuclide Sources

Radionuclide emissions to air have historically included releases from radionuclide processing and waste handling, emitted through building stacks and vents; releases caused by mechanical disturbance of contaminated soil or debris during project activities, including ER and decommissioning projects; and resuspension of contaminated surface soil by wind. Plutonium-239/240 and americium-241 were deposited on surface soil at RFETS by waste management practices (for example, release from stored waste at the 903 Pad) or by emissions from building stacks and vents (from accidental releases caused by building fires, as well as routine emissions). Wind or mechanical disturbance of the contaminated soil resulted in radionuclide-laden soil particles becoming airborne. These suspended particles were transported some distance downwind before being redeposited on the ground or in water by a variety of mechanisms that remove particles from the air, such as rainout or dry deposition. Concentrations of plutonium and americium in surface soil are low, with the aerial extent of surface contamination extending generally from the IA in decreasing concentrations eastward. Uranium contamination in surface soil is also present, however, unlike plutonium and americium, it is not widespread and exists in small, localized areas (see Section 3.0, Nature and Extent of Soil Contamination).

A large-scale, continuous environmental air monitoring program for radionuclides has been conducted at RFETS since 1971. The program was designed to quantify potential public exposure to radionuclides as a result of RFETS activities, and to determine compliance with applicable regulatory limits. It included two distinct tasks: effluent monitoring, accomplished through the continuous extraction of entrained PM from exhaust ducts of buildings with significant potential to release radionuclides; and ambient monitoring, accomplished through the continuous collection of airborne PM at representative locations on and around RFETS. Limited effluent monitoring for tritium was also conducted for many years but was discontinued in November 2000 because no potential tritium sources remained at RFETS. Effluent monitoring was discontinued at all locations as the buildings where effluent monitoring was conducted were decommissioned and demolished. (RFETS ambient data used to determine the nature and extent of air contamination are included on a CD ROM as Attachment 2 to this section.)

Radionuclide emissions from RFETS were historically subject to 40 CFR Part 61, Subpart H, National Emission Standards for Emissions of Radionuclides Other than Radon From Department of Energy Facilities (CAQCC Regulation No. 8, Part A, Subpart H) (EPA 1989). From 1998 through physical completion in October 2005, 14 ambient air samplers located around the RFETS perimeter were used to demonstrate compliance with the emission limits of 40 CFR 61, Subpart H. Filters were exchanged monthly and analyzed for the plutonium, americium, and uranium isotopes of interest. The maximum measured monthly off-site dose rates for 1999 through 2004, presented as a percentage of the 10-millirem (mrem) annual dose limit in 40 CFR 61, Subpart H, are shown on Figure 6.1 (see also Attachment 2). On an annual basis, maximum measured radionuclide concentrations, including uranium isotopes that are largely naturally occurring in the environment, totaled less than 3 percent of the annual dose limit between 1998 and 2004. (Maximum 2005 concentrations from monitoring conducted until physical completion in October 2005 also totaled less than 3 percent of the annual dose limit.) Cleanup of surface soil contamination and completion of radionuclide processing, waste handling, and decommissioning has lessened this dose potential even more (DOE 1999, 2000, 2001, 2002a, 2003, 2004a).

Although the off-site dose rate shown on Figure 6.1 is highest in year 2003, while substantial cleanup efforts were occurring at RFETS, the elevated dose does not appear to be related to RFETS activities. Instead, the sampler at which the elevated dose rate occurred is located north of the site, adjacent to a dirt road that saw increased levels of traffic due to residential and commercial development in the area. The traffic stirred up dust containing naturally occurring uranium isotopes, which drove up ambient concentrations measured by the sampling device. (Note that the maximum off-site dose rate for 2005 was comparable to that measured in 2003 but may have included a greater contribution from RFETS activities, because several building demolitions, as well as final site grading, occurred during this period, with attendant fugitive dust emissions.)

Ambient samplers were also used to monitor fugitive radionuclide emissions from decommissioning, demolition, and ER activities. In addition to the perimeter compliance demonstration network, for many years RFETS operated an internal network of samplers in and around the IA during project activities that could result in radionuclide emissions (see RFETS Quarterly Environmental Monitoring Reports for October-December 2001 and later for project monitoring results; for example, DOE 2002b). The measurements indicate that RFETS has remained in compliance with all regulatory requirements even during periods of substantial decommissioning and ER activities. For example, an approximate 7-year record of radionuclide concentrations (1997 through 2003) at a sampler located downwind of the 903 Pad shows annual average dose rates three orders of magnitude below the 40 CFR 61, Subpart H 10-mrem benchmark, with peak monthly dose rates two orders of magnitude below the 10-mrem level, even though this standard only applied beyond the RFETS fenceline, 2 to 3 kilometers (km) beyond this sampling location (see data for sampler S-107 in Attachment 2 to this section). Both off-site and on-site measurements have been reported at quarterly data exchange meetings with EPA and CDPHE staff and representatives from surrounding municipalities. These results are documented in the RFETS Quarterly Environmental Monitoring Reports (for example, DOE 2004b).

6.4.2 Landfill Sources

Both the Present Landfill and Original Landfill represent potential sources of VOC and HAP emissions primarily due to the decomposition of buried, decomposable waste. Decomposition of waste, along with possible volatilization of certain constituents and/or chemical reactions within the waste, generates landfill gas (LFG). Methane and carbon dioxide (CO_2) are the primary constituents of LFG, and are produced by microorganisms within the landfill under anaerobic conditions. LFG generation proceeds through several phases as the waste "ages," and the gas composition changes with each phase. Typically, LFG also contains a small amount of nonmethane organic compounds (NMOCs). NMOCs can contain various HAPs, greenhouse gases, and compounds associated with stratospheric ozone depletion. The NMOC fraction also contains VOCs. Maximum VOC and HAP emission potential occurs at the time waste is last placed in a landfill and shortly thereafter; emissions from waste decomposition decrease with time as the waste decays.

6.4.2.1 Present Landfill

The Present Landfill is located in the No Name Gulch drainage and occupies approximately 20 acres. It was placed into service in August 1968 for the disposal of solid wastes, including office trash, paper, rags, personal protective equipment (PPE), construction and demolition debris, scrap metal, empty waste containers, used filters, and electrical components. Although originally planned as a sanitary landfill, refuse disposed of also included materials containing polychlorinated biphenyls (PCBs) and asbestos; combustible materials contaminated with small amounts of beryllium; containers partially filled with paints, solvents, and foam polymers; Kimwipes and rags contaminated with organic compounds; metal cuttings and shavings (primarily stainless steel); tear gas powder; a tank containing Mercaptan™ (an odor additive to natural gas); a drum of solidified polystyrene resin; soil contaminated with approximately 700 gallons of diesel fuel; wood contaminated with chromium and aluminum oxide; and unknown chemicals and reactive chemical residues. Wastes with hazardous constituents ceased to be disposed of in the landfill by fall 1986. Sludge from the sanitary waste treatment plant was routinely disposed of at the Present Landfill from August 1968 through May 1970, and may have contained low levels of plutonium and depleted uranium (DOE 2004c).

Wastes delivered to the landfill were spread across the work area, compacted, and covered with a daily soil cover. From 1968 to 1978, the landfill received approximately 20 cubic yards (cy) of compacted waste per day. The Present Landfill remained in operation until March 1998, at which time it was placed in a contingent closure status and seeded to stabilize soil and control erosion. The volume of material in the landfill at the time it became inactive was estimated at 415,000 cy, including any daily soil cover incorporated as the waste was placed (DOE 2004c).

A RFCA accelerated action at the Present Landfill to install a landfill cover was completed in 2005. Barometric gas vents were placed into the landfill prior to placement of the final cover to allow pressure equalization (DOE 2004c). These vents represent a preferred pathway for LFG migration to the atmosphere. The rate of gas generation and release is a function of the waste composition in the landfill, waste volume, and age of the landfill.

In 2002, EPA's Landfill Emissions Model Version 2.0 (LANDGEM) was used to calculate total landfill gas emissions. Model results indicated relatively low rates of LFG generation, with the majority (approximately 80 percent) of methane and total LFG production occurring by 2025, and almost all potential production occurring by 2075 (K-H 2002). Gas generation calculations were revised for this section assuming a more appropriate arid area methane rate constant than was used in the 2002 modeling (see Attachment 2). The model-estimated peak year LFG generation rate (1998) was approximately 288,200 cubic meters per year (m^3/yr) (19.5 cubic feet per minute [cfm]).

LANDGEM was also used to estimate emissions of NMOCs. The calculation assumed a conservative default NMOC concentration in the landfill gas from EPA's Compilation of Air Pollutant Emission Factors (AP-42) (EPA 1995). Peak year (1998) NMOC emissions were estimated at approximately 2.5 megagrams per year (Mg/yr) (approximately 2.8 tons per year). Note that emissions of LFG are not the target of regulation under the federal Clean Air Act (CAA) because the principal components, methane and CO_2, are neither toxic nor precursors to other regulated pollutants, such as ozone or PM_{10}. CAA regulations instead focus on controlling or limiting emissions of certain trace components of LFG, such as NMOCs, that may include toxic contaminants or promote secondary pollutant formation.

Municipal solid waste landfill air emissions are regulated under 40 CFR 60, Subparts WWW and Cc (New Source Performance Standards and Emission Guidelines, respectively) (EPA 1996a, 1996b). These regulations apply to new landfills (Subpart WWW) and existing landfills (Subpart Cc). The applicability of these standards to the Present Landfill was evaluated in 1997 when these regulations became effective. Subpart Cc, which would apply to existing units such as the Present Landfill, applies to municipal solid waste landfills constructed or modified before May 30, 1991, which have design capacities greater than or equal to 3.3 million cy. The maximum design capacity of the Present Landfill was determined to be 571,000 cy, well below the 3.3 million-cy threshold. CDPHE was notified of the nonapplicability of this regulation on July 10, 1997 (DOE 1997).

For perspective, Subparts WWW and Cc only require emission controls for landfills meeting the above criteria that also have NMOC emissions exceeding 50 Mg/yr. The calculated emission rate from the Present Landfill in 1998 was only 2.5 Mg/yr, far below the control threshold. Because the maximum VOC and HAP emission potential occurs at the time the waste is last placed into the landfill and shortly thereafter, emissions from waste decomposition decrease with time as the waste decays. Consequently, future emission rates will be even lower, supporting the contention that airborne emissions from the Present Landfill do not pose a threat to health or the environment.[1]

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[1] LFG was also evaluated in the Final Interim Measure/Interim Remedial Action (IM/IRA) for Individual Hazardous Substance Site (IHSS) 114 and Resource Conservation and Recovery Act (RCRA) Closure of the RFETS Present Landfill (DOE 2004c).

6.4.2.2 Original Landfill

Between 1952 and 1968, approximately 74,000 cy of solid sanitary waste and construction debris were placed in the Original Landfill. The landfill was not designed or operated as an engineered landfill. The waste material was covered with a soil layer after disposal operations ceased. Accurate and verifiable records of the waste placed in the landfill are not available; however, the types of waste that may have been placed in the landfill include relatively small quantities of organic compounds, paint and paint thinner, oil, pesticides, and cleaners, as well as municipal-type solid waste.

Organic compounds commonly used from 1952 to 1968 may have included trichloroethene, carbon tetrachloride, tetrachloroethene, petroleum distillates, 1,1,1-trichloroethane, dichloromethane, and benzene. In the 1960s, the landfill may have received PCB wastes such as carbonless copy paper, transformer and vacuum pump cleanup paper and rags, small capacitors, and fluorescent light bulbs. Metals such as beryllium, lead, and chromium may also have been placed in the landfill (DOE 2005).

Activities listed for the landfill in October 1954 included its use as a burn pit for the Plant (EG&G 1992). Ash from the Plant incinerator, graphite, used caustic drums, and general trash may have been dumped in the burn pit; however, no records of waste types have been found. In 1995, geotechnical investigations were conducted at the Original Landfill and the fill material encountered was described, including sheet metal, wood, broken glass, plastic, rubber, metal shavings, graphite sand, solid blocks of graphite, concrete, asphalt, and portions of 55-gallon steel drums. Street cleaning wastes were also apparently dumped at the Original Landfill area (DOE 2005).

There is no information indicating that the Original Landfill was used for routine disposal of radioactive material or other hazardous substance waste streams. During the period of operation of the Original Landfill, several other areas within RFETS were used for the management and disposal of hazardous Plant wastes, including radioactive waste. Various controls and practices were used to segregate and manage radioactive wastes separately from Plant sanitary waste and construction debris (DOE 2005).

EPA’s Compilation of Air Pollutant Emission Factors (AP-42) (EPA 1995) describes methods to calculate methane and NMOC emissions from landfills using a theoretical first-order kinetic model of methane production developed by EPA (the same methodology employed by the LANDGEM model discussed above). Using 74,000 cy of waste, arid area default values for methane generation potential and methane generation rate constant, and assuming co-disposal of hazardous wastes (worst-case assumption), the equations yield an estimated LFG production/emission rate of 14 cfm for 1968. NMOC emissions of 4 Mg/yr were estimated for the same time period (see Attachment 2 to this section).

These emissions probably represent substantial overestimates because much of the disposed material was not organic (that is, would not generate LFG) and hazardous wastes were not routinely disposed of in the Original Landfill. The Operable Unit (OU) 5 Phase I Resource Conservation and Recovery Act (RCRA) Facility

Investigation/Remedial Investigation (RFI/RI) concluded that the Original Landfill does not generate hazardous concentrations of LFG, thus no gas collection or treatment action is required (DOE 2005). As with the Present Landfill, the Original Landfill is not subject to 40 CFR 60, Subpart Cc, because its design capacity is below the threshold level of 3.3 million cy. The estimated peak year NMOC emission rate (less than 4 Mg/yr) is also well below the control threshold (50 Mg/yr). As stated earlier, because the maximum VOC and HAP emission potential occurs at the time the waste is last placed into the landfill and shortly thereafter, emissions from waste decomposition decreases with time as the waste decays. Consequently, current and future methane and NMOC emissions will be less than those that occurred at the cessation of routine disposal operations in 1968. Thus, airborne emissions from the Original Landfill do not pose a risk to health or the environment.[2]

6.4.3 Subsurface Volatile Organic Compound Sources

VOCs such as carbon tetrachloride and 1,1,1-trichloroethane were used at RFETS as solvents, cleaning agents, and so forth, in support of weapons component manufacturing. Their use, storage, handling, and disposal at RFETS created some areas of known VOC contamination in soil. Areas of VOC-contaminated soil have been addressed through RFCA accelerated actions or, after evaluation in accordance with RFCA, determined to qualify for No Further Accelerated Action (NFAA).

A study of ambient airborne VOC concentrations in the IA was undertaken in June 1995 and completed in August 1996. Details of the study design can be found in the Final Interim Measure/Interim Remedial Action (IM/IRA) Implementation Plan for the Rocky Flats IA (DOE 1995). Study results can be found in the Annual Report, IM/IRA for the Rocky Flats IA (RMRS and K-H 1997). The airborne VOC data were evaluated to determine whether there may be evidence that unidentified VOC contamination exists as a potential source of airborne VOC emissions. The study tested for 31 different hydrocarbons known or believed to exist at RFETS. Of these, eight compounds were detected; one of these, acetone, is neither a HAP nor a VOC, and has no significance from an air quality perspective. The data from this study are considered a conservative snapshot of RFETS's VOC emissions potential for the following reasons:

- They were collected at a time when RFETS still maintained an inventory of VOC-containing solvents, cleaners, and so forth, which have since been removed.
- Less soil remediation had been completed than is currently the case.
- It is expected that a greater mass of VOC soil contamination existed at the time (that is, some amount has volatilized since then), resulting in a higher emissions potential than at present.

For comparison, ambient air concentration data for VOC HAPs were obtained for nearby sampling locations. Table 6.2 presents the results of this data assembly. The 1998

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[2] LFG was also evaluated in the Final IM/IRA for IHSS Group SW-2, IHSS 115, Original Landfill and IHSS 196, Filter Backwash Pond (DOE 2005).

CDPHE ambient average data are from five samplers located around the perimeter of RFETS (designated X-1, X-2, X-3, X-4, and X-5). The sampler locations are shown on Figure 6.2.

QA samples included as part of the study indicated that cross-contamination or insufficient cleaning of some of the sample canisters may have contributed to elevated results for acetone, toluene, and 1,1,1-trichloroethane throughout the project (RMRS and K-H 1997). Also, several of the detected compounds, including benzene, toluene, and xylene, are common constituents of automobile exhaust and are often present at detectable concentrations throughout the Denver airshed (CDPHE 2004). Finally, it should be noted that there was a known carbon tetrachloride source at RFETS that had not been remediated at the time of the study, but was remediated in 2004.

Table 6.2 also lists available toxicological benchmark levels, as well as background levels for pollutants included in EPA’s 1996 National-scale Air Toxics Assessment (NATA) (EPA 2004). Average VOC HAP concentrations measured in the IA study were below detection levels for all compounds; therefore, no average concentrations are shown in Table 6.2. The maximum values from the RFETS study are 24-hour averages and are best compared to the short-term (acute) toxicological reference levels shown. Annual average concentrations from the CDPHE samplers located at the site perimeter may be compared with the chronic benchmarks to indicate the significance of VOC HAPs to which the general public may be exposed (including any RFETS-derived HAPs and HAPs from other regional sources).

Several conclusions can be drawn from the data. (Note that this discussion excludes acetone, because it is neither a HAP nor a VOC.) First, the RFETS data, consisting largely of nondetects, reveal no significant persistent sources of VOC HAP emissions in the IA at the time of the study. Maximum 24-hour concentrations measured were orders of magnitude below any of the short-term toxicological benchmark levels and no adverse short-term health effects would be expected at these levels.

Second, the longer-term CDPHE data show VOC HAP concentrations due to all sources at the RFETS perimeter close to or below background levels for pollutants included in the NATA study. EPA defines “background” levels as contributions resulting from natural sources, persistence in the environment of past years’ emissions, and long-range transport from distant sources. In other words, background concentrations represent levels of pollution expected even if there had been no recent manmade emissions (EPA 2004). Where applicable, measured HAP concentrations at the RFETS perimeter were also well below chronic inhalation effect levels published by various sources. CDPHE ceased sampling for VOCs at the RFETS perimeter in July 2001, citing low measured levels of contaminants and noting that the VOCs that were measured “appear to be mainly motor vehicle emissions, rather than Rocky Flats plant emissions” (CDPHE 2001).

Based on the available ambient air monitoring data and the current knowledge of VOC contamination that remains at RFETS, no significant sources of VOC emissions remain following completion of accelerated actions.

6.4.4 Beryllium

The health effects of beryllium exposure in sensitive individuals have been well documented and the DOE Chronic Beryllium Disease Prevention Program rule, 10 CFR 850, establishes beryllium exposure limits and other requirements for RFETS workers. Beryllium is a HAP and EPA has promulgated beryllium emission limits for certain beryllium industry categories in 40 CFR 61, Subpart C. Unlike certain radioactive materials at RFETS, however, beryllium contamination was largely confined to building and equipment surfaces in areas where beryllium was processed, stored, or used and where beryllium-contaminated waste was managed. Soil and other environmental media at RFETS do not show significant levels or aerial extent of beryllium contamination; therefore, with the completion of accelerated actions, no significant source of airborne beryllium emissions exists. It is important to note, however, that regional soils contain small amounts of naturally occurring beryllium, which will continue to be suspended in dust following closure.

DOE implemented project monitoring for beryllium in ambient air during decommissioning and demolition of facilities with a history of significant beryllium operations at RFETS (that is, former Buildings 444/447, 865, and 883). The scope of project monitoring is described in the IMP Background Document (DOE et al. 1997) and the Final SAP for Quantification and Characterization of Potential Beryllium Release to the Ambient Air During Building Demolition at RFETS (URS 2001). Ambient monitoring performed around two demolition operations (former Buildings 111 and 865) serves to quantify expected levels of airborne beryllium during and following accelerated actions. (Beryllium monitoring data are contained in the RFETS monitoring data included in Attachment 2.)

Building 111 was demolished during November and December 2001. The former building was not contaminated with beryllium; rather, the demolition provided an opportunity to establish “baseline” levels of beryllium in RFETS air. (As noted above, beryllium occurs naturally in the RFETS environment in small amounts.) Beryllium concentrations were measured using six ambient air samplers placed in a circular fashion around Building 111, as close as possible to the demolition considering neighboring buildings and roads. Beryllium samplers ran 8 to 10 hours per day during project activity, with the filters exchanged and analyzed daily. The results were statistically distinguishable from zero and from the minimum detectable level, demonstrating that the sampling and analysis protocols were adequate to reliably quantify beryllium in ambient air at and below concentrations of interest.

The mean beryllium concentration for all six locations (30-day average) was 1.7×10^{-5} micrograms per cubic meter ($\mu g/m^3$). An appropriate benchmark for comparison is contained in the National Emission Standard for Beryllium (40 CFR 61, Subpart C), which limits ambient beryllium concentrations in the vicinity of a source subject to the standard to 1.0×10^{-2} $\mu g/m^3$ as a 30-day average (EPA 1973). (Note that no RFETS sources existing at the time of this monitoring study, including building demolition, were subject to this regulation because the regulation only applies to certain specific source types. The concentration limit, however, provides an appropriate benchmark concentration for comparison because it has been established by EPA at levels designed to protect public health.) Measured concentrations around the Building 111 demolition indicated a qualitative correlation to the dustiness of the air around the project and to stronger winds, with environmental beryllium being detected even prior to demolition activity. The resulting baseline concentrations established by this monitoring program are likely to be representative of airborne beryllium concentrations following completion of accelerated actions.

Beryllium monitoring was also performed during demolition of Building 865 and during removal of the slab. Former Building 865 was part of the RFETS research and development program. The building housed metalworking equipment for the study of nonplutonium metals and the development of alloys and prototype hardware. Operations included metalworking, machining, and metallurgical laboratory operations. Beryllium contamination occurred from operations involving mixing beryllium powders with other metals and compressing them into shapes, casting and heat-treating furnaces, and beryllium electrorefining.

A six-sampler network was employed to measure ambient airborne beryllium concentrations during Building 865 demolition and slab removal between July 21, 2003, and December 12, 2003. The sampling schedule included a baseline sampling period prior to the start of demolition, a brief pause between building demolition and slab removal, and baseline confirmation sampling following completion of slab removal. Some results greater than the predemolition baseline were observed; however, no results approached or exceeded the EPA benchmark concentration of 1.0×10^{-2} $\mu g/m^3$ 30-day average. These results confirmed that project controls were effective in minimizing the migration of beryllium contamination from the building and slab removal. The mean airborne beryllium concentration measured over the project was 1.2×10^{-4} $\mu g/m^3$, with a maximum measured concentration of 3.7×10^{-3} $\mu g/m^3$. Measured concentrations were consistently an order of magnitude lower than the 40 CFR 61, Subpart C benchmark, indicating beryllium in air will not be a concern following completion of all building demolitions and accelerated actions.

6.4.5 Other Contaminants

A variety of other air pollutants and emission sources at RFETS were historically subject to federal and state regulations. Regulated sources included the steam plant boilers; diesel-, gasoline-, and natural gas-fired equipment such as generators and compressors; vehicle refueling operations; sanitary landfill construction and operation; paint spray booths; sanitary waste filter press; the former Building 776 Supercompactor; the former Building 374 Spray Dryer; aggregate storage piles; tanks containing volatile substances; open burning activities; ODS releases from refrigerant leaks and maintenance operations; and fugitive dust emissions from earthmoving activities and other mechanical disturbances. In addition, asbestos demolition activities were subject to regulation under 40 CFR 61, Subpart M (National Emission Standard for Asbestos; Colorado Regulation No. 8, Part B).

In addition to radionuclides, airborne emissions of ODS, asbestos, CO, nitrogen oxides (NO_x), SO_2, VOCs, and PM_{10} have been regulated at RFETS. Maximum potential RFETS emissions of other pollutants, such as a number of CAA HAPs and Colorado "noncriteria reportable" pollutants, were historically emitted in such small amounts that specific regulatory requirements were not triggered.

Regulatory requirements applicable to RFETS emission sources included submitting Air Pollutant Emission Notices (APENs) for new emission units or activities with emissions above a reporting threshold; obtaining construction permits for nonexempt new or modified activities; and obtaining a sitewide Title V operating permit. An operating permit is required for all sources with potential emissions above certain thresholds. At RFETS, potential emissions of NO_x, primarily from the steam plant boilers and diesel-fired equipment, exceeded 100 tons per year, the applicable operating permit threshold, at the time that operating permit applications were due in 1996. The RFETS Title V operating permit (received July 1, 2002) was revised as decommissioning proceeded and sources of regulated emissions were removed from the site. The permit was retained as long as the aggregate potential NO_x emissions from diesel-fired equipment exceeded the 100-ton-per-year threshold. With completion of accelerated actions, activities covered by APENs and permits have been removed or shut down, and the APENs and permits have been cancelled. No sources remain that require APENs or permits.

6.5 Nature and Extent of Air Contamination

With the completion of accelerated actions under RFCA, sources of ongoing emissions to air include the following:

- Volatilization/release of VOCs from residual subsurface contamination and the closed landfills; and
- Resuspension of residual radioactive contaminants attached to surface soil particles.

However, as described in the site background discussion (Section 1.0), sources of VOC and radionuclide contamination were removed during accelerated actions conducted pursuant to RFCA. Former processing and waste storage buildings have been decommissioned, decontaminated, and demolished. Soils have been evaluated in accordance with RFCA. Based on the available ambient air monitoring data and the current knowledge of VOC contamination that remains at RFETS, no significant sources of VOC emissions remain following completion of accelerated actions and VOC emissions present no health or environmental concerns at present and future levels in ambient air.

Because the maximum VOC and HAP emission potential occurs at the time the waste is last placed into a landfill and shortly thereafter, emissions from waste decomposition decrease with time as the waste decays. Consequently, future VOC and HAP emission rates from the landfills will be even lower than those evaluated in Section 6.4, supporting the contention that airborne emissions from the Present Landfill and Original Landfill do not pose a threat to health or the environment.

Airborne radionuclide contamination following completion of accelerated actions is primarily caused by resuspended plutonium or americium in surface soil, because these substances were dispersed on and off RFETS by wind. The screening process carried out in this section identified only resuspended plutonium-239/240, americium-241, uranium-233/234, uranium-235, and uranium-238 from surface soils as air AOIs worth quantifying further, primarily because their long radioactive half-lives means they will persist in the environment and, therefore, represent an ongoing source of potential emissions in the future.

The diffuse, remnant contamination in surface soil will continue to result in small amounts of radionuclide particles in air due to the ongoing resuspension and movement of soil (fugitive dust) by wind, such as occurs on all open lands along the Front Range of Colorado. The remaining areas of plutonium, americium, and uranium contamination above background levels are described in more detail in Section 3.0, Nature and Extent of Soil Contamination. Ongoing emissions of plutonium, americium, and uranium from the remaining areas with actinide contamination above background levels are further evaluated in Section 8.0 of this report to quantify airborne concentrations.

6.6 References

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TABLES

Table 6.1
Summary of Air Emissions Sources of Historical Interest and Current Status

Historic Source of Airborne Emissions	Primary Pollutants Emitted	Nature of Emissions	Status/Conclusions	Ongoing Emission Source?
Radionuclide processing/operations and waste handling/storage	Plutonium, Americium, Uranium	Point source emissions from stacks and vents	No potential sources remain following completion of accelerated actions	No
Radionuclide surface soil contamination (resuspension by wind)	Plutonium, Americium, Uranium	Fugitive emissions	Minor continuing emissions from residual soil contamination below RSALs	Yes
Tritium	Tritium	Primarily point source emissions from stacks and vents	No potential sources remain (since at least 2000)	No
Beryllium processing/operations and waste handling/storage	Beryllium	Point source emissions from stacks and vents	No potential sources remain following completion of accelerated actions	No
Environmental restoration	Plutonium, Americium, Uranium VOCs PM/PM_{10} CO, NO_x, SO_2, VOCs, PM_{10} (from construction equipment and traffic)	Fugitive and tailpipe emissions	No potential sources remain following completion of accelerated actions	No
Decommissioning/building demolition	Plutonium, Americium, Uranium PM/PM_{10} CO, NO_x, SO_2, VOCs, PM_{10} (from construction equipment and traffic)	Fugitive and tailpipe emissions	No potential sources remain following completion of accelerated actions	No
Landfills	VOCs, HAPs LFG (methane and CO_2)	Fugitive emissions	Minor continuing emissions below regulated levels	Yes

Table 6.1
Summary of Air Emissions Sources of Historical Interest and Current Status

Historic Source of Airborne Emissions	Primary Pollutants Emitted	Nature of Emissions	Status/Conclusions	Ongoing Emission Source?
VOC soil contamination	VOCs, HAPs	Fugitive emissions	Minor continuing emissions from residual contamination below ALs; past sampling during period of higher potential emissions shows ambient levels below levels of concern	Yes
Uncontaminated fugitive dust sources (traffic, soil disturbances, stockpiles, street sanding, and so forth)	PM/PM_{10}	Fugitive emissions	No potentially significant sources remain following completion of accelerated actions, assuming no significant soil disturbing activities in future	Possible at low level if soil is mechanically disturbed, or from vehicle operations
Fuel combustion, gasoline dispensing, paint spray booths, tanks, refrigerant leaks, open burning, and so forth	CO, NO_x, SO_2, PM_{10}, VOCs, HAPs, ODS	Both point source and fugitive emissions	No regulated sources/sources requiring permits or APENs remain following completion of accelerated actions	No

Notes:

APEN = Air Pollutant Emission Notice
CO = carbon monoxide
LFG = landfill gas
EPA = U.S. Environmental Protection Agency
NOx = nitrogen oxides
PM/PM_{10} = particulate matter/fine particulate matter
RSAL = Radionuclide Soil Action Level
AL = Action levels
CO_2 = carbon dioxide
HAP = hazardous air pollutant; as used here, includes Colorado noncriteria reportable pollutants
ODS = ozone-depleting substance
SO_2 = sulfur dioxide
VOC = volatile organic compound
U = uranium

Table 6.2
Results Summary – 1995-1996 RFETS Ambient HAP Sampling

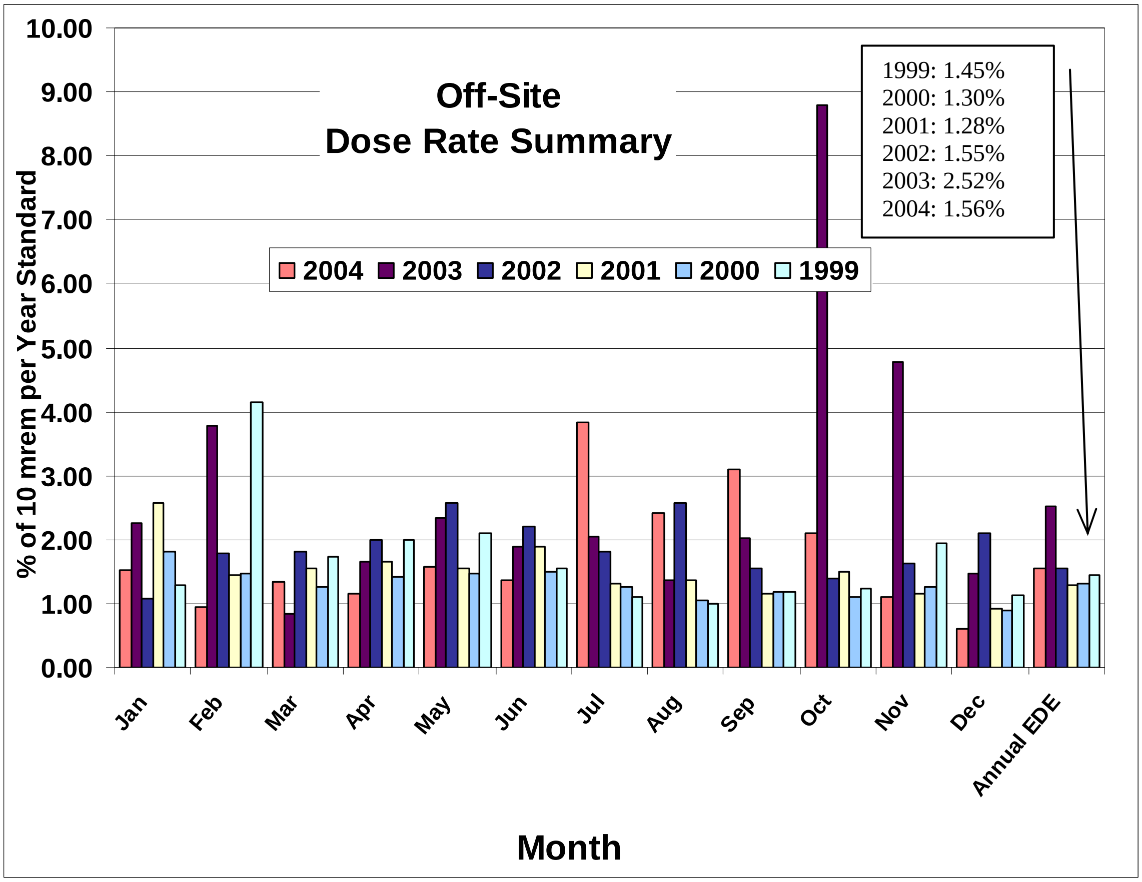
Compound	Sampler S-104 (ppb)	Sampler S-301, -302 (ppb)	Sampler S-008 (ppb)	Sampler S-205 (ppb)	Sampler S-116 (ppb)	Inhalation Short-Term Benchmark Concentration (ppb)	1998 CDPHE Annual Average Concentration (ppb)	Inhalation Long-Term Benchmark Concentration (ppb)
1,1,1-Trichloroethane	—	1/—	1/—	—	—	ATSDR MRL: 2,000 Cal REL: 12,500	0.06 ± 0.2	Cal REL: 183
1,1,2-Trichloroethane	—	1/—	1/—	—	—	ACGIH TLV: 10,000 OSHA PEL: 10,000	—	—
Carbon tetrachloride	2/—	—	2/—	—	—	ATSDR MRL: 200 Cal REL: 300	0.13 ± 0.04	ATSDR MRL: 30 Cal REL: 6.4 Background: 0.14
Methylene chloride	—	1/—	—	—	—	ATSDR MRL: 600 Cal REL: 4,000	0.05 ± 0.13	ATSDR MRL: 300 Background: 0.04
Benzene	—	2/—	3/—	3/—	—	ATSDR MRL: 50 Cal REL: 400	0.18 ± 0.09	Chronic Inhalation RfC: 9.3 Background: 0.15
Toluene	—	4/—	3/—	5/—	—	ATSDR MRL: 1,000 Cal REL: 9,800	0.31 ± 0.18	ATSDR MRL: 80 Chronic Inhalation RfC: 105
Xylene (m,p)	—	—	1/—	—	—	ATSDR MRL: 1,000 Cal REL: 5,050	0.10 ± 0.08	ATSDR MRL: 100 Chronic Inhalation RfC: 22.7

Notes: "—" indicates a nondetect. For RFETS results, first value is maximum concentration, second value is average concentration (all below detection levels). Results based on 24-hour samples.
S-116 was the upwind (control) sampler for most of the 1-year study due to predominant wind directions.
CDPHE HAP samplers were installed at sampling locations X-1, X-2, X-3, X-4, and X-5 at the RFETS fenceline (Figure 6.2).
The Agency for Toxic Substances and Disease Registry (ATSDR) minimum risk levels (MRLs) are daily exposures for the specified duration that are likely to be without an appreciable risk of noncarcinogenic adverse effects. Short-term MRLs are for 1-14 days exposure; chronic MRLs are for > 365 days of exposure.
The California Environmental Protection Agency (Cal) reference exposure levels (RELs) are concentrations at which no health effects are anticipated.
MRLs and RELs are listed on EPA's Air Toxics Website at www.epa.gov/ttn/atw/toxsource/summary.html.
ACGIH TLV, OSHA PEL are 8-hour time-weighted average concentrations based on a normal workweek. ACGIH and OSHA benchmark concentrations are from ATSDR at www.atsdr.cdc.gov/mrls.html.
Chronic inhalation RfC, from EPA's Integrated Risk Information System (IRIS), gives effect levels for noncancer effects due to chronic exposure (see www.epa.gov/iris).
Background levels are from EPA's 1996 National-scale Air Toxics Assessment.
Long-term benchmark concentrations are converted to ppb, where necessary, from milligrams or micrograms per cubic meter at sea level pressure.

ACGIH = American Conference of Governmental Industrial Hygienists
OSHA = Occupational Safety and Health Administration
PEL = Permissible Exposure Level
ppb = parts per billion
RfC = Reference Concentration
TLV = Threshold Limit Value

FIGURES

Figure 6.1
Maximum Monthly Measured Off-Site Dose Rates for 1999-2004



EDE = effective dose equivalent

Note: “Off Site” refers to locations outside current RFETS property fenceline.

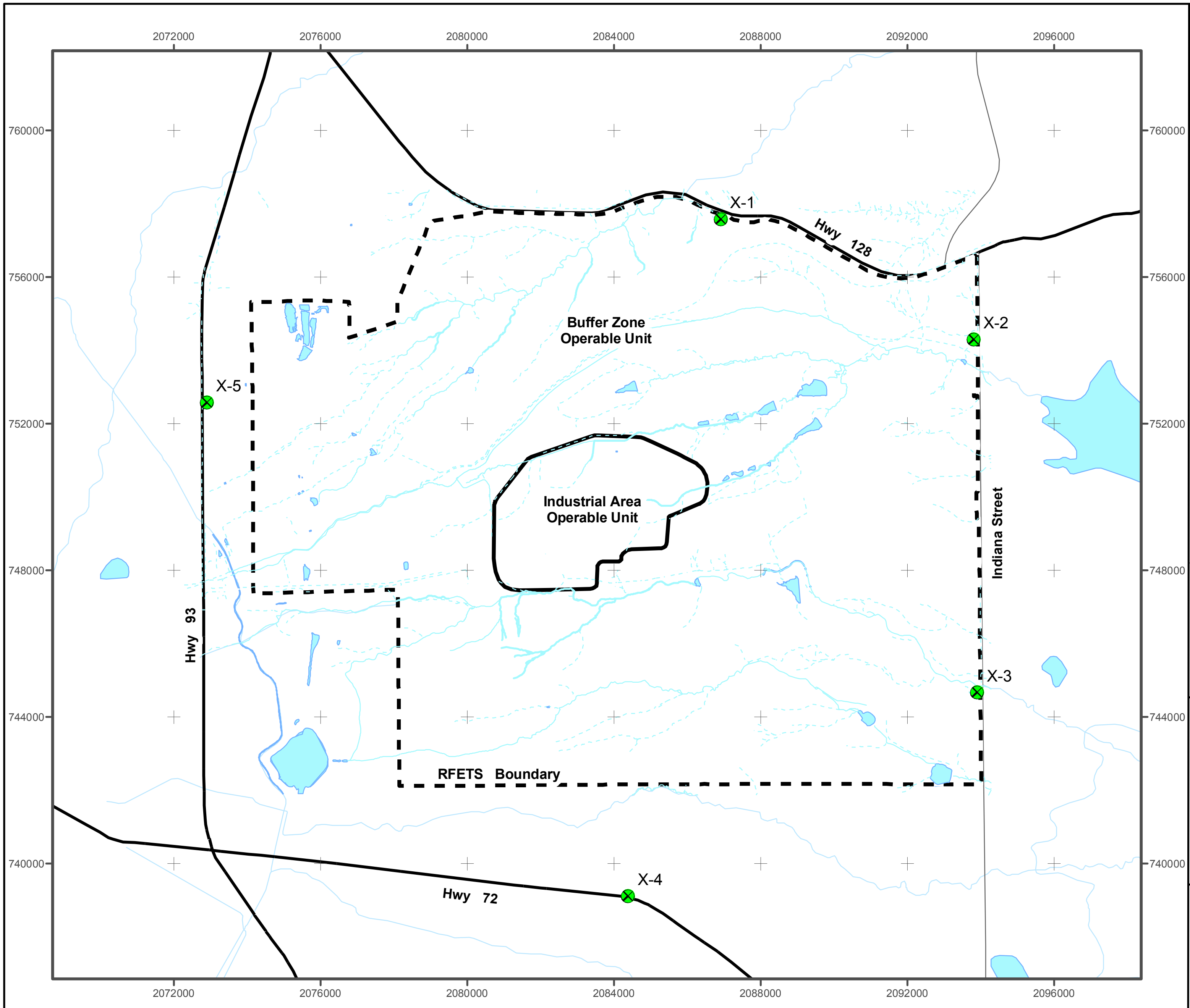


Figure 6.2
CDPHE Volatile Organic Compound Sampling Locations

KEY

⊗	CDPHE sampling station
—	Major roads

Standard Map Features

▭	IA OU boundary
🟦	Pond
▬ ▬	Site boundary
—	Perennial stream
—	Intermittent stream
- - -	Ephemeral stream

N
W E
S

0 2,000 4,000
Feet

Scale 1:48,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

File: W:\Projects\FY2005\RIFS_Fig\Sec06\
ArcMap\Fig6_02CDPHE_SampleLocs.mxd

RCRA FACILITY INVESTIGATION – REMEDIAL INVESTIGATION/ CORRECTIVE MEASURES STUDY – FEASIBILITY STUDY REPORT

NATURE AND EXTENT OF AIR CONTAMINATION

SECTION 6.0: ATTACHMENT 2

CD ROM, Analytical Data Used for Nature and Extent of Air
June 2006