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RISK BASED END STATE VISION DOCUMENT
FOR THE
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

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TABLE OF CONTENTS

APPENDIX A: Figures

EXECUTIVE SUMMARY

This document provides a description of the Risk-Based End State vision for the Rocky Flats Environmental Technology Site (RFETS). It was prepared pursuant to U.S. Department of Energy (DOE) Policy 455.1, *Use of Risk-Based End States*, and subsequent DOE guidance.

This document discusses the history of RFETS, including important environmental incidents. Cleanup progress is discussed, as is the history of formulating a future use for the Site, and the regulatory basis for an integrated, risk-based cleanup. Environmental conditions and cleanup approaches for major media (air, surface water, groundwater, surface soils, and subsurface soils) are discussed, and brief end-state visions for each medium are presented. The report contains brief discussions of physical setting, ecology, land use, legal ownership, and regional demographics. Finally, the report contains hazard-specific discussions for surface water, groundwater, surface soils and subsurface soils, the latter concentrating on the Original Process Waste Line system.

In December 2001, President George W. Bush signed the Rocky Flats National Wildlife Refuge Act of 2001. The Refuge Act provided for permanent Federal ownership of Rocky Flats and the establishment of the Rocky Flats National Wildlife Refuge. The Act also provided for DOE retention of administrative jurisdiction over lands and facilities that are part of the remedy at Rocky Flats. The recent modifications to Attachment 5 of the Rocky Flats Cleanup Agreement recognize that a wildlife refuge is the reasonably foreseeable future land use for the Site.

1.0 INTRODUCTION

This document provides a description of the Risk-Based End State vision for the Rocky Flats Environmental Technology Site. DOE Policy 455.1, *Use of Risk-Based End States*, was issued in July 2003 as a follow-up to the U.S. Department of Energy's (DOE's) 2002 Top-to-Bottom Review. The intent of this policy is to ensure that DOE's nationwide cleanup effort is driven by clearly-defined, risk-based end states, especially for those sites that do not have cleanup plans in place. The DOE guidance document, *Guidance for Developing a Risk-Based, Site-Specific End State Vision*, was finalized in September 2003. This document is being prepared and submitted to DOE Headquarters in accordance with that guidance.

1.1 ORGANIZATION OF THE REPORT

This report is organized in accordance with the aforementioned DOE guidance on risk-based end state visions. The report discusses the history of the Rocky Flats Environmental Technology Site (RFETS), including environmental incidents that have resulted in cleanup at the Site. There is a section on the status of the cleanup in Section 1, which also includes a discussion of the history of future use discussions at RFETS, as well as the recent revisions to the Rocky Flats Cleanup Agreement (RFCA), which incorporate an integrated, risk-based approach to cleanup at Rocky Flats. The report includes a discussion of the physical setting and human and ecological land use, in Section 2. Section 3 of the report discusses, by environmental medium, the environmental conditions at RFETS, anticipated approaches to cleanup, and a brief end state vision summary for each environmental medium. Section 3 also discusses land use, legal ownership, and demographics. Section 4 contains individual, hazard-specific discussions.

1.2 SITE MISSION

Mission and Operational History - - For about forty years, the Rocky Flats Plant was a key component of the nation's nuclear weapons production program. Located about eighteen miles northwest of downtown Denver, the Plant was involved in the production of nuclear weapons parts from plutonium, uranium, beryllium and stainless steel (Figure 1.2.a). The Plant also performed a number of auxiliary functions, including: recovery and purification of waste radionuclides; production of nuclear weapons transports; and basic research into metallurgy, machining techniques, nondestructive testing, coatings, remote engineering, chemistry and physics.

The need for Rocky Flats was established in January 1950, when President Truman ordered the Atomic Energy Commission to begin work on the hydrogen bomb. The Dow Chemical Company was selected as the contractor to provide the plutonium components for the bomb, and in March 1951 the Rocky Flats Site was selected for the new plant. The site was selected for its climate, its proximity to a metropolitan area from which a large workforce could be drawn, and because the area was attractive enough to aid in the

recruitment of employees. Construction began that year, and the first weapons components were shipped by mid-1953.

By the end of the 1950's, many of the buildings that now (or did) dominate the scenery at Rocky Flats were in operation, including 111, 444, 771, 776/77, 881 and 991. Building 707, which would become the main production building for plutonium parts, went into service in 1970. Building 371, built for plutonium reprocessing operations, started operational testing in 1981. Building 460, which produced stainless steel weapons parts, went into service in 1985. The Plant quickly became a large, stable employer in the area. The numbers of employees working at Rocky Flats rose from 1,813 in 1959 to 5,243 in 1989. Rockwell International replaced Dow Chemical as the contractor in 1975.

Nuclear weapons production continued at Rocky Flats through the 1980's. In 1989, a series of events occurred that would interrupt and ultimately end production at the Plant. On June 6, 1989, Federal agents from the Federal Bureau of Investigation and the EPA executed a search warrant at the Plant, to investigate suspected violations of environmental laws. Later that year, DOE asked EG&G to replace Rockwell. Shortly after assuming control, EG&G issued a work stoppage to address safety concerns. That work stoppage evolved into an exhaustive effort to review and resume production operations, with substantial DOE oversight. However, when President George Bush, Sr. announced the cancellation of a submarine-based warhead program in January 1992, the need for production at Rocky Flats ended. The end of weapons manufacturing at Rocky Flats came in July 1994, when the last stainless steel parts were produced in Building 460.

In the mid-1990's the Rocky Flats mission changed from weapons production to Site cleanup and closure. Kaiser-Hill was named as the Site's Integrating and Management Contractor in April 1995. In July 1996, DOE, EPA and the State of Colorado signed the RFCA. Among other things, RFCA's Preamble contains a number of objectives for Site cleanup (based in part upon the recommendations of the citizen-based Future Site Use Working Group) and an overall schedule (albeit non-enforceable) for the completion of Site cleanup within 20-25 years (that is, 2016-2021). DOE and Kaiser-Hill are now working to a closure project baseline that calls for project completion by December 2006.

Environmental Incidents - - Over the course of fifty years, accidents and disposal practices have led to a number of environmental incidents at Rocky Flats. Some of the more noteworthy are described below.

- Building fires occurred on a number of occasions at Rocky Flats; of these, two are most notable. On September 11, 1957, a fire occurred in a glovebox in B771 in a plutonium fabrication line. The fire and subsequent control efforts resulted in the spread of contamination within the building and breached the filter plenums. The fire caused about $800,000 in damage. On May 11, 1969, a major fire occurred in gloveboxes in B776, started by the spontaneous ignition of plutonium, causing extensive building contamination and release of plutonium to the atmosphere. The fire caused $26.5 million in damage; it took over two years to complete decontamination efforts in the building. No

injuries occurred, but 33 employees were treated for contamination. The fire led to a number of follow-on actions including use of inert atmospheres in gloveboxes, upgrades to the retention pond system, and purchase (in 1974) of additional buffer zone property.

- Drum storage in the area known as the 903 Pad, located off the southeast corner of the Industrial Area, caused environmental contamination. The Plant stored drums containing radioactive waste on the Pad beginning at least in 1958, and possibly as early as 1955. The wastes contained various hazardous constituents, including beryllium, solvents and uranium, as well as waste oils containing plutonium. Leaking drums were discovered as early as 1959, when a rust inhibitor was added to the drum contents in an attempt to prevent further deterioration. The area was closed in April 1967 when a heavy rainstorm caused the release of more contamination from the drums. The drums were removed in 1968, by which time numerous drums were empty, their contents having leaked entirely. Plant personnel placed an asphalt pad over the area in November 1969, after first removing some of the most contaminated soil. The 1996 RCRA Facility Investigation/Remedial Investigation for Operable Unit 3 (Offsite Areas) concluded that the 903 Pad is the major source for plutonium releases to the environment from Rocky Flats operations. The 903 Pad is the subject of a removal action that is underway in 2003.
- The Plant used various disposal trenches and waste dumps during its early years. Many of these old disposal sites, such as the Mound, Trenches T-1, T-3, T-4, etc., are located just to the northeast of the 903 Pad near the old Inner East Gate, in the Mound-East Trenches Area. The various disposal areas were used from about 1954 to 1968. Many of the wastes disposed there originated from B444 or the 800 area buildings. Common contaminants included depleted uranium and solvents; uranium in drums excavated from Trench T-1 made it necessary to take precautions to prevent these drums from catching fire from spontaneous combustion. A number of these sites (the Mound Source Area and Trenches T-1, T-3 and T-4) were remediated in the late 1990's. The Plant's Original Landfill, used from 1952 to 1968, lies on the hillside south of B460, and extends down to near Woman Creek. The Original Landfill received various wastes, including contaminated incinerator ash. Uranium is believed to be among the contaminants in the Original Landfill.
- The Plant put wastewaters containing nitrates and radioactive contaminants (primarily uranium) in a series of solar evaporation ponds that were in use in various configurations since December 1953. The Solar Ponds were located in the northeast corner of the Industrial Area, and were lined with earth, clay, concrete, asphalt and other materials at one time or another. In 1961, results from monitoring wells showed high nitrate concentrations in groundwater around the ponds, and a french drain system to capture this groundwater was installed in the 1960's. This system was upgraded in 1981, to include a pump house to capture more of the contaminated water. The Solar Ponds are no longer in use, having been drained and the sludge removed from them in the 1980's and 1990's. The remedial actions at the Solar Ponds were completed late in 2002.

- Industrial accidents have caused environmental releases at Rocky Flats. Tritium escaped from the Plant in 1973; its source was tritium-contaminated parts that had been shipped to Rocky Flats. The tritium reached Great Western Reservoir, then the drinking water supply for the City of Broomfield. Unlike plutonium, americium and uranium isotopes, tritium does not remain in the environment for long periods of time. In February 1989, overflow of chromic acid from a plating bath tank in B444 eventually reached the sewage treatment plant and the pond system before being contained. After this incident, DOE signed a Federal Facility Compliance Agreement with EPA pursuant to the Clean Water Act, which led ultimately to substantial improvements to the sewage treatment plant. These improvements were intended to minimize the possibility of an industrial release to downstream surface water from Rocky Flats.

Some of these incidents, such as the 1973 tritium release, had only transitory effects. Others, however, such as releases from the 903 Pad, necessitate large cleanup efforts, and will likely ultimately affect site end state and DOE's long-term stewardship activities. Figure 1.2.b shows Individual Hazardous Substance Sites at Rocky Flats.

1.3 STATUS OF THE CLEANUP PROGRAM

Work at Rocky Flats is performed under a closure contract between the DOE and Kaiser-Hill, LLC (K-H). The scope of this contract generally includes items such as management and shipment of special nuclear materials, waste management and shipping, environmental restoration, decontamination and decommissioning of site buildings, and site management in general. The closure contract describes the most significant attributes of physical completion to be accomplished by K-H. The scope of physical completion includes, among other things:

1) All buildings are demolished, except continuing water treatment structures or other structures with a DOE declared continuing mission;
2) All IHSS's are dispositioned per RFCA;
3) All wastes are removed except for materials that can be left in place, recycled or used as fill materials;
4) Closure caps are used for the remediation of the two old landfills;
5) Building foundations, utilities or other remaining structures, paved roads and/or parking lots are covered by a minimum of three feet of fill after final grade;
6) Surface water on-site meets health-based standards; and,
7) Water leaving the Site meets water quality standards.

The target date for achieving physical completion under the closure contract is December 15, 2006, although both K-H and RFFO anticipate achieving physical completion in advance of that date.

The scope of the environmental restoration program is to characterize, evaluate and remediate (as necessary) Individual Hazardous Substance Sites (IHSS's), Under-Building Contamination (UBC) and groundwater plumes at Rocky Flats. Environmental restoration work is performed under the Rocky Flats Cleanup Agreement (RFCA) and other applicable requirements. RFCA is a Federal Facility Agreement and Consent Order

entered into between DOE, the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Health and Environment (CDPHE), under the authority of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Colorado Hazardous Waste Act. Environmental restoration projects at Rocky Flats are performed as accelerated actions. DOE and K-H are beginning work on a Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study, which will lead to a Proposed Plan and, ultimately, a Corrective Action Decision/Record of Decision for Rocky Flats.

As of October 1, 2003, 33% of the environmental restoration scope of work under the closure contract had been completed. Significant accomplishments to date include:

- Excavation and removal of several areas of subsurface contamination, including Trenches T-1, T-3, and T-4; the Mound and Ryan's Pit disposal areas; and numerous UBC areas;
- Removal of the Solar Ponds, along with regrading and revegetation of the area;
- Installation of three passive groundwater collection and treatment systems;
- Initiation of the removal of contaminated soil at the 903 Pad; and,
- Achieving 172 no further action determinations for IHSS's and other areas at Rocky Flats.

While specific decisions regarding individual accelerated actions have not been made at this time, the anticipated work scope remaining includes the following:

- Placing engineered covers on the Original and Present Landfills;
- Completion of surface soil excavation at the 903 Pad, the 903 Pad Lip Area, and the Americium Zone;
- Excavation of sediments in three detention ponds;
- Evaluation and remediation, as needed, of groundwater contamination in the Site's Industrial area;
- Characterization and remediation, as needed of remaining UBC areas; and,
- Characterization and remediation, as needed, of the Site's Original Process Waste Line system.

Finally, the environmental restoration work scope include the final Site contouring and revegetation, expected to be the last scheduled activity under the closure contract.

DOE, its regulators, and local stakeholders have been actively discussing post-closure land use at Rocky Flats since the early 1990's. In 1994, the Future Site Use Working Group, a citizen-based initiative, was convened to provide DOE with recommendations on cleanup and future land use. The Working Group released its report in June 1995, recommending, among other things:

> "The entire Site should be cleaned up to safe levels and should primarily be managed as a natural and cultural resource preserve for ecological and technical research and for public education and interpretation. The Industrial Area should be maintained as an employment center. The Site should be managed for visitor use related to these designated purposes."

The Preamble to RFCA (a non-enforceable part of the document), signed in July 1996 carries this sentiment forward, stating, "Cleanup decisions and activities are based on

open space and limited industrial uses…" The concept of reserving portions of the Rocky Flats Industrial Area for future industrial use was specifically examined by the Rocky Flats Industrial Area Transition Task Force, another citizen-based group that had DOE and K-H participation. In its report, released in August 1998, the Task Force recommended that "all facilities and infrastructure be decontaminated, demolished and removed as part of the Rocky Flats cleanup and closure project," although the Task Force left open the possibility of reconstructing industrial facilities at a later date.

In 2000, DOE designated 800 acres (later expanded to 1,700 acres) of the northwestern buffer zone as the Rock Creek Reserve, setting aside this area for management of its ecological resources. This designation was accompanied by signing an interagency agreement with the U.S. Fish and Wildlife Service (USFWS), giving them authority and funding to co-manage the property with DOE. In 2001, the USFWS produced the Rock Creek Integrated Management Plan. In December 2001, President George W. Bush signed the Rocky Flats National Wildlife Refuge Act of 2001. The Refuge Act provided for permanent Federal ownership of Rocky Flats and the establishment of the Rocky Flats National Wildlife Refuge. The Act also provided for DOE retention of administrative jurisdiction over lands and facilities that are part of the remedy at Rocky Flats.

The recent modifications to Attachment 5 of RFCA recognize that a wildlife refuge is the reasonably foreseeable future land use for the Site. The new radionuclide soil action levels (RSALs; the RSAL for plutonium is 50 picoCuries per gram [pCi/g]) and new action levels for other soil contaminants of concern were adopted based upon contamination levels that were calculated to pose a lifetime excess cancer risk of 1x10-5 to a wildlife refuge worker. This is the midpoint of the acceptable lifetime excess cancer risk range promulgated pursuant to CERCLA and complies with the anticipated relevant and appropriate requirements for radiation dose limits for a refuge worker as well as for a hypothetical rural resident.

The new RSALs and soil action levels were predicated upon the adoption of an integrated risk-based approach for surface and subsurface contamination. This approach requires removal of soils contaminated above the action levels to specified depths, and the application of a risk screen methodology to contaminated soils below that depth. The risk screen considers pathways of exposures that may pose a lifetime excess cancer risk of 1x10-5 or greater to a wildlife refuge worker. The RFCA Parties proposed that soils above the RSALs for plutonium and americium be removed down to three feet below the surface. Removal of soil between three and six feet below the surface was also proposed for plutonium concentrations above three nanoCuries per gram, depending upon the extent and volume of contamination. Soils exceeding other action levels would be removed down to a depth of six inches. Below these removal depths the risk screen is applied to determine if additional removal is warranted. The modifications to RFCA Attachment 5 also state that institutional controls will be used as appropriate to ensure protection of human health and the environment. The RFCA, as well as recent modifications to Attachments 5 and 14 (Attachment 14 refers to the Original Process Waste Lines), may be found at the Rocky Flats Field Office website, www.rfets.gov.

2.0 REGIONAL CONTEXT RISK BASED END STATE DESCRIPTION

2.1 PHYSICAL AND SURFACE INTERFACE

Rocky Flats is situated about two miles east of the Front Range of Colorado, on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Figure 2.1.a). Site elevation is about 6,000 feet. The climate is temperate and semi-arid, typical of Colorado's Front Range. Summer high temperatures are typically in the mid-80 degree Fahrenheit range, while wintertime highs are typically within the low 40-degree F range. Annual average precipitation is about 14.5 inches, with about half falling as rain and the remainder as snow. Precipitation is highest from April through June, with over forty per cent of the annual average precipitation falling during those months.

Nearly the entire Site is covered with unconsolidated surficial deposits, including Rocky Flats Alluvium along the tops of the pediments, including the IA; Valley Fill Alluvium along stream beds; colluvium along the margins of the creek floodplains; and artificial fill in some areas of the IA. These unconsolidated deposits transmit the vast majority of groundwater at the Site. Beneath the unconsolidated materials is bedrock from the Arapahoe Formation (composed primarily of claystones), which has a thickness of about 25 feet or less. This is underlain by the unweathered Laramie Formation, consisting of an upper, thick, claystone interval and a lower sandstone/claystone/coal interval. The Laramie Formation is 600 to 800 feet thick beneath the Site; its low permeability precludes the movement of shallow groundwater through the Laramie Formation into the regional Laramie-Fox Hills aquifer below. Because of the Site's geology and the dissected nature of its topography, shallow groundwater in the IA surfaces and leaves the Site via surface drainages.

Surface water at the Site travels generally from west to east, with three primary drainages traversing Rocky Flats (Figure 2.1.b). These are, from north to south: Rock Creek, which drains the undeveloped northwestern expanse of the Site; Walnut Creek, which drains the central part of the Site, including most of the IA; and Woman Creek, which drains the southern portion of the IA and the southern part of the RFETS Buffer Zone. These creeks are small, and are ephemeral or intermittent in nature, gaining or losing flows in response to precipitation. All of the drainages contain permanent, man-made ponds, most of which were constructed during the Rocky Flats weapons production years.

2.2 HUMAN AND ECOLOGICAL LAND USE

Rocky Flats lies approximately eighteen miles northwest of downtown Denver, Colorado (Figure 2.2.a). It occupies about 6,400 acres (roughly ten square miles), of which about 400 acres is a developed Industrial Area (IA), containing about 404 permanent structures, with the remainder being a largely undeveloped Buffer Zone. The majority of the Site lies within Jefferson County, Colorado, while a small portion of the northern part of the Site lies within Boulder County, Colorado. Rocky Flats is generally surrounded by

undeveloped open space, with some private, largely-undeveloped holdings on its western and southern borders (Figure 2.2.b). However, approximately 11,000 people live within four miles of the Site's boundaries; population densities are shown in Figure 2.2.c, and regional land use in Figure 2.2.d. Communities near Rocky Flats include the cities of Broomfield, Westminster, Arvada, Louisville, Superior and Boulder.

The Site's topography and proximity to the mountains supports a unique, diverse array of plant communities (Figure 2.2.e). Much of the Site is undisturbed prairie, including mesic mixed grasslands in the eastern part of the Site (covering about 2,000 acres), and xeric tallgrass prairie on flat upland areas in the western part of the Site (covering about 1,800 acres). The xeric tallgrass community is a rare plant community along the Front Range. Also found at Rocky Flats are wetlands (including seep wetlands along valley cuts; Figure 2.2.f), upland riparian woodlands, and Great Plains riparian woodlands.

Wildlife at Rocky Flats is also diverse, with over 250 terrestrial vertebrates having been recorded at the Site. Nearly 200 species of birds have been found at Rocky Flats. The Site and the region are home to the Preble's Meadow Jumping Mouse, classified as a Threatened Species under the Federal Endangered Species Act (Figure 2.2.g).

3.0 SITE-SPECIFIC RISK-BASED END STATE DESCRIPTION

3.1 PHYSICAL AND SURFACE INTERFACE

Air - - Air quality has been monitored at Rocky Flats by DOE and CDPHE for many years and has been excellent. The Site has a number of individual facilities, such as the steam plant and building emergency generators that are sources of pollutants (primarily particulates, nitrogen oxides and carbon monoxide) and have State-issued air quality permits. These permits require RFFO to limit fuel use and file annual reports to the regulators to demonstrate compliance. RFFO expects that these permits and their associated reporting requirements will be canceled as the facilities regulated under these permits are removed.

Rocky Flats is also required to demonstrate compliance with the radionuclide National Emission Standards for Hazardous Air Pollutants (rad-NESHAPs). In accordance with an agreement made with the EPA and CDPHE, rad-NESHAPs compliance is demonstrated with a network of fourteen air monitors around the perimeter of Rocky Flats. Data from calendar year 2000 (the latest available) show that total radionuclide emissions from Rocky Flats were less than 1.5% of the allowable limit at the monitor with the highest radionuclide levels. The largest component of these emissions appeared to be naturally occurring uranium, and the highest emissions were noted at a monitor located upwind of Rocky Flats, in the vicinity of gravel mining operations. The results for 2000 are typical of those seen in previous years.

Given the typically excellent air quality at Rocky Flats, RFFO is planning no remedial actions aimed at air quality improvements, although project specific air monitoring is incorporated as appropriate into a number of remedial actions. Additionally, the Site will

be revegetated to minimize fugitive dust. The current monitoring network may be reduced substantially after closure, considering past results and considering that substantial amounts of surface contamination will be removed as part of Site cleanup. RFFO anticipates that the post-closure air monitoring network, if any, will be specified pursuant to the final CAD/ROD, or post-closure regulatory agreement. RFFO recognizes that air monitoring is an important community issue, and intends to work closely with regulators and surrounding communities regarding post-closure air monitoring.

End-State Vision Summary: During closure, the Site will be revegetated, which will help minimize fugitive dust. Some perimeter air monitoring for radionuclides may remain in place for some period of time following closure.

Surface water - - Surface water at Rocky Flats has received a great deal of attention over the years from Site personnel, regulators and stakeholders, largely because of the potential for surface water to transport environmental contaminants offsite. Two major drainages, Woman Creek and Walnut Creek, drain water from the Industrial Area and contaminated reaches of the Buffer Zone (Figure 2.1.b). The Site constructed a series of retention ponds in these drainages to help contain any potential release of contaminated water, and substantially upgraded its sewage treatment plant to further minimize the possibility of an industrial release to surface water. In the early 1990's DOE provided a grant to the City of Broomfield for a project known as Option B. This project replaced Great Western Reservoir (located in the Walnut Creek drainage) with a new water supply for the City of Broomfield, and constructed Woman Creek Reservoir to intercept flow from Rocky Flats before it reached Standley Lake, the drinking water supply for the cities of Westminster, Thornton and Northglenn.

Surface water protection is a focal point of RFCA. Under RFCA, the Site must demonstrate compliance with water quality standards for radionuclides at designated RFCA Points of Compliance (POC's). The POC's are located on Woman Creek, Walnut Creek and the Mower Diversion Ditch at the Site boundary, and downstream of Terminal Ponds A-4, B-5 and C-2. The Site also monitors radionuclide levels in surface water at a number of RFCA Points of Evaluation (POE's), located upstream of the pond system. The RFCA water quality standards for plutonium and americium are each 0.15 picoCuries per liter, and these standards were based on a 10^{-6} excess cancer risk from consuming two liters of water per day for thirty years. Compliance with the RFCA standards is determined using rolling thirty-day average values that are adjusted for flow rates, although the modifications to RFCA Attachment 5 allow for a yearly average for the purpose of demonstrating compliance at the outfalls of the terminal ponds. The Site has demonstrated consistent compliance with these standards at POC's, but has noted higher values at certain POE's, especially those draining the Industrial Area. RFFO expects that monitoring to demonstrate compliance with surface water quality standards at defined points will continue following closure.

There are two general environmental pathways by which surface water quality at Rocky Flats could be compromised. The first of these is through seepage of contaminated

groundwater into surface water. This pathway is of importance for contaminants such as organic solvents and soluble species such as nitrates and uranium.

The second major pathway by which contaminants can enter surface water at Rocky Flats is surface runoff from contaminated soils. This pathway is of most concern for plutonium and americium. These radionuclides are found dispersed in surface soils in the Industrial Area (where they can be washed into the Walnut Creek Drainage) and in a contaminant plume in surface soil downwind of the 903 Pad, located primarily in the Woman Creek drainage. Plutonium and americium are virtually insoluble in the environment at Rocky Flats. They bind tightly to clays and other particulate material. Their movement in the environment is caused primarily by mechanical processes, such as erosion of soils by water and wind.

Controlling movement of these contaminants can be accomplished in two ways. One is by removal of contaminated surface soils. RFFO is beginning to remove substantial quantities of contaminated soils in the vicinity of the 903 Pad, but erosion models performed by the Rocky Flats Actinide Migration Evaluation Panel indicate that a combination of measures will need to be implemented to control actinide migration to surface water. By example, runoff from the Industrial Area sometimes contains plutonium and americium levels that exceed RFCA water quality action levels as measured at POE's, but the soil contains only low concentrations of actinides (that is, levels that are less than the soil action levels contained in the recent revisions to RFCA Attachment 5), and will probably not be removed. The other means of controlling the movement of these contaminants is by restricting the erosion of the particles to which they attach. This can be done a number of ways: by covering contaminated soils with clean soil, by recontouring and revegetating contaminated areas, and by restricting runoff by constructing water management structures.

All of these techniques will probably be used during the closure of Rocky Flats. Soil cover and revegetation may be very successful in reducing migration of plutonium and americium from the Industrial Area. Revegetation will employ native soils and seed mixes to the extent practicable. The exact nature of the water management system that will be used following closure is not yet known, awaiting the results of a sitewide water balance study and a final land configuration design. However, water management after closure may include ponds or other retention structures in the major drainages (Walnut and Woman Creeks), as well as diversion structures similar to the South Interceptor Ditch now in use in the Woman Creek Drainage. All of these types of features have been shown to work well in controlling the amounts of particulates in surface water, thereby effectively reducing the concentrations of waterborne plutonium and americium.

End State Vision Summary: The Terminal Ponds will likely remain in place for some period of time following Site closure, and will likely be operated in a mode similar to current operations. The South Interceptor Ditch will likely remain in place. Smaller, upstream ponds in each drainage may be removed or reconfigured to allow for passive, flow-through operations. Surface water monitoring will likely continue for some period

of time after closure. Surface water at the Site will likely not be used as a drinking water source.

Groundwater - - There is a shallow, unconfined groundwater aquifer beneath the Rocky Flats Industrial Area, located in the Rocky Flats Alluvium. This aquifer has been contaminated in several places by organic solvents (especially carbon tetrachloride and trichloroethylene), nitrates, and uranium (Figure 3.1.a). However, this aquifer does not contain much water, and it is isolated from the regional Laramie-Fox Hills aquifer by several hundred feet of impermeable claystones of the upper Laramie Formation. Shallow groundwater beneath the Industrial Area surfaces in the form of seeps and springs before leaving the Site. Recognizing these facts, RFCA established groundwater action levels for the purpose of preventing the contamination of surface water.

In some areas, such as the 903 Pad/Ryan's Pit plume, groundwater contamination may never reach surface water, because of distance and the limited lifetime of the contaminants. In this case, monitored natural attenuation may be used in lieu of treatment of contamination as a remedial approach. In another case, the Property Utilization and Disposal (PU&D) yard plume located northwest of the Industrial Area, microbial degradation of organic contaminants is being enhanced through injection of lactic acid into the shallow aquifer. Both of these techniques may provide reasonable alternatives to more highly engineered approaches to groundwater treatment.

Other groundwater contaminant plumes at Rocky Flats require continued treatment in order to protect surface water. Examples include the East Trenches, Mound, and Solar Ponds plumes. Since groundwater in all three plumes is shallow and underlain by impermeable bedrock, the Site has installed groundwater barriers that lead to passive, gravity-fed treatment units. The treatment units are filled with an appropriate medium (such as iron filings and/or sawdust) that treat or remove contaminants. The media in these treatment units need to be replaced periodically, but have a life expectancy of ten years or more. Groundwater barriers and passive treatment systems may find additional uses at Rocky Flats as the nature of the groundwater contamination beneath the Industrial Area becomes better characterized. RFFO does not anticipate the need for more resource-intensive groundwater treatment systems, such as pump-and-treat systems, at Rocky Flats.

The current groundwater management approach at Rocky Flats does have long-term stewardship ramifications. Monitoring is anticipated, to track the effectiveness of monitored natural attenuation as well as the performance of treatment systems. Groundwater monitoring will also be performed as appropriate to determine if contaminants are migrating from known disposal sites, such as the original landfill and the present landfill. Treatment units themselves need periodic maintenance, including replacing the treatment media. Finally, specific institutional controls will be used where appropriate to deter drilling into and use of the contaminated groundwater that will probably remain under the Rocky Flats Industrial Area, although it should be emphasized that the amount of groundwater is extremely limited in most areas. Institutional controls

restricting groundwater use are specifically contemplated in Attachment 5 of RFCA, and are also discussed in the recent revisions to RFCA Attachment 5.

End-State Vision Summary: Groundwater collection and treatment systems now in place are expected to remain in place and operational following closure. An additional groundwater collection and treatment system is being considered for a contaminated groundwater plume beneath the Industrial Area. Groundwater monitoring will likely continue after closure. A restriction on pumping of contaminated groundwater (except for remedy-related purposes) will likely be in effect following closure, and groundwater at Rocky Flats will likely not be used as a drinking water source.

Surface soils - - The remediation of contaminated surface soils, especially soils containing radionuclides, will comprise an important part of the Rocky Flats closure project. Per RFCA Attachment 5, the purposes of setting action levels for the remediation of surface soils are to protect persons using the land, to protect surface water quality from runoff, and to protect ecological resources.

The Radionuclide Soil Action Levels (RSALs) were modified in 2003 for Rocky Flats surface soils. The RSALs guide the cleanup of surface soils containing plutonium, americium and uranium. The RSALs were recalculated using several different exposure scenarios (such as a rural resident and a wildlife refuge worker) and risk levels (from $1x10^{-4}$ to $1x10^{-6}$). The RSAL for plutonium now found in the revisions to RFCA Attachment 5 is 50 pCi/g, corresponding to less than a $1x10^{-5}$ excess cancer risk for a wildlife refuge worker. This could mean that soil remediation in the vicinity of the 903 Pad would extend to an area of about thirty acres (Figures 3.1.b and c). Soil removal, either through excavation or soil vacuum, is currently envisioned as the primary means of remediation. Soil removal would be followed by regarding and revegetation of the disturbed areas with native seed mixes.

End State Vision Summary: While no formal decision has been made, soils in the vicinity of the 903 Pad that exceed to 50 pCi/g action level for plutonium will likely be removed. Disturbed areas will likely need continued monitoring to ensure the success of revegetation efforts, in order to minimize future erosion. Areas with residual surface radionuclide contamination may require restrictions or other controls to avoid potential disturbance. If the risk posed by soils that are left behind after remediation is so high as to preclude reasonably foreseeable future uses, then some form of institutional control may be needed to preclude this use.

Subsurface Soils - - Per RFCA Attachment 5, action levels for remediation of subsurface soils are set for three reasons: protection of a future land user, protection of surface water through groundwater contamination, and protection of ecological resources.

Contamination of subsurface soils has occurred at Rocky Flats in a number of places, primarily in and around the Industrial Area. Examples have included leaking underground storage tanks (such as a carbon tetrachloride tank near B776), drum disposal trenches (such as T-3 and T-4 in the so-called East Trenches Area), the Solar Ponds, and

may include leaks from process waste lines. The Original Landfill is the most significant example of subsurface disposal outside the Industrial Area. Certain areas of subsurface soil contamination, such as the old Mound Site (a former drum disposal area) have caused local groundwater contamination.

The extent to which subsurface soil will be remediated at Rocky Flats, especially in the Industrial Area, is likely to be related to two factors. The first of these is the depth of contamination, which relates to the amount of risk that contamination poses to a future land user. The second factor is whether subsurface contamination is significant enough to warrant remediation because of a threat to surface water quality via a groundwater pathway. The revisions to RFCA Attachment 5 discuss subsurface soil remediation in detail. For non-radionuclide contaminants, soil contamination below six inches would be remediated if a soil risk screen showed that the contamination posed greater than a $1x10^{-5}$ risk to a wildlife refuge worker, or to protect surface water. For plutonium and americium, subsurface soils 3-6 feet below the surface would be remediated or not depending on the magnitude and extent of contamination, although any soils exceeding 7 nCi/g at this depth would be remediated. Soils below six feet would be remediated if a soil risk screen indicated that they posed a risk of greater than $1x10^{-5}$ to a wildlife refuge worker, or to protect surface water.

End State Vision Summary: Two areas will likely have engineered soil covers that will remain after closure: the Original Landfill and the Present Landfill. Original Process Waste Lines will be remediated in accordance with Attachment 14 of RFCA. Certain disposal areas and trenches (such as T-1, T-3 and the Mound Area) have already been remediated; others are likely to remain in place. A removal action for the carbon tertrachloride tank near B776 is being planned. Areas with residual subsurface soil contamination will likely remain in or near the Industrial Area. Areas with residual subsurface soil contamination will likely require restrictions to prevent intrusion.

3.2 HUMAN AND ECOLOGICAL LAND USE

Following cleanup and closure, RFFO expects that administrative jurisdiction over most of the Site will be transferred to the U.S. Fish and Wildlife Service (USFWS), for operation as a National Wildlife Refuge, per the Rocky Flats National Wildlife Refuge Act of 2001. Specific land uses, which could include trails, an interpretive center, limited hunting, or restricted access, are now being evaluated by USFWS as part of a Comprehensive Conservation Plan (CCP) for the Refuge. The draft CCP is expected to be released for public comment in January 2004.

RFFO expects that, consistent with the Refuge Act, DOE will retain administrative jurisdiction over property or facilities, including engineered structures, related to its response actions at Rocky Flats. Attachment 5 of RFCA contains a figure that shows the anticipated extent of areas with institutional controls at closure (Figure 3.2.a). RFFO expects that the property will be left at closure in a condition consistent with the use of the surrounding lands as a National Wildlife Refuge.

There are two active gravel mines now operating on Rocky Flats in the western portion of the Buffer Zone. Private parties own the mineral rights for other areas of Rocky Flats. RFFO anticipates that gravel mining at the Site will continue for some period of time following closure.

Most of the Site will be managed by USFWS as a National Wildlife Refuge following closure. Ecological values for the Site Buffer Zone are expected therefore to remain unchanged, or to improve slightly under this management. Ecological values of the Industrial Area, which will be regraded and revegetated with native seed mixes, are expected to improve substantially.

End-State Vision Summary: Administrative jurisdiction over most of the Site will be transferred to USFWS for operation as a National Wildlife Refuge. Areas for which administrative jurisdiction is retained by DOE are expected to have conditions consistent with use of the surrounding land as a Refuge. Gravel mining at Rocky Flats is expected to continue following closure. Ecological values for the Buffer Zone will remain stable or improve slightly, and ecological values for the Industrial Area will improve substantially.

3.3 SITE CONTEXT LEGAL OWNERSHIP

Per the requirements of the Refuge Act, Rocky Flats will remain in Federal ownership, although, per the Refuge Act, DOE may make land available along the eastern boundary for the purpose of transportation improvements. No application for such land has yet been received, and RFFO is unaware of any pending applications. Administrative jurisdiction over the Site will likely be divided between DOE and USFWS as described above; title to all of this property will be retained by the United States.

RFFO anticipates that land now in public ownership near and adjoining Rocky Flats will remain in public ownership (Figure 2.2.b). Recent acquisitions by county and municipal governments have expanded the amount of publicly-held open space near Rocky Flats, and this trend may continue. The specific uses to which these lands may be put can change in some cases. As an example, the City and County of Broomfield recently constructed a jail on property that it owns east of Rocky Flats.

Mineral rights ownership at Rocky Flats is divided among the U.S. Government and a number of private parties. Mining for gravel currently takes place in the western buffer zone.

Rocky Flats is bordered by private property to the south and west, which is largely undeveloped. RFFO has no information from these landowners as to future plans for this property.

End-State Vision Summary: Most of Rocky Flats will remain in Federal ownership, per the requirements of the Refuge Act. Much of the land surrounding Rocky Flats is

publicly-owned, and is expected to remain so. RFFO has no information regarding the plans for private property adjoining the Site.

3.4 SITE CONTEXT DEMOGRAPHICS

The Denver metropolitan area and the northwestern portion of that area (in which Rocky Flats is located) have grown substantially over the last several years. That growth is expected to continue. According to the Denver Regional Council of Governments (DRCOG), the number of building permits issued in the Denver metropolitan area has increased from 5,944 in 1990 to 28,285 in 2002. Population in the Denver metropolitan area is expected to increase from 2,414,649 (2000 census data) to 3,431,013 in the year 2025 (DRCOG projection). Jefferson County's population is expected to increase from 527,056 in 2000 to 700,456 in 2025; Boulder County's population is expected to increase from 291,288 in 2000 to 372,999 in 2025 (2000 census data and DRCOG projections).

End-State Vision Summary: Population in the Denver area and in the vicinity of Rocky Flats is expected to increase substantially in coming years. Potential impacts of this population growth on the management of the Rocky Flats National Wildlife Refuge are expected to be addressed in the Comprehensive Conservation Plan being prepared by the U.S. Fish and Wildlife Service.

4.0 HAZARD SPECIFIC DISCUSSION

4.1 Hazard Area 1: Landfills

There are two landfills at Rocky Flats for which accelerated actions are being planned under RFCA: the Original Landfill and the Present Landfill (Figures 4.1 a and b). Neither of these landfills is currently in use. A third on-site landfill was constructed in the mid-1990's, never used, and has subsequently been decommissioned.

The Present Landfill is located north of the Industrial Area at the head of No Name Gulch, the drainage immediately to the north of North Walnut Creek. Disposal operations began there in 1968, and continued until 1998. The landfill was originally intended as a sanitary landfill to receive uncontaminated solid wastes such as office trash, construction debris, scrap metal, etc. However, the landfill also received hazardous wastes streams (such as paints and solvents), beryllium-contaminated materials, asbestos-containing materials, PCBs from fluorescent light ballasts, and radioactively contaminated sludge from the Rocky Flats Sewage Treatment Plant. The landfill occupies about twenty acres, and is unlined. Waste thickness reaches forty feet along the eastern face of the landfill. East of the landfill is the East Landfill Pond, which is a body of water that exists year-round**,** occupying about 2.5 acres, with a 7.5 million gallon capacity. Seepage from the eastern face of the landfill discharges to the pond by means of a passive treatment system consisting of stepped flagstones and gravel, which are designed to remove low levels of VOCs that occur in the seepage. Water from the East Landfill Pond is periodically pumped to Pond A-3 in North Walnut Creek.

The Original Landfill occupies about twenty acres on the north side of Woman Creek, immediately south of Building 460. The Original Landfill operated as a waste dump from the opening of Rocky Flats in 1952, until the construction of the Present Landfill in 1968. The landfill contains about 70,000 cubic yards of waste of various types, including construction debris, concrete, scrap metal, etc. The landfill also contains solvents, paints, oils, pesticides, and items contaminated with beryllium and uranium. About twenty kilograms of uranium-238 (known as depleted uranium) ash are thought to have been disposed of in the landfill. The landfill is located on steep, unstable slopes. While a soil cover was placed on the landfill after 1968, debris is exposed in some areas. Contamination in the Original Landfill is sporadic. Surface soils exceed RFCA action levels at four locations for radionuclides and one location for non-radionuclides. No subsurface samples have yet shown contamination in excess of any RFCA action levels. Uranium-238 exceeds RFCA action levels in groundwater in two monitoring wells within the landfill boundary, although the Original Landfill does not appear to be affecting surface water in Woman Creek. The landfill extends close to areas of Woman Creek that serve as habitat for the threatened Preble's Meadow Jumping Mouse, a situation that could complicate remediation.

4.2 Hazard Area 2: Groundwater Plumes

Several areas of localized groundwater contamination exist in and around the Industrial Area at Rocky Flats (Figure 3.1.a). These groundwater plumes are found in the shallow, unconfined aquifer underlying the Industrial Area. As discussed in Section 3.1, the unconfined aquifer is separated from the regional Laramie-Fox Hills aquifer by several hundred feet of impermeable bedrock, and all water in the unconfined aquifer surfaces before leaving the site. Some of the plumes found in the unconfined aquifer include the Solar Ponds plume, Mound Plume, East Trenches plume, and other plumes.

The Solar Ponds, formerly located in the northeast corner of the Industrial Area, received industrial wastewater containing nitrates and uranium, beginning in 1953. The ponds were present in various configurations throughout most of the Plant's operating history, and were drained and had sludge removed form them in the 1980's and 1990's. The ponds leaked, and the resulting groundwater plume flows generally northward from the Solar Ponds towards North Walnut Creek. An Interceptor Trench System (ITS), constructed in 1981 (and replacing earlier trenches constructed in 1971) collected approximately 2.4 million gallons of groundwater from the Solar Ponds plume annually, which was transferred from a pump house, ultimately to Building 374 for treatment. Some contaminated groundwater was not collected by the ITS, and entered North Walnut Creek. Nitrate concentrations at the pump house have been measured at about 220 milligrams per liter (mg/l) as nitrogen. Uranium concentrations have been measured at 61 pCi/l there. However, uranium concentrations in groundwater are higher near the Solar Ponds themselves.

The Mound plume, located just east of the Industrial Area, flows in a northerly direction towards South Walnut Creek. Tetrachloroethylene (or perchloroethylene, PCE) and trichloroethylene (TCE) are the predominant contaminants in the groundwater; PCE

concentrations have been measured as high as 528,000 micrograms per liter (ug/l), and TCE concentrations have been found up to 18,000 ug/l. Contaminated soil remaining in the Mound disposal area was removed in order to eliminate the ongoing source of VOC contamination in the area.

The groundwater contaminant plume treated by the East Trenches system emanates primarily from the area of disposal Trenches T-3 and T-4, which were remediated in 1996. The plume flows in a generally northerly direction from the trenches towards South Walnut Creek. The East trenches plume is located just east of the Mound Plume. The groundwater contaminants are PCE, which has reached concentrations of 6,800 ug/l, 1,1-trichoroethane, which has reached concentrations of 730 ug/l, and carbon tetrachloride, which has reached 460ug/l. The East Trenches area also has uranium contamination in soils, which has been measured at levels as high as 3,240 pCi/g.

The East Trenches plume, located just east of the Mound plume, emanates primarily from the area of disposal Trenches T-3 and T-4, which were remediated in 1996. The plume flows in a generally northerly direction from the trenches towards South Walnut Creek. The East Trenches plume is located just east of the Mound Plume. The groundwater contaminants are PCE, which has reached concentrations of 6,800 ug/l, 1,1-trichoroethane, which has reached concentrations of 730 ug/l, and carbon tetrachloride, which has reached 460ug/l. The East Trenches area also has uranium contamination in soils, which has been measured at levels as high as 3,240 pCi/g.

Several other shallow groundwater plumes are found at Rocky Flats. Groundwater contaminated by VOC's underlies much of the Industrial Area; this contamination is thought to have emanated from several sources. Contaminants include carbon tetrachloride (a leaking underground storage tank containing carbon tetrachloride was located in the vicinity of Building 776), TCE, DCE and tetracholorethylene. A passive groundwater treatment system is under consideration for this contaminant plume. A shallow groundwater plume associated with the former Property Utilization and Disposal Yard is located to the northwest of the Industrial Area; microbial degradation of organic contaminants in this plume is being enhanced through the injection of lactic acid into the shallow aquifer. Finally, VOC groundwater contamination is also found in the 903 Pad/Ryan's Pit area to the southeast of the Industrial Area. In this area, groundwater contamination may never reach surface water, owing to the distance to surface water and the limited life of these contaminants.

4.3 Hazard Area 3: Surface Water

As stated in Section 3.1, two major drainages, Walnut Creek and Woman Creek, receive water from the Industrial Area and other contaminated portions of Rocky Flats (Figure 2.1.b). RFETS collects samples from several RFCA Points of Compliance (POC's) and Points of Evaluation (POE's) in these two drainages to assess compliance with the RFCA water quality standards for radionuclides. RFCA surface water standards are applied at POC's. Exceedances of action levels are measured at POE's. POC's are located at the outfalls of the three terminal ponds (A-4, B-5, and C-2), as well as where Walnut Creek

and Woman Creek cross Indiana Street, at the Site's eastern boundary. RFETS also collects water from other locations across Plantsite, and analyzes these samples for a variety of constituents

The RFCA water quality standards for both plutonium and americium are 0.15 picoCuries per liter (pCi/l). These standards correspond to a calculated one in one million excess cancer risk to a person drinking two liters of water per day. RFETS determines compliance with these standards by calculating rolling thirty-day, flow-weighted averages for plutonium and americium. Samples at both POC's and POE's are collected continuously using automated sampling equipment.

Data from the Walnut and Woman Creek POC's collected since the 1997 have shown consistent compliance with the RFCA water quality standards for both plutonium and americium. The average concentrations of plutonium and americium from the POC at Walnut Creek and Indiana Street from 1997-2001 were 0.012 and 0.009 pCi/l, respectively. Average concentrations of plutonium and americium from the POC at Woman Creek and Indiana Street from 1997-2001 were 0.005 and 0.004 pCi/l, respectively. The highest individual sample result for plutonium at either POC was 0.220 pCi/l collected at the Walnut Creek and Indiana POC on April 9, 1997. This sample result did not cause RFETS to exceed the thirty-day, flow-weighted average for plutonium.

Water quality data from some of the POE's, which are located upstream of the ponds, show higher concentrations of radionuclides in general than samples taken below the ponds. This is attributable to the fact that these POE's monitor drainages containing low levels of radionuclide soil contamination, and due to the fact that the ponds are very effective at removing plutonium and americium through the settling of particulates. As an example, GS-10 is a RFCA POE located in the South Walnut Creek drainage upstream of the B-series ponds, and samples runoff from the RFETS Industrial Area. Average plutonium concentrations at GS-10 from 1997-2001 were 0.127 pCi/l, and average americium concentrations were 0.180 pCi/l. Maximum concentrations at GS-10 were also higher than those observed downstream; the highest value for plutonium was 2.27 pCi/l, and the highest value for americium was 8.39 pCi/l.

The amount of water flowing from Rocky Flats is low compared with downstream flows in the Big Dry Creek Drainage, of which Walnut and Woman Creeks are a part. From 1997-2001, flow in Walnut Creek at Indiana Street averaged about 0.7 cubic feet per second (cfs), and flow in Woman Creek at Indiana Street averaged 0.4 cfs. By comparison, the average flow in Big Dry Creek at its confluence with the South Platte River was about 43 cfs. Walnut Creek had measurable flow about 84% of the time, and Woman Creek had measurable flow about 68% of the time. The Rocky Flats sewage treatment plant is also small in comparison with its downstream neighbors. It discharges about 0.15 million gallons per day (MGD), and has a design capacity of 0.5 MGD. The City of Broomfield wastewater treatment plant's current capacity is 5.4 MGD, with a planned upgrade to 8 MGD by 2003. Westminster's treatment facility has a permitted capacity of 9.2 MGD.

4.4 Hazard Area 4: Surface Soil

Drum storage in the area known as the 903 Pad, located off the southeast corner of the Industrial Area, caused environmental contamination. The Plant stored drums containing radioactive waste on the Pad beginning at least in 1958, and possibly as early as 1955. The wastes contained various hazardous constituents, including beryllium, solvents and uranium, as well as waste oils containing plutonium. Leaking drums were discovered as early as 1959, when a rust inhibitor was added to the drum contents in an attempt to prevent further deterioration. The area was closed in April 1967 when a heavy rainstorm caused the release of more contamination from the drums. The drums were removed in 1968, by which time numerous drums were empty, their contents having leaked entirely. Plant personnel placed an asphalt pad over the area in November 1969, after first removing some of the most contaminated soil. The 1996 RCRA Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit 3 (OU3; Offsite Areas) concluded that the 903 Pad is the major source for plutonium releases to the environment from Rocky Flats operations.

The most prominent area of surface soil contamination at Rocky Flats extends to the east of the 903 Pad (Figures 3.1.b and c). This area is contaminated by plutonium and americium. The distribution of plutonium and americium in the surface soils is generally configured as a west to east trending plume. Radionuclide activities decrease with distance from the 903 Pad. Concentrations of plutonium in surface soils can be as high as 100,000 pCi/g in the immediate vicinity of the 903 Pad. Surface soil contamination is quite extensive: recognizable plutonium contributions from Rocky Flats extend beyond the Site's eastern boundary, although in the areas off of Rocky Flats, the levels of contamination allow for unrestricted use. The highest level of plutonium observed off site in the OU3 RFI/RI report was 6.47 pCi/g. Plutonium and americium activities reach background levels within two to three miles of the east entrance of RFETS.

Because of the nearly insoluble nature of plutonium and americium in the environment at Rocky Flats, the majority of the activity for these two elements in surface soil occurs near the surface. The RFI/RI report for OU3 found that levels for these two radionuclides fell to background within about two inches of the surface. Closer to the 903 Pad, more recent sampling has shown that plutonium levels exceeding the 50 pCi/g action level may extend to about a foot below the surface. Beneath the 903 Pad itself, where drums containing plutonium and solvents leaked directly into the ground, plutonium-containing soil has been excavated to a depth of up to eight feet.

4.5 Hazard Area 5: Subsurface - - Original Process Waste Lines

The Original Process Waste Line (OPWL) system consisted of about 35,000 feet of pipeline and 73 tanks that existed in RFETS Areas 100, 400, 500, 600, 700, 800, and 900 (Figure 4.5.a). The purpose of the OPWL system was to transport and temporarily store aqueous chemical and radioactive process wastes from point of origin to on-site treatment facilities. The OPWL was first constructed when RFETS began production activities in

1952, and was added onto until it was replaced by the New Process Waste Lines, a double-lined, fully inspectable system, beginning in 1975. Some of the OPWL was removed, some were incorporated into the NPWL, and some were left in place.

The pipelines range from one to ten inches in diameter. They are constructed of a variety of materials, including black iron, cast iron, stainless steel, fiberglass, polyvinyl chloride, Pyrex and Teflon. Valve vaults and manholes provided access for operation and maintenance. The material transported included various process wastes containing low-level radioactive materials, nitrates, caustics and acids. The OPWL also handled a small quantity of other materials, including medical decontamination fluids, miscellaneous laboratory wastes, and laundry effluent.

Numerous accidental releases of process waste occurred during the operation of the OPWL, and may have resulted in environmental contamination (Figure 4.5.b). Releases occurred throughout the system at tank/pipeline connections, pipeline joints, elbows and reducers, junction boxes and valves. Releases also occurred as a result of pipeline breakage due to construction activities, settling, overflows, and pipeline corrosion and deterioration. The potential contamination associated with the OPWL system has not been fully characterized; potential contaminants of concern include radionuclides, metals, VOCs, semi-volatile organic compounds, and nitrate.