CORRECTIVE ACTION DECISION/
RECORD OF DECISION
FOR
ROCKY FLATS PLANT (USDOE)
PERIPHERAL OPERABLE UNIT
AND
CENTRAL OPERABLE UNIT

JEFFERSON AND BOULDER COUNTIES, COLORADO

DECLARATION

SITE NAME AND LOCATION

The Rocky Flats Plant (also referred to as the Rocky Flats Environmental Technology Site, RFETS, Rocky Flats, or simply as the site), is a 6,241-acre Department of Energy (DOE) facility owned by the United States. Rocky Flats is located in the Denver metropolitan area, approximately sixteen miles northwest of Denver, Colorado, and ten miles south of Boulder, Colorado. Nearby communities include the Cities of Arvada, Broomfield, and Westminster, Colorado. The majority of the site is located in Jefferson County, with a small portion located in Boulder County, Colorado.

The EPA Superfund Identification Number for Rocky Flats is CO7890010526. Two Operable Units (OUs) are present within the boundaries of the site: the Peripheral OU and the Central OU. The Central OU consolidates all areas of the site that will require additional remedial/corrective actions, while also considering practicalities of future land management. The Offsite Areas at Rocky Flats, also known as OU 3, were addressed under a separate Corrective Action Decision/ Record of Decision (CAD/ROD) dated June 3, 1997, EPA/ROD/R08-97/196 1997 (DOE 1997).

STATEMENT OF BASIS AND PURPOSE

This document presents the selected corrective actions/remedial actions for the Peripheral OU and the Central OU at Rocky Flats. These actions were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, as amended by the Superfund Amendments and Reauthorization Act of 1986. The selected remedies/corrective actions were also chosen in accordance with the Colorado Hazardous Waste Act (CHWA). The Resource Conservation and Recovery Act (RCRA) is administered in Colorado through the CHWA, by the Colorado Department of Public Health and Environment (CDPHE). This document fulfills the requirements of a Corrective Action Decision under CHWA. To the extent practicable, the selected remedies are also consistent with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP).

Rocky Flats was investigated and the remedies were selected in compliance with the Federal Facility Agreement and Consent Order – Rocky Flats Cleanup Agreement (RFCA) (DOE, et al. 1996), signed by the U.S. Environmental Protection Agency (EPA), the State of Colorado, and DOE on July 19, 1996. RFCA governed the cleanup of Rocky Flats. The remedy selection for the Peripheral OU and the Central OU is based on the Administrative Record for Rocky Flats. The State of Colorado and EPA concur with the selected remedy/corrective action.

ASSESSMENT OF THE SITE

Rocky Flats was proposed by EPA for inclusion on the CERCLA National Priorities List in 1984 (EPA 1984), and the listing became final in 1989 (DOE 1989). The site was proposed for listing because activities at Rocky Flats resulted in the release of materials defined by CERCLA as hazardous substances, contaminants, and pollutants. Hazardous substances released to the environment from the activities at Rocky Flats have included, but were not limited to: radionuclides (such as plutonium-239/240, americium-241, and various uranium isotopes), organic solvents (such as trichloroethene, tetrachloroethene, and carbon tetrachloride), metals (such as chromium), and contaminants such as nitrates. Apart from the activities of DOE and its contractors, there are no other known, significant, human-caused sources of contamination at Rocky Flats.

Considerable site remediation took place during the late 1990s and early 2000s under the auspices of RFCA, which adopted an accelerated action approach to the cleanup, equivalent to the removal authority found in CERCLA. Major site accomplishments completed under RFCA, and to complete site closure in general, included:

- removal of 21 tons of weapons-grade nuclear material (plutonium and enriched uranium);
- removal of 800 structures, including five major plutonium facilities and two major uranium facilities;
- treatment to date of more than sixteen million gallons of contaminated groundwater and seep water;
- investigation and appropriate disposition of 421 Individual Hazardous Substance Sites (IHSSs);
- construction of three passive groundwater treatment systems, one passive seep treatment system, and two engineered covers over abandoned landfills; and,
- removal of more than 1.3 million cubic meters of waste, including contaminated soils.

The RCRA Facility Investigation-Remedial Investigation/Corrective Measures Study-Feasibility Study (RI/FS) (DOE 2006) and Proposed Plan (DOE 2006a) evaluated site conditions and considered the need for additional remedial actions in light of the cleanup activities already performed at Rocky Flats.

In accordance with the Rocky Flats National Wildlife Refuge Act of 2001, Public Law 107-107 (Refuge Act), the future use of Rocky Flats is as a national wildlife refuge. The U.S. Fish and Wildlife Service (USFWS) will assume jurisdiction and control of most of the site for wildlife refuge purposes. The DOE will retain jurisdiction of real property and facilities to be used in carrying out any final response actions. There is no current or planned residential use of the site, and Rocky Flats is not an environmental justice site.

Based upon the RI/FS report, which included both a Human Health and Ecological Risk Assessment, DOE (as the Lead Agency under CERCLA) has determined that no action is necessary to protect public health or welfare or the environment for the Peripheral Operable Unit. For the Central Operable Unit, the response action selected in this CAD/ROD is necessary to protect public health or welfare or the environment from actual or threatened releases of pollutants or contaminants from this site.

DESCRIPTION OF THE SELECTED REMEDIES

The selected remedy/corrective action for the Peripheral OU is no action. The RI/FS report concludes that the Peripheral OU is already in a state protective of human health and the environment. The NCP provides for the selection of a no action remedy when an OU is in such a protective state and therefore, no remedial action for the Peripheral OU is warranted.

The selected remedy/corrective action in the Central OU is institutional and physical controls, incorporating continued monitoring and maintenance. As mentioned, substantial remedial actions have already been conducted at Rocky Flats. The RI/FS evaluated site data and the need for additional remedial actions in light of the accelerated actions that had already been completed. The selected remedy/corrective action includes management actions that are designed to ensure that the site remains protective of human health and welfare and the environment, and to ensure that existing remedies continue to function properly.

Source materials constituting principal threats in the Central OU at Rocky Flats (that is, solvents such as trichloroethene, also known as dense non-aqueous phase liquids) have been addressed through accelerated actions such as source removal, installation of passive groundwater collection and treatment systems, and groundwater quality enhancements. These actions are not expected to eliminate groundwater contamination in the short term, but are expected to have a positive long-term impact on groundwater and surface water quality.

The major components of the selected remedy/corrective action for the Central OU are as follows:

1) monitoring and maintenance of accelerated actions completed at the Present and Original Landfills, and at the passive groundwater collection and treatment systems;
2) environmental monitoring based upon the Rocky Flats Fiscal Year (FY) 2005 Integrated Monitoring Plan (K-H 2005), as well as additional sampling to reduce some uncertainties associated with the Ecological Risk Assessment;
3) the following institutional controls –
    a. the construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices) is prohibited;
    b. excavation, drilling and other intrusive activities below a depth of three feet are prohibited, except for remedy-related purposes and routine or emergency maintenance of existing utility easements, in accordance with pre-approved procedures;
    c. no grading, excavation, digging, tilling, or other disturbance of surface soils of any kind is permitted, except in accordance with an erosion control plan (including Surface Water Protection Plans submitted to EPA under the Clean Water Act) approved by EPA or CDPHE; any such soil disturbance shall restore the soil surface to pre-existing grade;
    d. surface water may not be used for drinking water or agricultural purposes;
    e. the construction or operation of groundwater wells is prohibited, except for remedy-related purposes;
    f. digging, drilling, tilling, grading, excavation, construction of any sort, and vehicular traffic, are prohibited on the covers of the Present and Original Landfills, except for authorized response actions; and,
    g. activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap or surveyed benchmark are prohibited; and,
4) physical controls to consist of signage to be installed along the perimeter of the Central OU, and protection of engineered components of the remedy, monitoring locations and survey points so as to ensure that they continue to function as designed.

The selected remedy/corrective action will be implemented through a modification to the Rocky Flats Environmental Covenant (DOE 2006b) to include all of the institutional controls required for the Central OU, through DOE retention of jurisdiction for or access to any real property to be used in carrying out the final response action (that is, the Central OU and designated monitoring points outside the Central OU), and through an interagency agreement/corrective action order among DOE, EPA and CDPHE.

CERCLA STATUTORY DETERMINATIONS

The selected remedy/corrective action for the Peripheral OU attains the mandates of CERCLA Section 121, and to the extent practicable, the NCP. The selected remedy for the Peripheral OU is protective of human health and the environment, complies with applicable or relevant and appropriate requirements (ARARs), and is cost-effective. The selected remedy/corrective action complies with applicable requirements of the CHWA. No accelerated actions were taken in the Peripheral OU, and no remedial action alternatives were evaluated for the Peripheral OU. Because no hazardous substances, pollutants, or contaminants occur in the Peripheral OU above levels that allow for unlimited use and unrestricted exposure, a five-year review will not be required for the selected remedy/corrective action in the Peripheral OU.

The selected remedy/corrective action for the Central OU attains the mandates of CERCLA Section 121, and to the extent practicable, the NCP. The selected remedy/corrective action for the Central OU is protective of human health and the environment, complies with ARARs, and is cost-effective. The selected remedy/corrective action utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable, and also satisfies the statutory preference for treatment as a principal element of the remedy. The selected remedy/corrective action complies with applicable requirements of the CHWA. Because this remedy will result in hazardous substances, pollutants or contaminants remaining in the Central OU above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years to ensure that the remedy continues to be protective of human health and the environment. In order to coordinate this review with the schedule for periodic review already established at Rocky Flats (DOE 2002), the next remedy review will be performed by September 2007.

CAD/ROD DATA CERTIFICATION CHECKLIST

The following information is included in the Decision Summary section of this CAD/ROD. Additional information can be found in the CAD/ROD Administrative Record file for Rocky Flats.

- Analytes of Interest (AOIs) and chemicals of concern (COCs) and their respective concentrations.

- Comprehensive risks represented by the chemicals of concern.

- Cleanup levels established for surface and groundwater AOIs and the basis for these levels.

- How source materials constituting principal threats are addressed (not applicable to the Peripheral OU).

- Current and reasonably anticipated future land use assumptions and potential future beneficial uses of groundwater used in the comprehensive risk assessment and the CAD/ROD.

- Potential land and groundwater use that will be available at Rocky Flats as a result of the selected remedies/corrective actions.

- Estimated capital, annual operation and maintenance, and total present worth costs, and the number of years over which the remedy cost estimates are projected (not applicable to the Peripheral OU).

- Key factors that led to selecting the remedies/corrective actions.

AUTHORIZING SIGNATURES

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DECISION SUMMARY

1. SITE NAME, LOCATION AND DESCRIPTION

The Rocky Flats Plant (also referred to as the Rocky Flats Environmental Technology Site, RFETS, Rocky Flats, or simply as the site), is a 6,241-acre DOE facility owned by the United States. Rocky Flats is located in the Denver metropolitan area, approximately sixteen miles northwest of Denver, Colorado, and ten miles south of Boulder, Colorado (Figure 1). Nearby communities include the Cities of Arvada, Broomfield, and Westminster, Colorado. The majority of the site is located in Jefferson County, with a small portion located in Boulder County, Colorado.

The EPA Superfund Identification Number for Rocky Flats is CO7890010526. DOE is the lead agency for the remediation under CERCLA, in accordance with Executive Order 12580. EPA and CDPHE are the Support Agencies. DOE provided funding for the cleanup activities at Rocky Flats, and will continue to provide for the ongoing remedy, using funds appropriated annually by Congress.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

Rocky Flats was a large industrial facility, comprised of over 800 structures, including several large processing facilities for plutonium and uranium. The vast majority of industrial activities (including waste disposal), took place in or near the center of the site, in the approximately 300-acre Industrial Area. Several waste disposal pits and two larger landfills are or were present at the site (Figure 2).

The majority of the site, known previously as the Buffer Zone, contained some supporting activities such as waste disposal, but was generally left undisturbed. This land provided a security and safety buffer area around the Industrial Area. Portions of the Buffer Zone have been co-managed by the U.S. Fish and Wildlife Service for ecological resources since 1999.

The Atomic Energy Commission and its successor agency, the Energy Research and Development Administration, had jurisdiction and control of Rocky Flats from 1951 to 1974, and from 1975 to 1977, respectively. Since 1977, the site has been under the jurisdiction and control of DOE. Since 1951, four companies have managed and operated Rocky Flats on behalf of DOE or its predecessors. Dow Chemical Company managed the site from its inception until 1975, at which time Rockwell International Company (Rockwell) became the contractor. EG&G Rocky Flats became the contractor in 1990. Kaiser-Hill Company, LLC (K-H) was the contractor after July 1, 1995. K-H was DOE's contractor that performed the vast majority of cleanup and closure work at Rocky Flats. Ongoing site operations are performed by the DOE Office of Legacy Management, with site operations performed under contract to S.M. Stoller Corporation.

The mission of the site changed in the early 1990s. In February 1991, DOE introduced a plan to realign the Nation's nuclear weapons program. As part of this realignment, DOE announced in February 1992 that Rocky Flats would no longer have a nuclear weapons production mission. Since that time (with the exception of limited production of stainless steel parts that continued through the early 1990s), the mission at Rocky Flats was the safe storage and disposition of nuclear weapons materials and wastes, the safe deactivation of nuclear production facilities, demolition and removal of buildings and infrastructure, and environmental cleanup. The vast majority of these activities were completed in late 2005. Current site activities include environmental monitoring, maintenance of environmental response actions, and land and natural resources management. Per the Refuge Act of 2001, the Secretary of Energy shall transfer administrative jurisdiction over certain lands at Rocky Flats to the Secretary of the Interior, for the purpose of establishing the Rocky Flats National Wildlife Refuge. This transfer is expected to occur in 2007.

Over the decades, manufacturing activities, accidental industrial fires and spills, and support activities such as waste management resulted in the release of contaminants to the air, soil, sediment, groundwater, and surface water at Rocky Flats. Some of the more noteworthy environmental incidents and practices were:

- 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 historic Building 771 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. On May 11, 1969, a major fire occurred in gloveboxes in historic Building 776, started by the spontaneous ignition of plutonium, causing extensive building contamination and release of plutonium to the atmosphere. 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 historic 903 Pad, located off the southeast corner of the former 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-239/240. 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. The 903 Pad is the major source for plutonium-239/240 releases to the environment from Rocky Flats operations.

- The Plant used various disposal trenches and waste dumps during its early years. Many of these historic disposal sites, such as the Mound and Trenches T-1, T-3, and T-4, are located just to the northeast of the 903 Pad, in the Mound-East Trenches Area. The various disposal areas were used from about 1954 to 1968. Many of the wastes that ended up there originated from historic Building 444 or other buildings on the south side of the former Industrial Area. 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 1990s.

- 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 former 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 1960s. This system was upgraded in 1981, to include a pump house to capture more of the contaminated water. The Solar Ponds no longer exist, having been drained and the sludge removed from them in the 1980s and 1990s.

- Two major landfills operated at the site. The first, known as the Original Landfill, occupies about twenty acres on the north side of Woman Creek. The Original Landfill operated as a waste dump from the opening of Rocky Flats in 1952 until 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. The second landfill, known as the Present Landfill, was located north of the former 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.

Locations of the aforementioned areas are shown on Figure 2. Contaminants released to the environment from the activities at Rocky Flats have included, but were not limited to: radionuclides (such as plutonium-239/240, americium-241, and various uranium

isotopes), organic solvents (such as trichloroethene, tetrachloroethene, and carbon tetrachloride), metals (such as chromium), and nitrates.

In 1989, The Federal Bureau of Investigation and EPA agents executed a search warrant to confirm alleged violations of federal environmental laws and regulations at Rocky Flats. Following the search, the U.S. Department of Justice indicted Rockwell, the management and operating contractor at the time of the search, for commission of environmental crimes at the site. In 1992, Rockwell's plea of guilty for environmental crimes was accepted in District Court, and Rockwell consequently agreed to pay a fine of $18.5 million.

Results of early environmental investigations indicated that such operations at Rocky Flats had resulted in the release of materials defined by CERCLA as hazardous substances, contaminants and pollutants, and by the RCRA as hazardous wastes and hazardous waste constituents. Environmental investigation and cleanup of Rocky Flats took place under the auspices of three compliance agreements/orders.

The 1986 Compliance Agreement - - On July 31, 1986, DOE, EPA and CDPHE entered into a Compliance Agreement (CERCLA VIII-86-08 and RCRA VIII-86-06) (DOE et al. 1986) that established milestones for major environmental operations and investigations at the site, and requirements for compliance with CERCLA. This Agreement also established roles and requirements for compliance with RCRA and the CHWA, through compliance with interim status requirements and submittal of permit applications and closure plans for hazardous waste units. Under this Agreement, DOE and Rockwell identified over 2,000 waste generation points and178 Solid Waste Management Units (SWMUs) and RCRA/CHWA-regulated closure sites. SWMUs, per RCRA, are inactive waste disposal sites, accidentally contaminated sites, and sites found to pose environmental concerns.

The Interagency Agreement (IAG) - - The 1986 Compliance Agreement did not reflect the requirements of the 1986 Superfund Amendments and Reauthorization Act, including the requirements governing Federal facilities under Section 120 of CERCLA. In addition, the environmental priorities at the site had been clarified in light of the investigations that had taken place under the 1986 Compliance Agreement. For these reasons, DOE, EPA and CDPHE negotiated the IAG (Federal Facility Consent Order CERCLA VIII-91-03, RCRA [3008{h}] VIII-91-07, and State of Colorado Docket #91-01-22-01), which was signed on January 22, 1991 (DOE et al., 1991). The IAG regulated and provided for enforcement of DOE's investigation, planning and conduct of environmental response actions at Rocky Flats. The IAG organized remedial activities into sixteen OUs, based upon similarities of geography, contaminants, or other interrelationships. Considerable environmental investigation and planning work took place under the IAG, which had a schedule containing over 200 individual milestones. It became apparent in 1992 and 1993 that DOE would be unable to meet some of these milestones. Under the terms of a Tolling Agreement signed among the Parties on July 7, 1994, DOE paid cash penalties and conducted supplemental environmental projects

totaling $2.8 million. In light of these events, the Parties began in mid-1994 to negotiate a comprehensive environmental agreement to replace the IAG.

RFCA - - On July 19, 1996, DOE, EPA and CDPHE signed RFCA (Federal Facility Agreement and Consent Order CERCLA VIII-96-21, RCRA [3008{h}] VIII-96-01, and State of Colorado Docket #96-07-19-01) (DOE et al. 1996). RFCA expanded the cleanup scope to include the disposition of all buildings (not included in the IAG), and changed the regulatory approach in several other significant respects. It incorporated an unenforceable Preamble that set out objectives for eight subject areas, developed in consultation with local stakeholders. The eight subject areas addressed in the Preamble were: Weapons Useable Materials and Transuranic Waste, Waste Management, Water Quality, Cleanup Guidelines, Land Use, Environmental Monitoring, Building Disposition, and Mortgage Reduction. RFCA consolidated the sixteen IAG OUs into two primary OUs: the Industrial OU, for which CDPHE served as the Lead Regulatory Agency (LRA); and the Buffer Zone OU, for which EPA served as the LRA. The LRA held sole authority for approval of documents and cleanup activities in the area under its purview. RFCA coordinated all of DOE's cleanup obligations under CERCLA, RCRA and the CHWA into a single document.

RFCA also implemented a consultative, accelerated action approach toward work at the site, focusing on IHSSs (of which there would ultimately be more than four hundred; selected IHSSs are shown in Figure 2), rather than the larger OUs. RFCA also committed the Parties to make use of accelerated actions to remediate IHSSs, allowing remedial work to be conducted through accelerated review and approval processes. Rather than use the RI/FS process, accelerated actions were reviewed, approved, and conducted under decision documents. Types of decision documents included:

- Proposed Action Memoranda (PAMs), used when remedy selection was straightforward and the project in question was estimated to take place in six months or less;

- Interim Measure/Interim Remedial Actions (IM/IRAs), used when a formal evaluation of remedial options was needed, and/or when a project was anticipated to take more than six months to complete; and,

- RFCA Standard Operating Protocols (RSOPs), used for routine accelerated actions that were similar in nature, for which standardized procedures were developed.

Decision documents were made available for formal and informal public review prior to approval by the LRA.

As mentioned, building removal at Rocky Flats was also performed under the auspices of RFCA. As required by RFCA, a Decommissioning Program Plan established the framework for the disposition of all facilities at the site. Facilities were screened for contamination, and were assigned as Type 1, 2, or 3, depending on the type and amount

of contamination associated with the facility. Type 1 buildings were those free of contamination, although hazardous substances such as polychlorinated biphenyls or friable asbestos may have been present in the facility's structure. Type 1 buildings included facilities such as office buildings and cafeterias. Type 2 buildings were without significant contamination or hazards, but in need of some decontamination, and included the majority of industrial facilities at Rocky Flats. Type 3 buildings were those with significant contamination and/or hazards. These were the buildings that were used for plutonium component production, plutonium storage and/or plutonium reprocessing, and included Buildings 371/374, 707, 771/774, 776/777, and 779. Pre-demolition characterization of buildings was done according to LRA-approved characterization plans and protocols. Decommissioning of facilities was performed under the auspices of PAMs, IM/IRAs, and RSOPs, although for Type 3 buildings a separate decision document, the Decommissioning Operations Plan, was used.

The need for and extent of an accelerated action under RFCA was determined by evaluating environmental conditions against action levels found in RFCA Attachment 5 (DOE et al. 2003). Action levels were calculated for soils, groundwater and surface water, as follows:

- soil action levels were calculated to be protective of a wildlife refuge worker based on either a lifetime excess cancer risk of 1×10^{-5} or a Hazard Index of 1, whichever resulted in a lower number;

- groundwater action levels were based on surface water protection based on maximum contaminant levels or (where these were not available) a residential groundwater ingestion-based preliminary remediation goal; and,

- surface water action levels were based on the Colorado surface water use classifications for Rocky Flats, with numeric values derived from either basic or site-specific standards.

Perhaps the most prominent of the actions levels established under RFCA was the action level for plutonium in surface soil. This action level was set at 50 picoCuries per gram (pCi/g), which corresponds roughly to an excess lifetime cancer risk to the wildlife refuge worker of 5×10^{-6}. This level appears in the modifications to RFCA Attachment 5, dated May 28, 2003, and was based upon extensive scientific research (submitted for peer review), and close consultation with local stakeholders. The complete listing of action levels that guided the accelerated actions under RFCA appears in Attachment 1 of this CAD/ROD.

Three environmental permits covering operations at Rocky Flats were issued to DOE and its contractors. These were: a National Pollutant Discharge Elimination System Permit (CO-0001333), a CHWA Permit (CO7890010526), and a State of Colorado Air Quality Operating Permit (FID#0590003, OP#96OPJE124). As cleanup and closure activities have progressed, all of these permits have been terminated. In lieu of a post-closure

CHWA permit for the Present Landfill, DOE, EPA and CDPHE are entering into an enforceable agreement including post-closure requirements, which will be known as the Rocky Flats Legacy Management Agreement (RFLMA). In addition, DOE has granted an environmental covenant (DOE 2006b) to CDPHE pursuant to Section 25-15-321, Colorado Revised Statutes. This covenant, dated May 22, 2006, incorporates institutional controls and other post-closure requirements for the Rocky Flats Present Landfill.

Activities performed at Rocky Flats under the auspices of RFCA, and to complete site closure in general, included the following:

- All special nuclear materials were packaged and shipped to other DOE facilities, including:
  - Approximately 21 tons of weapons-grade material; and
  - Approximately 100 tons of plutonium residues and 30,000 liters of plutonium and enriched uranium solutions, which were processed to meet transportation and receiver site requirements;
- More than 800 structures were decontaminated to the degree necessary and removed, including five major plutonium facilities and two uranium facilities totaling over one million square feet;
- 1,457 gloveboxes, many of them highly contaminated with radioactive materials, were decontaminated, removed from their buildings and disposed of off-site;
- 690 tanks, many of which were highly contaminated, were decontaminated, removed and shipped off-site;
- 421 IHSSs, Potential Areas of Concern, Under Building Contamination Sites, and Potential Incidents of Concern were investigated and dispositioned, either by accelerated actions or by a determination that no accelerated action was required;
- Engineered covers were installed on the Present Landfill and the Original Landfill;
- Three groundwater treatment systems (addressing contamination from the Solar Ponds, East Trenches disposal area, and the Mound Site disposal area) and one seep treatment system (at the Present Landfill) were installed and continue to operate; more than 11 million gallons of groundwater and 5 million gallons of seep water have been successfully treated to date;
- All waste from cleanup and closure activities was managed and packaged appropriately, and shipped for off-site disposal, including:

- More than 15,000 cubic meters (m^3) of transuranic and transuranic mixed waste;
- More than 500,000 m^3 of low-level and low-level mixed radioactive wastes (this includes contaminated soils from areas such as the 903 Pad and Lip Area);
- More than 820,000 m^3 of sanitary waste, much of it building debris; and
- More than 4,300 m^3 of non-radioactive hazardous waste.

Many of these activities were achieved by or in coordination with the conduct of accelerated CERCLA and RCRA/CHWA remedial actions, using RFCA action levels. To complete the cleanup and closure process, a final CERCLA and RCRA/CHWA remedial decision was required based on the levels of hazardous substances remaining after the completion of the aforementioned actions. The RI/FS for Rocky Flats (DOE 2006), dated June 2006, analyzed site conditions following the completion of these actions, calculated the risks posed by residual contaminants to the anticipated future land users, and evaluated alternatives for the final remedial action. The Rocky Flats Environmental Technology Site Proposed Plan (DOE 2006a), dated July 2006, identified DOE's preferred final remedy for the site and provided the rationale for that preference. The selected final remedial decisions for Rocky Flats are documented in this CAD/ROD.

RFCA remains in effect as of the date of this CAD/ROD. It will be superseded by RFLMA. The purpose of RFLMA is to establish the regulatory framework for implementing the final remedial/corrective actions specified in this CAD/ROD, serve as the enforceable agreement for post-closure requirements, and ensure that the final remedial action remains protective of human health and the environment.

The Refuge Act provides that future ownership and management of Rocky Flats shall be retained by the United States. Under the Refuge Act, the Secretary of Energy will retain administrative jurisdiction over those engineered structures at the site used for carrying out a response action, and any lands or facilities related to a response action. This CAD/ROD presents the final delineation of engineered structures, lands and facilities to be retained related to response actions.

3. COMMUNITY PARTICIPATION

The Draft RI/FS report for the Rocky Flats Environmental Technology Site (DOE 2005) was released for public review and information in October 2005, and was available at that time in the Rocky Flats public reading rooms and online. Several informational public meetings on the draft RI/FS were held, at which representatives from DOE and its contractor, EPA and CDPHE were present to answer questions. These meetings included a discussion at the Rocky Flats Citizens Advisory Board meeting on November 3, 2005. The final RI/FS report was approved by EPA and CDPHE on July 5, 2006. Copies of the final RI/FS report were placed at seven information centers in the Denver metropolitan area on July 14, 2006. In addition, the RI/FS report was available on line at

www.rfets.gov, and copies on compact disc were available at the public information meetings during the comment period for the Proposed Plan.

DOE, EPA and CDPHE held a pre-release informational meeting for the Proposed Plan on May 30, 2006, to explain changes that were made to the draft RI/FS report, and to describe the major components of the Proposed Plan. The Proposed Plan was released for formal public comment on July 14, 2006. Notice of the public comment period appeared in *The Rocky Mountain News* and *The Denver Post* from May 22 through May 28, 2006, and was also provided at the informational public meeting. DOE sent out community and media advisories prior to the release of the Proposed Plan, and prior to each informational meeting and the public hearing. The Proposed Plan was placed in seven information centers in the Denver metropolitan area, was available at the informational meetings held during the comment period, and was available on line at www.rfets.gov. The Proposed Plan included discussions on future land use and use of groundwater at Rocky Flats. The Rocky Flats administrative record file was available for public review at the Front Range Community College reading room in Westminster, Colorado, as well as on line at www.rfets.gov.

DOE held two informational meetings during the public comment period, at which agency representatives presented the scope and purpose of the Proposed Plan, discussed opportunities to provide input on the Proposed Plan, and responded to questions from the public. The first informational meeting was held on July 19, 2006, in Golden, Colorado, and the second informational meeting took place in Westminster, Colorado on August 8, 2006. Prior notice of each meeting was provided through advertisements in the aforementioned newspapers, running from July 13 through July 19, 2006, and again from August 2 through August 8, 2006. A public hearing for the Proposed Plan took place on August 31, 2006, in Arvada, Colorado; separate sessions were held in the afternoon and in the evening on that date to accommodate as many members of the public as possible. Prior notice of the public hearing was accomplished through advertisements in the aforementioned newspapers that ran on August 30 and August 31, 2006, with a display ad posted in both papers on August 29, 2006. Both written and oral public comments were accepted at the public hearing. A transcript of the public hearing has been made available to the public and placed in the Rocky Flats administrative record file.

The public comment period for the Proposed Plan extended from July 14 through September 13, 2006. No requests for extension of the public comment period were received. DOE's responses to public comments received during the comment period are included in the Responsiveness Summary section of this CAD/ROD.

4. SCOPE AND ROLE OF OUS

OUs were created at Rocky Flats based upon the source of contamination, contamination type, and distribution of contamination. The IAG grouped IHSSs by similar contaminant or geographic location into sixteen OUs. Under the IAG, no-action CAD/RODs were

completed for three of these OUs: OU 11 (the West Spray Field), OU 15 (Inside Building Closures) and OU 16 (Low-Priority Sites).

RFCA began the consolidation of these sixteen OUs into ten, when it was signed in 1996. The ten retained OUs consisted of the three for which CAD/RODs were obtained under the IAG, the Off-Site Areas (OU 3), and four other OUs for which CAD/RODs were anticipated to be completed in the near future: OU 1 (the 881 Hillside), OU 5 (Woman Creek), OU 6 (Walnut Creek) and OU 7 (Present Landfill). The remaining OUs were consolidated into the Buffer Zone (or BZ) OU, for which EPA was the LRA, and the Industrial Area (or IA) OU, for which CDPHE was the LRA. Under RFCA, a no-action CAD/ROD for OU 3 (DOE 1997) was approved by EPA and CDPHE in June 1997. The CAD/ROD for OU 1 (DOE 1997a) was also signed in 1997, with the selected remedy/corrective action including removal of contaminated soil and pumping and treatment of contaminated groundwater. Soil contamination at OU 1 was later addressed jointly with other contaminated soil removed in connection with the 903 Pad Drum Storage Site (IHSS 112). Subsequent investigation failed to find significant contamination sources at OU 1. In light of that, a major modification to the CAD/ROD for OU 1 (DOE 2001) was approved in 2001, allowing cessation of groundwater treatment after additional monitoring. Groundwater treatment was discontinued at OU 1 in 2002.

The OUs were further consolidated in 2004, when the RFCA Parties modified the 1996 OU consolidation plan that appeared in RFCA Attachment 1. The IHSSs contained in OUs 5, 6, and 7 were placed in the BZ OU to reduce the need for additional, individual CAD/RODs for these areas. This consolidation resulted in a final total of seven OUs under RFCA (the BZ OU, the IA OU, and the five OUs for which CAD/RODs were approved). The BZ OU-IA OU boundary is shown in Figure 2. The RI/FS report evaluated conditions in the BZ and IA OUs, taking into account the accelerated actions that had been taken for the IHSSs in these OUs pursuant to RFCA. The RI/FS report re-evaluated information from those OUs on site for which CAD/RODs had already been approved (i.e., OUs 1, 11, 15, and 16), and the results of this re-evaluation are incorporated into this CAD/ROD. The RI/FS report did not further evaluate conditions in OU 3 (the Off-Site Areas), for which a no-action CAD/ROD had already been approved.

The RI/FS report identifies the areas at Rocky Flats that have been impacted by DOE activities. Based upon this, the RFCA Parties decided to reconfigure the OU boundaries to consolidate all areas of the site that may require further remedial action into a single OU. This OU is called the Central OU, and is surrounded by the Peripheral OU (Figure 3). The boundary of the Central OU was also drawn considering the practicalities of future land management. The information presented in the RI/FS report, including the results of the Comprehensive Risk Assessment, provide the basis for evaluating remedial alternatives and rendering the final remedial action/corrective action decisions for the Peripheral and Central OUs.

5. SITE CHARACTERISTICS

Physical Characteristics of Rocky Flats

Rocky Flats is located at the interface between the Great Plains and the Rocky Mountains. Approximately two miles west of the site's western boundary, the foothills of the Front Range of the Rocky Mountains rise sharply above the plains. The site's western portion is located on a broad, relatively flat pediment that slopes eastward from these foothills. On the eastern portion of Rocky Flats, the pediment surface is dissected by small stream valleys that trend generally from the west down to the east. The primary topographic features at the site are the Rock Creek, Walnut Creek and Woman Creek drainages. Sixteen named, man-made retention ponds exist at the site, including ten in the Walnut Creek drainage, two in the Woman Creek drainage, two in the Rock Creek Drainage, and two along Smart Ditch near the site's southern boundary (Figure 4). In addition, several man-made ditches cross the site, including the South Interceptor Ditch, McKay Ditch, Upper Church Ditch and Smart Ditch.

Rocky Flats is biologically diverse, reflecting its geographical setting. Five primary plant communities occur there: mesic mixed grassland, xeric tall grass prairie, wetlands, riparian woodlands and tall upland shrubs. Grasslands are the dominant plant communities. Typical wildlife includes mammals such as mule deer, coyote, whitetail deer, black-tailed prairie dogs, foxes, elk, skunks, and a variety of rodents and other small mammals. The Preble's meadow jumping mouse (*Zapus hudsonius preblei*), a Federally-listed threatened species at the time of this CAD/ROD, is found along the drainages. Over 200 species of birds have been observed at Rocky Flats. A small number of reptiles and amphibians occur at the site, including the prairie rattlesnake. The U.S. Fish and Wildlife Service began native fish restoration efforts in 2002 with the introduction of common shiners and northern redbelly dace into the Lindsay Ranch Pond.

Site accelerated remedial actions resulted in removal of buildings, except for the former east and west vehicle inspection sheds. Surface pavement has been removed. Revegetation and erosion mats and/or hydromulching were utilized to control erosion in areas of disturbed soil and sloping surfaces. Five functional channels were configured to also minimize soil disturbance and were generally placed in areas of existing major surface water drainage features. Erosion was controlled in the functional channels by armoring the entire length of the channel with riprap or erosion matting and revegetation. Each of the five functional channels was designed to convey the 100-year storm event.

Other manmade features of the site include protective covers constructed under approved IM/IRA decision documents at two landfills, the Original Landfill (DOE 2004) and Present Landfill (DOE 2004a), which were used for historic site operations. The Original Landfill, located in the southwestern corner of the historic IA OU, has a soil cover layer with a minimum thickness of two feet. Present Landfill cover consists of a soil cover, geosynthetic clay liner, flexible membrane liner, geocomposite drainage layer, cushion layer, cobble layer, and soil cover layer.

Between the ground surface and three feet below grade, essentially all structures have been removed, with the exception of some utility lines less than two inches in diameter, three groundwater collection and treatment systems that serve an ongoing function, and the Present Landfill seep collection and treatment system. At depths greater than three feet below grade, some subsurface structures remain in place following the completion of accelerated actions under RFCA. These include slabs, tunnels, and building foundations (including in some areas caissons or grade beams); sewer lines and water lines; culverts, foundation drains, and storm drains; and valve vaults and process waste lines (both Original Process Waste Lines and New Process Waste Lines). Figures 5 and 6 depict remaining slabs, tunnels, and building foundations, as well as remaining valve vaults and process waste lines.

Some subsurface features may contain residual contamination (see Figures 5 and 6). In particular, these features include slabs and building foundations, as well as valve vaults and process waste lines. Portions of the former Buildings 371/374 basement and sub-basement slab/walls, former Building 730 basement slab, former Building 771 first and second floor slabs and walls, former Building 771C slab, former Building 774 first and second floor slab/walls, and the tunnel between former Buildings 771 and 776 have residual americium-241 and plutonium-239/240 contamination. The remaining contamination in these former building slabs, walls, and tunnel is fixed within the building concrete matrix after concrete surface removal by mechanical decontamination was performed to the extent practical. In addition, portions of former Building 991 floor slabs have residual non-friable asbestos contamination.

With regard to site geology, Pierre Shale and Fox Hills Sandstone underlie the site, with the latter exposed in quarries along the western edge of the site. The Laramie and Arapahoe Formations are exposed at the surface or underlie the site. Unconsolidated surficial deposits (for example, the Rocky Flats Alluvium [RFA] and the Verdos terrace alluvium) unconformably overlie bedrock. The unconsolidated surficial deposits, combined with the weathered portion of subcropping bedrock formations, form the upper hydrostratigraphic unit (UHSU). Figure 7 shows a generalized stratigraphic column for the Rocky Flats area. Because of the wide extent of unconsolidated surficial materials beneath the historic IA and eastern BZ OUs, and relatively high hydraulic conductivity compared to that of the underlying weathered claystone, the unconsolidated portion of the UHSU is the primary influence on groundwater flow and contaminant transport at the site. Groundwater flow in the UHSU generally follows site topography (Figure 8).

In the western portions of the site, where the thickness of the RFA may exceed 100 feet, the depth to UHSU groundwater is 50 to 70 feet. The depth to groundwater generally becomes shallower, and the saturated thickness becomes thinner, from west to east as the alluvial layer thins and the underlying claystones are closer to the surface. The amount of groundwater in the UHSU is limited. Although some monitoring wells in the UHSU are capable of producing enough water for residential uses, groundwater at the site has never been used as a drinking water source, and this use is not anticipated in the future.

The relatively small portion of infiltrating precipitation that does become shallow groundwater ultimately discharges to surface water before reaching the eastern boundary of the Central OU. Therefore, the UHSU groundwater that has been impacted by site activities discharges to surface water prior to leaving the Central OU. In addition to the UHSU, a lower hydrostratigraphic unit (LHSU) has been identified at the site. The UHSU and LHSU are separated by extremely low-permeability claystone that serves to isolate them hydraulically. The LHSU is composed of the unweathered Arapahoe, Laramie, and Fox Hills Formations. The upper Laramie Formation claystones of the LHSU, with low permeability, act as an effective aquitard that restricts downward vertical groundwater flow from the UHSU to the LHSU. Because the LHSU is hydraulically isolated from the UHSU, and because the LHSU does not show evidence of contamination from the UHSU, the LHSU is not a concern as a contaminant transport pathway from RFETS.

Two archeological surveys were conducted at Rocky Flats, in 1989 and 1991. These surveys identified local points of interest in the former BZ OU, such as Lindsay Ranch and an apple orchard. However, at that time, no sites or artifacts were found to be eligible for listing on the National Register of Historic Places.

On January 16, 1998, 64 buildings and facilities at Rocky Flats were included in a district that was formally added to the National Register of Historic Places. A Historic American Engineering Record (HAER) (HAER 1998) for the district was created using various reports, photographs, and drawings to document the history and significant contributions from 1953 to 1992 for the Rocky Flats Plant. The Rocky Flats district HAER was reviewed and accepted by the U.S. Department of Interior, National Park Service on January 22, 1999, and the HAER was transmitted to the Library of Congress. As a result of the National Park Service accepting the HAER, decontamination, decommissioning, and demolition of buildings within the historic district complied with National Historic Preservation Act requirements.

6. CHARACTERIZATION AND SAMPLING APPROACH

The DOE began more than 20 years ago to develop an extensive body of documentation about the use of hazardous substances and the known or suspected release of hazardous substances at Rocky Flats. Information was gathered from an extensive review of Rocky Flats operating records and contemporaneous documents. In addition, interviews were conducted of persons with knowledge of Rocky Flats operations and of events that did release or were suspected of releasing hazardous substances. The information collected is organized in the Rocky Flats Historical Release Report (HRR), originally published in 1992, which has been periodically updated as investigation and cleanup of the site progressed. The final version of the HRR is provided as Appendix B of the RI/FS report.

Sampling and analysis of surface and subsurface soil, groundwater, and surface water were extensively used to locate and measure hazardous substance contamination at historical IHSSs and guide the conduct and completion of remediation activities. Under

RFCA, environmental monitoring was performed under the auspices of a site-wide Integrated Monitoring Plan (IMP). Additional monitoring was conducted pursuant to environmental permits (including the NPDES permit and the State of Colorado Air Quality Operating Permit) issued to DOE and its contractors. Environmental data for Rocky Flats were collected in accordance with agency-approved Sampling and Analysis Plans (SAPs) and standardized contract-required analytical procedures. Approved Work Plans and SAPs specified the use of EPA-approved sampling procedures and analytical methods, data quality requirements, and data management processes, and specified the appropriate data quality objectives.

Data used in the RI/FS report came from a number of sources, including:

- investigations conducted at Rocky Flats prior to RFCA;
- samples collected to determine whether RFCA accelerated actions were required;
- samples collected to determine if RFCA accelerated actions were complete, or to evaluate the performance of ongoing treatment systems; and
- routine sampling conducted pursuant to environmental permits or the IMP.

Soil data used in the RI/FS report were collected between June 28, 1991, and August 22, 2005; groundwater and pond sediment data were collected between June 28, 1991, and July 31, 2005; and surface water data were collected between January 1, 2000, and July 31, 2005. Approximately two million environmental data records were used in the RI/FS report.

Data used to make accelerated action decisions included field screening methods (gammaspectroscopy and x-ray fluorescence). These data were appropriate for an accelerated action decision because in accordance with approved SAPs, field screening methods were approved as a conservative method to determine when to take an accelerated action. These data are inappropriate for decision making in the RI/FS, because field screening quality control elements do not meet specific RI/FS quality assurance/quality control requirements. Conclusions in the RI/FS report therefore did not include field screening data.

7. THE NATURE AND EXTENT OF ENVIRONMENTAL CONTAMINATION AT ROCKY FLATS

The nature and extent of contamination evaluations considered the following environmental media: soil, groundwater, surface water, sediment, and air. These evaluations were conducted to show the types of analytes of interest (AOIs) remaining in the environmental media and their extent at Rocky Flats following the completion of RFCA accelerated actions. The purpose of identifying AOIs was to focus the nature and extent evaluation on constituents that were detected at concentrations that may contribute

to the risk to future receptors and to show the overall spatial and temporal trends of those constituents on a site-wide basis. These evaluations identified fourteen AOIs for surface soil, ten AOIs for subsurface soil, nineteen AOIs for groundwater, eighteen AOIs for surface water, five AOIs for sediment, and five AOIs for air. AOIs for individual environmental media are discussed in ensuing sections.

Surface and Subsurface Soil Contamination - - Sampling and analysis of surface and subsurface soil, groundwater, and surface water were extensively used to locate and measure hazardous substance contamination at historical IHSSs and guide the conduct and completion of remediation activities for contaminated soil. All historic soil sources of contamination were addressed through the IAG and/or the RFCA accelerated action process. No other areas had activities that indicated any waste management or industrial activities that would potentially affect subsurface soil or other environmental media. To support this conclusion, additional surface soil sampling was conducted in the former BZ OU using radionuclides and metals as indicator parameters. If radionuclides and metals were not detected, the RFCA Parties agreed that there was no indication of subsurface contamination in that area.

Surface soil measurements are for soil within the top six inches at the time of sampling, and subsurface soil measurements are for soil deeper than six inches from the surface at the time of sampling. Subsurface measurements are further sorted by the following depth intervals: six inches to three feet, three to eight feet, eight to twelve feet, and greater than twelve feet. These depths are used in relation to the following general considerations:

- Less than or equal to six inches – Contamination is accessible to surface users by direct contact or suspension from wildlife refuge worker (WRW) surface use activities or wind and/or water erosion.

- Greater than six inches and less than or equal to three feet – Contamination may be accessible by localized disturbance of small areas related to WRW surface uses, such as post-hole digging or vegetation management, and by burrowing animals such as prairie dogs.

- Greater than three feet and less than or equal to eight feet – Contamination may be accessible by possible deeper disturbances related to WRW surface users, or by localized disturbance of small areas by burrowing animals.

- Greater than eight feet and less than or equal to twelve feet – This is below the average depth of burrowing animals.

- Greater than 12 feet – Contamination measurements at depth intervals below twelve feet are presented to further show the vertical gradation of soil contamination levels.

The RI/FS report considered site conditions immediately following completion of accelerated actions prior to any soil backfilling or re-contouring to match the surrounding

geomorphology. Consequently, the RI/FS report did not represent the final configuration of the site. This approach provided a conservative representation of contamination remaining in soil at the site because it did not take into account the additional protectiveness provided by the clean soil added through backfilling and grading.

Approximately 4,400 samples were collected in surface soil at Rocky Flats. Approximately 9000 samples were collected in subsurface soil.

Soil AOIs were identified using the screening process summarized in Figure 9. The screening steps for identification of soil AOIs were:

1) Comparison to background – The background comparison was used to distinguish between contamination related to site activities and naturally-occurring conditions. Background data for Rocky Flats were collected in the 1990s, and are summarized in the RI/FS report. The value used for this comparison was the mean of the analyte plus two standard deviations. If all sample results were less than this value, the analyte was eliminated from further consideration. For non-naturally occurring materials (such as organic solvents), there is no background value; therefore, such compounds were only eliminated if they were not detected.
2) Comparison to WRW Preliminary Remediation Goals (PRGs) – Analytes that were retained for further evaluation after comparison to background were compared to the PRGs for the WRW. The PRGs are levels in soil that correspond to either a 1×10^{-6} lifetime excess cancer risk, or which have a toxicity quotient of greater than 0.1, whichever value is less. If all values for an analyte were below the WRW PRG, it was eliminated from further consideration.
3) Evaluation of process knowledge and frequency of detection – Analytes were assessed using process knowledge (that is, knowledge of historical operations and the use of chemicals at Rocky Flats). Analytes were eliminated from further consideration if they were not used or used in only very limited quantities. Analytes were also eliminated from further consideration if they occurred at levels greater than the WRW PRG less than one per cent of the time, unless the sample occurred in a contiguous area, or if process knowledge showed that the analyte was associated with historic site activities.

The fourteen analytes retained for further evaluation in surface soils the RI/FS report are summarized in Table 1.

Of particular note among these analytes are two radionuclides, plutonium-239/240 and americium-241. These two elements were strongly associated with site activities. Plutonium-239/240 was the material used to make triggers for nuclear weapons at Rocky Flats, and americium-241 is a widely distributed radioactive daughter product of plutonium. Their distributions in surface soils are shown in Figures 10 and 11, respectively. The highest residual surface soil value for plutonium-239/240 was 183 pCi/g, found in a confirmation sample from the floor of an excavation five feet below

grade (now backfilled) near the former Building 776. This location also recorded the highest remaining level of americium-241 in surface soil at Rocky Flats (51.2 pCi/g).

Isotopes of uranium (including uranium-233/234, uranium-235 and uranium-238) are found in surface soil at Rocky Flats as a result of site activities, although a considerable portion of the uranium found at the site has a geologic origin. The maximum levels of uranium-233/234 (47.5 pCi/g), uranium-235 (2.2 pCi/g) and uranium-238 (209.3 pCi/g) in surface soil were found at the historical Ash Pits, located in the southwestern portion of the Central OU. These locations have been backfilled with soil. Other surface soil occurrences of uranium isotopes that exceeded the WRW PRG were found in the Original Landfill, and are now underneath the soil cover there.

The ten AOIs for subsurface soil are summarized in Table 2, which also includes the depth ranges at which these AOIs were encountered. Subsurface AOIs included:

- metals such as lead (which is associated with a former firing range);

- the semi-volatile organic compound benzo(a)pyrene, associated with historic disposal sites, and which is associated with asphalt;

- radionuclides including plutonium-239/240 and americium-241 (associated with historic disposal sites such as the East Trenches Area), as well as isotopes of uranium, associated with the historical Ash Pits; and,

- volatile organic compounds (VOCs) such as trichloroethene and carbon tetrachloride, which were widely used as solvents at Rocky Flats, and which are associated both with historic disposal (such as the East Trenches) and storage.

In general, AOIs in subsurface soils were bound both laterally and vertically by soils containing levels that were below background values or below the WRW PRGs. Certain of the subsurface soil AOIs, such as VOCs and uranium, are found as contaminants in shallow groundwater at Rocky Flats.

Groundwater Contamination - - Groundwater monitoring has been conducted at Rocky Flats since the first groundwater monitoring wells were installed in the vicinity of the historical Solar Evaporation Ponds in 1954. Additional wells were installed in 1960, 1966, and 1971. Until 1974, groundwater monitoring focused primarily on the detection of select radionuclides and major ions (for example, nitrate and fluoride), and the measurement of pH. Additional wells were installed, and the groundwater monitoring program was expanded in 1974 in conjunction with DOE and U.S. Geological Survey efforts to characterize the hydrology of the site. Additional wells were installed in 1981 and 1982 as part of the first RCRA groundwater monitoring program. The groundwater monitoring program was expanded significantly in 1986 when DOE entered into the Compliance Agreement with EPA and CDPHE, followed by the Site being added to the National Priorities List by EPA in 1989. Groundwater monitoring after 1986 included

hazardous, non-hazardous, and radiological constituents to facilitate a comprehensive understanding of the nature and extent of groundwater contamination at Rocky Flats.

In 1991, DOE, EPA, and CDPHE entered into the IAG, which was superseded by RFCA in 1996. The IMP, required under RFCA to implement environmental monitoring programs at the site, served as the site's groundwater monitoring plan. The IMP outlined the monitoring goals for groundwater and described the various components of the groundwater monitoring program. The IMP, originally published in May 1997, replaced the Groundwater Protection and Monitoring Program Plan. Following the signing of this CAD/ROD, groundwater monitoring at Rocky Flats will be conducted under the auspices of RFLMA, which will incorporate the monitoring requirements of this CAD/ROD.

Data used to evaluate the nature and extent of groundwater contamination were obtained from:

- Previous investigations conducted at the site prior to and under RFCA;
- Routine quarterly and semiannual groundwater monitoring under RFCA; and
- Groundwater samples collected to evaluate the performance of RFCA accelerated actions.

Groundwater data were collected in accordance with agency-approved SAPs, the IMP, and standardized analytical procedures. Data used to evaluate groundwater nature and extent include 528,889 records, specifically 488,455 records for the UHSU and 40,434 records for the LHSU. Groundwater data were collected from 939 wells in the UHSU, and from 68 wells in the LHSU.

Groundwater AOIs were identified using the screening process summarized in Figure 12. The screening steps for identification of groundwater AOIs were:

1) Non-detect and background comparison – Analytes that were not detected were not evaluated further. Analytes that were detected in groundwater samples were compared to the 99/99 upper tolerance level (UTL) value, which is a statistical value that includes 99 per cent of the population with 99 per cent confidence. Analytes that exceeded the 99/99 UTL value were retained for further evaluation.
2) Determination of surface water standards and standard comparison – Groundwater at Rocky Flats is managed for the purpose of protection of surface water, and therefore the Colorado Water Quality Control Commission surface water standards are applied to groundwater at the site. Where there is no State of Colorado water quality standard, maximum contaminant levels (MCLs) established by EPA apply. For each analyte, the appropriate surface water standard or MCL was determined. Groundwater analytes that did not have either a surface water standard or an MCL were not evaluated further.

3) Determination of contiguous, mappable plumes – For each remaining analyte, the RI/FS report considered the most recent available data from each well to determine if a contiguous, mappable plume for that analyte exists. In the UHSU, three adjacent wells with analyte concentrations above surface water standards or MCLs formed the basis for a contiguous, mappable plume. If such a plume did exist, the analyte was evaluated further.
4) Process knowledge evaluation – This screen involves an assessment of contaminants that cannot be reasonably be expected to be AOIs, even though they form contiguous, mappable plumes. This includes a number of criteria, including historical site use of a chemical, use of stainless steel pumps or casings, improper well completion, and geohydrology.

Nineteen AOIs were evaluated further for the UHSU. No analytes were considered to be AOIs for the LHSU, based on the lack of potential for groundwater contaminants to migrate downward through the thick, underlying shale strata and reach the regional drinking water aquifer below.

Sampling results for the nineteen AOIs found in UHSU groundwater are summarized in Table 3. The most significant groundwater contaminants are VOCs, uranium and nitrate. VOCs are found in association with historic disposal sites, such as the East Trenches Area, the 903 Pad, the Mound Site and Ryan's Pit. The most prevalent VOCs are tetrachloroethene and trichloroethene, both of which were used extensively as solvents at Rocky Flats. A third VOC, carbon tetrachloride, is also found extensively in UHSU groundwater, both in association with historic disposal sites, and with a leaking underground storage tank formerly located in the vicinity of former Building 771. Other VOCs are found in UHSU groundwater, including vinyl chloride. These are primarily daughter products formed by the degradation of tetrachloroethene, trichloroethene, and carbon tetrachloride, although low levels of benzene have been found in the seep emanating from the Present Landfill.

Total uranium (including the isotopes uranium-233/234, uranium-235, and uranium-238) was the only radionuclide AOI identified in UHSU groundwater. Uranium isotope occurrences above the surface water standard are found in the area of the historic solar evaporation ponds, the Original Landfill, and the Ash Pits, although concentrations in these and other areas of UHSU groundwater are influenced by high uranium concentrations derived from natural sources. The only contiguous, mappable plume for total uranium isotopes is found in the vicinity of the solar evaporation ponds.

Nitrate is a common contaminant of UHSU groundwater at Rocky Flats. Its primary source was the solar evaporation ponds, although smaller nitrate plumes occur in connection with the former 903 Pad and in Operable Unit 1, the former 881 Hillside.

Figure 13 shows the major groundwater plumes for VOCs, uranium and nitrates in the UHSU at Rocky Flats.

Surface Water and Sediment Contamination - -Surface water monitoring has been conducted at Rocky Flats throughout the site's history, from 1952 to the present. Surface water and sediment data were collected under numerous investigations and included analyses for radionuclides, metals, VOs, semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), pesticides, herbicides, dioxins (sediment only), and water quality parameters (including inorganic constituents such as nitrate and fluoride). Data were initially collected for effluent monitoring of Plant releases and reservoir and drinking water monitoring. Subsequently, surface water and sediment data have been reported in numerous site reports and were warehoused in the Rocky Flats Environmental Database System and its successor, the Soil Water Database. Surface water data have been collected from 404 locations and sediment data from 369 locations in four drainage basins that include Rock Creek, Walnut Creek (including the McKay Ditch), Woman Creek, and Lower Smart Ditch since June 28, 1991. Past data were collected under a variety of programs. These programs included, but were not limited to:

- Sitewide characterization (for example, OU RCRA Facility Investigations/RIs);
- Accelerated actions and IM/IRAs;
- NPDES sampling;
- Event-related surface water monitoring;
- Automated surface water monitoring;
- Ponds A-4, B-5, and C-2 pre-discharge sampling;
- Former Building 891 treatment facility effluent monitoring;
- Incidental waters;
- Remediation projects;
- Groundwater treatment system effluent monitoring; and
- Other special projects.

Since May 1997, the IMP, required under RFCA, guided the site's surface water and sediment monitoring programs. Under RFCA, an important feature of the site's surface water monitoring program, particularly for the radionuclides plutonium-239/240 and americium-241, was continual, flow-weighted monitoring at specific locations known as Points of Compliance (POCs) and Points of Evaluation (POEs). Attachment 5 of RFCA specified notifications, evaluations and actions to be taken by DOE if surface water action levels (0.15 picoCuries per liter [pCi/l] for plutonium-239/240 and americium-241) were exceeded at POEs or POCs (exceedances at POCs could subject DOE to

monetary penalties). Figure 14 shows the locations of POEs, POCs and other relevant surface water features.

Surface water AOIs were identified using the screening process summarized in Figure 15. The screening steps for identification of surface water AOIs were:

1) Determination of surface water standard – For each analyte, it was determined whether a surface water standard (based upon the State of Colorado surface water quality standards) existed. Where the standard was lower than the practical quantification level (PQL) for a given analyte, the PQL was used for comparison purposes in subsequent screening steps. Analytes that did not have surface water standards established were not evaluated further.
2) Nondetect and background comparisons – Analytes that were not detected were not evaluated further. Analytes that were detected were compared to the mean background value plus two standard deviations. Analytes that exceeded this value were retained for further evaluation, as were analytes (such as VOCs) that were detected, but for which no background value exists.
3) Surface water standard comparison/frequency of detection – Analytes were compared to their corresponding surface water standard (or PQL). Analytes with values that exceeded standards in more than one per cent of samples were retained for further evaluation.
4) Process knowledge evaluation – Process knowledge was used to determine whether an analyte should be evaluated further, based upon its historic use at the site. Other factors, such as the distribution of an analyte relative to its use at the site, accelerated actions taken to remove the contaminant, and the natural abundance and distribution of an analyte were considered in this step.

Eighteen AOIs were retained for surface water and evaluated further in the RI/FS report.

The principal types of contaminants found in surface water at Rocky Flats are radionuclides, VOCs, and nitrate, although all these contaminants were not found in all surface water drainages at the site (Table 4). Summary statistics for surface water AOIs are presented in Table 5.

Radionuclide AOIs include plutonium-239/240, americium-241 and uranium isotopes. The highest single level of plutonium-239/240 recorded in a surface water sample (259 pCi/l) was from a sample collected at a monitoring station (no longer in existence) known as GS-32, on the northern edge of the former Industrial Area. The sample in question was collected on June 16, 2004, during the demolition of Buildings 779 and 776/777. The relatively high activities for plutonium-239/240 and americium-241 during this period were associated with high total suspended solids concentrations in the water, which in turn resulted from disturbed soils on the Building 779 foundation slab. Plutonium-239/240 and americium-241 activities decreased in August 2004 once slab removal was completed and the area was stabilized. During the active remediation of Rocky Flats, exceedances of water quality action levels occurred at POEs and other monitoring locations in and around the former Industrial Area. However, since the

completion of active remediation, and with the re-contouring and progressive re-vegetation of the site, levels of plutonium-239/240 and americium-241 at surface water POEs and POCs have remained below action levels. Total uranium isotope levels have been increasing in surface water in South Walnut Creek, due to the greater influence of shallow groundwater (which contains substantial concentrations of naturally-occurring uranium) on surface water quality following site closure.

Seven VOCs, including tetrachloroethene, trichloroethene, carbon tetrachloride and certain of their degradation products, were identified as AOIs in surface water. In general, these have occurred in seeps, drain outfalls and ponds along South Walnut Creek. Tetrachloroethene has occurred most frequently at the former Building 771 footing drain outfall, as well as at the outfall of former monitoring station SW056 (disrupted as part of site closure). Trichloroethene occurred transitorily in Ponds B-2 and B-4, at SW-056, and at a seep between Woman Creek and the South Interceptor Ditch southeast of the former 903 Pad. Carbon tetrachloride occurred most frequently at the former Building 771 footing drain outfalls and at monitoring Station SW061. Given the volatile and reactive nature of these analytes, VOC concentrations in surface water at Rocky Flats tend to be low and transitory, and do not have a large geographic extent.

Nitrate in surface water at Rocky Flats occurs in excess of the surface water standard in the North Walnut Creek drainage, at the outfall of the former Building 774 footing drain, at station GS-13, and at the outfalls of Ponds A-2 and A-3. All of these are in the vicinity of the former solar evaporation ponds, which contaminated shallow groundwater with nitrate.

Sediment AOIs were identified using the screening process summarized in Figure 16. The screening steps for identification of sediment AOIs were:

1 Comparison to background – The background comparison was used to distinguish between contamination related to site activities and naturally-occurring conditions. The value used for this comparison was the mean of the analyte plus two standard deviations. If all sample results were less than this value, the analyte was eliminated from further consideration. For non-naturally occurring materials (such as organic solvents), there is no background value; therefore, such compounds were only eliminated if they were not detected.
2 Comparison to WRW PRGs – Analytes that were retained for further evaluation after comparison to background were compared to the PRGs for the WRW. The PRGs are levels in soil that correspond to either a 1×10^{-6} lifetime excess cancer risk, or which have a toxicity quotient of greater than 0.1, whichever value is less. If all values for an analyte were below the WRW PRG, it was eliminated from further consideration.
3 Evaluation of process knowledge and frequency of detection – Analytes were assessed using process knowledge. Analytes were eliminated from further consideration if they were not used or used in only very limited quantities. Analytes were also eliminated from further consideration if they occurred at

levels greater than the WRW PRG less than one per cent of the time. Other factors, such as the distribution of an analyte relative to its use at the site, accelerated actions taken to remove the contaminant, and the natural abundance and distribution of an analyte were considered in this step.

Five analytes were retained as AOIs for sediments, although not all AOIs were present in all drainages (Table 6).

The analytes retained for further evaluation in sediments the RI/FS report are summarized in Table 7. They include one SVOC (benzo(a)pyrene), two metals (arsenic and chromium) and two radionuclides (plutonium-239/240 and americium-241). Benzo(a)pyrene is found in the South Walnut Creek drainage in Pond B-4 sediments, and at various locations in the former Industrial Area. No concentrations of benzo(a)pyrene in sediments exceeded ten times the WRW PRG value. Arsenic values exceeding the WRW PRG are found along North and South Walnut Creeks, and in various locations in the former Industrial Area and Buffer Zone, including many (such as the D-series ponds in the southeastern portion of the site) that were unaffected by Rocky Flats activities.

The only occurrence of americium-241 in sediments above the WRW PRG is from a sample from Pond B-4 in South Walnut Creek. Plutonium-239/240 is more widespread in sediments, with levels above the WRW PRG found in sediments in Ponds A-1, A-2 and B-4, and in various ditches in and around the former Industrial Area, and near the historic 903 Pad. The highest concentration of plutonium-239/240 in sediments (217 pCi/g) occurred in Pond B-4, and was co-located with the aforementioned americium-241 sample. This sample was collected at a depth interval of 2.5 to 3.9 feet. Re-sampling of this location showed that levels of plutonium-239/240 and americium-241 exceeding 50 pCi/g were at depths greater than three feet. Consistent with RFCA action levels, the area was not remediated further.

Air Contamination - - Monitoring programs and other studies were conducted during both the production era and cleanup phase at Rocky Flats. 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 fence line showed maximum airborne radionuclide concentrations of no more than three per cent of the limiting standard during the entire cleanup phase. With completion of all accelerated actions and the attendant removal of all historical air emissions sources except for wind erosion of the minor, remnant contamination in surface soils, future air emissions from the site will be less than those in the past.

During the weapons production era, the major sources of airborne contamination comprised releases of radionuclides, 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 activities represented additional sources of emissions to air. These sources were eliminated or decreased as buildings were demolished and soil contamination was cleaned up.

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, 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 and remediated 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. VOC emissions present no health or environmental concerns at present and future levels in ambient air. Air modeling conducted for radionuclide parameters predict that, even for scenarios involving a fire in the historic 903 Pad area, emissions will be much lower than the EPA's ten millirem benchmark level for an airborne exposure pathway. None of the other potential air contaminants is regarded as having a significant environmental effect at Rocky Flats.

8. FATE AND TRANSPORT OF ENVIRONMENTAL CONTAMINANTS AT ROCKY FLATS

To assess contaminant fate and transport, information is used about the site physical characteristics, contaminant source characteristics, and contaminant distribution to develop a conceptual understanding of the dominant transport processes that affect the migration of different contaminants in various environmental media at Rocky Flats. The primary focus of investigating contaminant fate and transport at the site, consistent with RFCA objectives, is evaluating the potential for contaminants to impact surface water quality.

Evaluation of a contaminant's fate and transport is based upon the following two questions:

1) Does a complete migration pathway to surface water exist based on an evaluation of contaminant transport in each environmental medium?
2) Is there a potential impact to surface water quality based on an evaluation of data at representative groundwater and surface water monitoring locations in the creek drainages?

This fate and transport analysis focuses on contaminants that were identified as AOIs for each medium through the nature and extent evaluation process.

The chemistry of each AOI is unique. As a result, each AOI interacts differently with the geochemical environment surrounding it, making the transport mechanism (particulate, dissolved, or both) and rate of migration highly variable for each AOI. In addition, the persistence in the environment varies greatly from one AOI to another, ranging from certain organic compounds that biodegrade in a period of weeks, to stable metals that persist indefinitely.

The location of the AOI, particularly in relation to surface water drainages, plays an important role in its fate and transport. For example, an AOI located in surface soil is subject to different transport mechanisms, such as wind and water erosion, than a contaminant located several feet below the ground surface. An AOI that is primarily transported by surface transport mechanisms, but is located in subsurface soil (such as waste deposited into a trench during historic operations), may not be mobile and available for transport via subsurface mechanisms. The AOI's geochemistry, persistence, and location, coupled with the results of predictive numerical transport modeling and process knowledge, were considered when the potential migration pathway(s) to surface water was evaluated.

AOIs evaluated for fate and transport fall into one of the following analyte groups:

- Radionuclides;
- VOCs;
- Metals;
- SVOCs;
- PCBs;
- Dioxins; and
- Water quality parameters, including inorganic compounds such as nitrate.

Table 8 presents a listing of all AOIs, and identifies the environmental medium, or media, associated with each. For each of the contaminants identified as an AOI, a description of the fate and transport characteristics for that analyte is provided in Table 9. In addition to general fate and transport characteristics, Table 9 provides fate and transport information specific to Rocky Flats, such as data from site-specific studies related to the chemical form or mobility of specific contaminants.

Based upon the hydrologic flow MIKE SHE model, VOC fate and transport modeling was conducted. The VOC transport modeling in UHSU groundwater focused on

tetrachloroethene and carbon tetrachloride, as well as their degradation products. The modeling was conducted to evaluate the movement and fate of each VOC at potential groundwater discharge areas that could impact surface water quality. The modeling scope included:

- Review of all historical UHSU water quality data;
- Development of a flow and transport model using historical conditions to determine appropriate parameter values; and
- Adaptation of the flow and transport model to the post-accelerated action configuration to predict long-term or maximum groundwater VOC concentrations that may discharge to surface water.

The model results were analyzed to assess whether the simulations conclusively indicated that surface water standards would be exceeded at the groundwater discharge locations. Model simulations predicted that only tetrachloroethene, trichloroethene, and carbon tetrachloride would be above surface water standards at groundwater discharge locations.

Extensive evaluation, research, and actinide modeling was conducted as part of the Actinide Migration Evaluation (AME). The AME Pathway Analysis study was conducted to quantify the environmental transport of plutonium-239/240, americium-241, uranium-233/234, uranium-235, and uranium-238 in different environmental media at Rocky Flats and to provide recommendations for long-term protection of surface water quality. The actinide transport pathways quantified included air, surface water, groundwater, and biota. The results of the AME study confirmed that the dominant transport pathways for plutonium-239/240 and americium-241 are air and water erosion. For uranium the dominant pathway is dissolved transport. In addition, as part of the AME, Rocky Flats samples from select groundwater and surface water monitoring locations were sent to Los Alamos National Laboratory for specialized analyses (High-Resolution Inductively Coupled Plasma/Mass Spectrometry and Thermal Ionization Mass Spectrometry) to quantify uranium isotope fractions and thereby determine the proportions of natural versus anthropogenic uranium in samples of groundwater and surface water.

Representative groundwater monitoring locations assessed potential impacts to surface water quality as measured at Area of Concern (AOC) and Sentinel wells (Figure 14). The AOC and Sentinel well classifications, consistent with the FY 2005 IMP (K-H 2005), are as follows:

- AOC wells – Wells that are within a drainage and downgradient of a contaminant plume or group of contaminant plumes. These wells are monitored to determine whether the plume(s) may be discharging to surface water.
- Sentinel wells – Wells that are typically located near downgradient contaminant plume edges, in drainages, and downgradient of existing

groundwater treatment systems. These wells are monitored to identify changes in groundwater quality.

The environmental media evaluated first were surface soil and sediment because they represent the surface transport mechanisms. Subsurface soil and groundwater are evaluated second as part of the subsurface transport mechanism evaluation process.

Summary of Surface Transport Pathway Evaluation - - Environmental media with contaminants subject to surface transport mechanisms are surface soil and sediment. Complete pathways from surface soil to surface water were identified for two surface soil AOIs: americium-241 and plutonium-239/240. These AOIs have been observed intermittently above the surface water standard (which is higher than background or the PQL) at representative surface water locations upstream of the terminal ponds in the North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch (SID)/Woman Creek drainages. Other than americium-241 and plutonium-239/240, all other surface soil AOIs were identified as having limited surface transport pathways to surface water.

The primary historic source of americium-241 and plutonium-239/240 in surface soil was remediated at the historical 903 Pad/Lip area, which is expected to improve long-term surface water quality. In addition, removal of impervious areas has decreased runoff volumes and peak discharge rates resulting in reduced soil erosion and associated particulate transport of americium-241 and plutonium-239/240 from surface soil to surface water.

For the remaining surface soil AOIs, the most current data for those analytes measured in surface water show concentrations below the highest of the surface water standard, background, or PQL at the representative surface water locations downstream of the terminal ponds in the North Walnut Creek, South Walnut Creek, and SID/Woman Creek drainages.

Complete pathways from sediment to surface water were identified for two sediment AOIs: americium-241 and plutonium-239/240. These are the same AOIs identified in surface soil as having a complete pathway to surface water. Americium-241 and plutonium-239/240 have been observed intermittently in surface water above the surface water standard (which is higher than background or the PQL) at representative surface water locations upstream of the terminal ponds in the North Walnut Creek, South Walnut Creek, and the SID/Woman Creek drainages. All other sediment AOIs are identified as having limited transport pathways to surface water.

Accelerated actions taken to remediate contaminants in sediments include sediment removal at the historical Bowman's Pond and vicinity, located north of former Building 774, and at Ponds B-1, B-2, and B-3 (historical IHSSs NE-142.5, -142.6, and -142.7, respectively) in the South Walnut Creek drainage. As noted for surface soil, removal of impervious areas has decreased runoff volumes and peak discharge rates resulting in

reduced sediment erosion and decreasing the associated transport of americium-241 and plutonium-239/240 from sediment to surface water.

For the remaining sediment AOIs, the most current data for those analytes measured in surface water have concentrations below the highest of the surface water standard, background, or PQL at the representative surface water locations downstream of the terminal ponds in the North Walnut Creek, South Walnut Creek, and the SID/Woman Creek drainages.

Summary of Subsurface Transport Pathway Evaluation - - Environmental media with contaminants subject to subsurface transport mechanisms are subsurface soil and groundwater. Complete pathways from subsurface soil to surface water (via groundwater) were identified for five subsurface soil AOIs, all of which are VOCs. These AOIs include carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and trichloroethene. All of these subsurface soil AOIs are associated with one or more groundwater areas, as discussed below. Consequently, these subsurface soil AOIs are also detected in groundwater at concentrations above the surface water standard at one or more Sentinel wells. Tetrachloroethene was observed in subsurface soil at a location south of former Building 991, but it does not form a contiguous, mappable plume in groundwater in that area. All other subsurface soil AOIs were identified as having limited transport pathways from subsurface soil to surface water via groundwater, including plutonium-239/240 and americium-241, which have very low mobility in the subsurface environment.

Accelerated actions related to the subsurface soil AOIs (subsurface soil removals) have been taken at the historical Mound Site/Oil Burn Pit No. 2 area, historical East Trenches, Carbon Tetrachloride Plume (historical IHSS 118.1), and historical 903 Pad/Ryan's Pit area. These actions were taken to disrupt the pathway from subsurface soil to surface water via groundwater, by reducing residual subsurface soil contamination. For the subsurface AOIs, the most current data for those analytes measured in groundwater show concentrations below the highest of the surface water standard, background, or PQL at all AOC wells.

Complete pathways from UHSU groundwater to surface water were identified for ten groundwater AOIs: uranium (sum of isotopes, uranium-233/234, uranium-235, and uranium-238), cis-1,2-dichloroethene, carbon tetrachloride, tetrachloroethene, trichloroethene, chloroform, methylene chloride, nitrate/nitrite, fluoride, and sulfate. No AOIs are identified for groundwater in the LHSU. Groundwater AOIs with complete subsurface pathways (with the potential to impact surface water quality) are primarily associated with one or more Sentinel wells in five groundwater areas. These areas are identified based on groundwater AOIs with complete pathways being detected above the highest of the surface water standard background, or PQL at Sentinel wells. These five groundwater areas and their associated contaminants, shown on Figure 17, are:

- North of former Building 771 (north of the Carbon Tetrachloride Plume) – Trichloroethene;

- The historical East Trenches area – Carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, methylene chloride, and cis-1,2-dichloroethene. This contamination is captured by the East Trenches Plume Treatment System (ETPTS);

- The historical Solar Ponds area (downgradient portion between the Solar Pond Plume Treatment System and North Walnut Creek)—Nitrate/nitrite, sulfate, and uranium (although uranium at the AOC and Sentinel wells downgradient from the Solar Ponds is predominantly from natural uranium sources, based on analyses of uranium isotope ratios). Nitrate is observed at a Sentinel well in the former 700 Area Northeast Plume which is captured by the Solar Ponds Plume Treatment System (SPPTS);

- The historical Mound Site/Oil Burn Pit No. 2 area (downgradient portion between South Walnut Creek and the Mound Site Plume Treatment System [MSPTS]) – Chloroform, trichloroethene, tetrachloroethene, 1,2-dichloroethane, cis-1,2-dichloroethene, 1,1-dichloroethene, and methylene chloride. These AOIs may exceed the surface water standards between the MSPTS and South Walnut Creek. Carbon tetrachloride, chloroform, methylene chloride, tetrachloroethene, and sulfate exceed the surface water standards between Oil Burn Pit No. 2 and the MSPTS (contaminated groundwater from the historical Oil Burn Pit No. 2 is treated at the MSPTS); and

- The historical 903 Pad/Ryan's Pit area (both the northern flow path downgradient of the 903 Pad area toward South Walnut Creek and the southern flow path downgradient of the 903 Pad/Ryan's Pit areas toward Woman Creek) – Carbon tetrachloride, chloroform, tetrachloroethene, trichloroethene, and cis-1,2-dichloroethene.

South of former Building 991, tetrachloroethene and trichloroethene are observed in subsurface soil and groundwater in Sentinel well 99305, although they do not form a contiguous, mappable plume. To improve surface water quality south of former Building 991, an accelerated action was conducted at the former SW056 location. Accelerated actions related to the groundwater AOIs (that is, installation of groundwater treatment systems) have been taken at the historical Mound Site/Oil Burn Pit No. 2, the historical East Trenches area, and in the area of the historical Solar Ponds. These actions were taken to disrupt the pathway from groundwater to surface water by collecting and treating contaminated groundwater.

For the remaining groundwater AOIs, the most current data for those analytes measured in shallow groundwater show concentrations below the highest of the surface water

standard, background, or PQL at all AOC wells with the exception of well 10594 (located downgradient of Pond A-1 in North Walnut Creek with sulfate results above background, which is higher than the surface water standard or PQL, in samples collected in 1995 and 1996).

Summary of Surface Water Evaluation - - Four surface water AOIs were observed intermittently above the highest of the surface water standard, background, or PQL at representative (non-background) surface water locations. These AOIs are americium-241, plutonium-239/240, uranium (sum of isotopes), and nitrate/nitrite. Americium-241 was observed intermittently above the surface water standard at surface water monitoring locations upstream of the terminal ponds in North Walnut Creek (SW093), South Walnut Creek (GS10), and the SID/Woman Creek drainage (GS51 and SW027). Plutonium-239/240 has been observed intermittently above the surface water standard at the same locations upstream from the terminal ponds as americium-241, as well as at station SW018 in the North Walnut Creek watershed. Uranium (sum of isotopes) was detected above the surface water standard in North Walnut Creek (GS13) and South Walnut Creek (GS10), although at both locations it is predominantly from natural uranium sources, based on analyses of uranium isotope fractions. Nitrate/nitrite was observed in North Walnut Creek (GS13) above the surface water standard. All other surface water AOIs were observed infrequently or not at all at concentrations above the highest of the surface water standard, background, or PQL at the representative surface water locations.

9. CURRENT AND POTENTIAL FUTURE LAND AND RESOURCE USES

As of the date of this CAD/ROD, all of Rocky Flats is the property of the United States, with activities there administered by DOE. The site is closed to public access. Per the Refuge Act, the majority of the site is to have jurisdiction transferred to the U.S. Fish and Wildlife Service (Service), for the purpose of becoming a national wildlife refuge. The transfer will occur upon achieving closure as defined in the Refuge Act.

The purposes of the Refuge are as follows:

- Restoring and preserving native ecosystems;
- Providing habitat for and population management of native plants and migratory and resident wildlife;
- Conserving threatened and endangered species; and
- Providing opportunities for compatible scientific research.

Management options for the Refuge were evaluated and proposed in a Comprehensive Conservation Plan (CCP) (USFWS 2004) prepared by the Service in 2004. The CCP served as the Environmental Impact Statement for this action as required under the National Environmental Policy Act.

As a result of the Refuge Act, the following land management implications are expected:

- Land ownership will remain with the United States; however, jurisdiction for certain portions of Rocky Flats will be transferred from DOE to the U.S. Department of the Interior, although DOE will retain the Central Operable Unit (Figure 3) for remedy-related purposes.

- The U.S. Department of the Interior, specifically USFWS, will administer the Refuge.

- The lands retained by DOE are expected to be managed consistent with the Refuge, unless the needs of the remedy dictate otherwise.

- Once designated as a National Wildlife Refuge, the transferred property will not be subject to annexation by any unit of general local government.

- The Refuge Act prohibits the United States from transferring any rights, title, or interest in land within the boundaries of Rocky Flats, except for the purpose of transportation improvements on the eastern edge of the site that is bordered by Indiana Street.

- Use of the land for residential, commercial, or industrial purposes will not occur, and surface water and groundwater will not be used for potable water supplies. The land is not anticipated to be used as cropland, although the CCP allows for limited livestock grazing for the purpose of vegetation management.

Specific prohibitions on activities on lands to be retained by DOE are discussed in Section 16 of this CAD/ROD.

Until recently, land around the site consisted primarily of rangeland, preserved open space, mining areas, and low-density residential areas. However, this rural pattern is beginning to change due to the spread of development from the surrounding communities. The towns of Superior and Broomfield have already experienced extensive development north and northeast of the site. The population distribution in areas around Rocky Flats as of 2004 is presented in Figure 18.

State-owned lands southwest and west of the site are used for grazing, mining, and storage and conveyance of municipal water supplies. Along Highway 93, an area of land approximately 1,200 feet wide adjacent to the site's western boundary is available for eventual development, open space, or highway right-of-way. The 259-acre DOE National Wind Technology Center is located adjacent to the northwestern corner of the Peripheral OU on lands transferred from the DOE Rocky Flats Project Office. Preserved open space is the primary existing and proposed use of the lands immediately north (Boulder County and City of Boulder) and east (Cities of Broomfield and Westminster) of the site.

Areas within the Peripheral OU and adjacent privately owned lands west of the site have been permitted by the State of Colorado and Jefferson County for mineral extraction (primarily clay, sand, and gravel mining). To the south, several horse operations and small hay fields exist at present. However, a mixed-use residential and commercial development known as Vauxmont, within the City of Arvada, is proposed for an area immediately adjacent to the southern boundary of the site. By 2020, the Denver Regional Council of Governments projects that the entire area south of the site will be developed, as well as areas to the southeast that are either not already developed or protected as open space (by the City of Westminster) around Standley Lake.

As discussed previously, shallow groundwater that has been contaminated by site-related activities becomes surface water prior to leaving the Rocky Flats Central Operable Unit. Surface water in Walnut Creek is not used for drinking water in the vicinity of Rocky Flats. Water in Walnut Creek downstream of Rocky Flats may be impounded by the City of Broomfield in Great Western Reservoir, which stores effluent for re-use as irrigation water. Surface water in Woman Creek is also not used as a drinking water supply. Water leaving the site in Woman Creek is collected in Woman Creek Reservoir above Standley Lake. It is then held, tested, and released to Walnut Creek below Great Western Reservoir. Woman Creek Reservoir is operated by the Woman Creek Reservoir Authority, a consortium of the Cities of Westminster, Thornton and Northglenn, using funds provided by DOE.

10. SUMMARY AND CONCLUSIONS OF THE COMPREHENSIVE RISK ASSESSMENT

This section summarizes the Comprehensive Risk Assessment (CRA) for Rocky Flats. The details of the CRA are found in Appendix A of the RI/FS report. The CRA was conducted in accordance with the regulatory agency-approved CRA Work Plan and Methodology (DOE 2005a). The CRA consisted of two parts: a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA). The CRA was designed to provide information to help determine the final remedy that is adequately protective of human health and the environment. The CRA estimated the risks posed by the site if no additional actions were taken. It provided the basis for taking additional action and identified the contaminants and exposure pathways that need to be addressed by the remedial action selected in this CAD/ROD.

Under CERCLA, EPA considers environmental concentrations corresponding to a 10^{-6} to 10^{-4} cancer risk range and a total non-cancer hazard index (HI) less than or equal to 1 to be adequately protective of human health. CDPHE defines acceptable human health risk as a lifetime excess cancer risk less than 1×10^{-6} from exposure to carcinogenic compounds and/or a hazard quotient (HQ) less than 1.0 for non-carcinogenic compounds (CDPHE 1994). CDPHE guidance requires evaluation of contaminant concentrations on a SWMU or release site basis. This was implemented at Rocky Flats on an IHSS-by-IHSS basis during the accelerated action process. By addressing cumulative impacts from multiple release sites, the CRA's exposure unit approach complements, but does not

supplant, CHWA's emphasis on individual release sites. State regulations also require that residual radioactivity be evaluated against annual dose criteria. These regulations establish a 25- millirem (mrem) annual dose limit for human receptors under use restrictions. If institutional controls restricting use were to fail, residual radioactivity must be less than 100 millirems per year (mrem/yr) to the appropriate human receptor.

The overall risk management goal identified for use in the ERA, as stated in the CRA Methodology, is the following:

> *Site conditions due to residual contamination should not represent significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination.*

The ERA was designed and implemented to determine whether site conditions meet the defined goal.

For purposes of the CRA, the site was divided into twelve Exposure Units (EUs) for assessing potential risks for human and terrestrial ecological receptors, and seven Aquatic EUs (AEUs) for assessing potential risks for aquatic ecological receptors. The EUs and AEUs are shown on Figure 19 and Figure 20, respectively. In addition, a site-wide analysis was conducted for wide-ranging terrestrial receptors, such as coyote and mule deer. The EUs were designated based on known sources and potential contaminant release patterns to collectively assess areas with similar types of potential contamination. Other criteria used in distinguishing the EUs included separate watersheds, as well as similar topography and vegetation. The resulting units also represent "functional areas," meaning they all fall within a size range where future wildlife refuge workers would likely spend their time. Table 10 presents a summary of the EU characteristics. The AEUs represent a framework for evaluating population risks to aquatic receptors from exposure to surface water and sediment within aquatic systems at Rocky Flats. The basis for these AEUs is that they represent separate drainages or the upper and lower portions of a large single drainage.

Site Data Quality, Adequacy and Overview- - The data used in the CRA are the result of implementation of regulatory agency-approved SAPs and SAP Addenda that were prepared to characterize background and site conditions for soil, sediment, groundwater, and surface water for the years 1991 through 2005. Data Quality Assessments (DQAs) were prepared for the site-wide data set, for each EU and each AEU. Data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability parameter analysis. Field and laboratory quality control sample data were also reviewed. Based on the DQAs, EPA and CDPHE determined that the CRA data met the data quality objectives, and were of adequate quality for the CRA.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, were used in the CRA, because these data meet the approved analytical quality assurance/quality control programs established by the IAG and RFCA. For the CRA, analytical data for samples collected over this time frame constitute a reasonably

representative data set for use in calculating concentration estimates for the CRA. For subsurface soil and subsurface sediment, only samples from a depth of up to eight feet below ground surface were used in the CRA. This was done because it is not anticipated that workers or burrowing animals will dig to depths deeper than eight feet.

The sampling data used for the HHRA (that is, used for evaluating direct contact pathways including incidental ingestion, inhalation, dermal contact, and external radiation that were evaluated on an EU basis) and ERA for each EU are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and
- Subsurface soil data (ERA).

For the HHRA, the surface soil and surface sediment data were combined into one medium because both are surficial media and exposure patterns are assumed to be similar. For the same reason, the subsurface soil and subsurface sediment data were also combined for the HHRA.

Sitewide evaluations in the HHRA (that is, evaluations for exposure pathways, including ingestion of surface water and exposure to VOCs in indoor air that were performed on a sitewide basis) were performed using the following data:

- Groundwater data (indoor air pathway);
- Subsurface soil/subsurface sediment data (indoor air pathway); and
- Surface water data.

For the AEUs the following data were used:

- Sediment data; and
- Surface water data.

Approximately two million data records were used in the CRA.

Human Health Risk Assessment - - In the first step of the HHRA, Contaminants of Concern (COCs) were identified. In this step, chemical concentrations in each EU are evaluated to assess whether a quantitative assessment of risk needs to be conducted. The human health COC selection process is illustrated on Figure 21. The COCs selected for each EU are listed in Table 11, including the range of detected concentration and frequency of detection within the EUs. COCs were identified for surface soil/surface

sediment in five of the twelve EUs. The COCs include arsenic, vanadium, benzo(a)pyrene, dioxin and plutonium-239/240.

In the next step of the HHRA, an exposure assessment was conducted to evaluate the pathways through which people may be exposed to the COCs identified for Rocky Flats. The Site Conceptual Model (SCM) provides an overview of potential human exposures at the site. The SCM describes what kind of human populations may be present, through which environmental media humans may be exposed, and through which pathways exposure may occur. The SCM is illustrated on Figure 22. The future land use for Rocky Flats is a wildlife refuge. Therefore, human populations who may be present include WRWs and WRVs. Workers may staff a visitor center, monitor and maintain the trail system, and track the on-site wildlife populations. Visitors may hike, bike, and bird-watch at Rocky Flats. WRW receptors are assumed to be adults, while WRV receptors will likely include both adults and children.

Workers and visitors could theoretically contact contaminants in surface soil, subsurface soil, sediment, surface water, and groundwater. All exposure pathways included in the SCM were identified as complete (meaning that exposure through the pathway is at least theoretically possible). In addition, the pathways were identified as either significant or insignificant. Insignificant pathways were associated with such low exposure that there will be negligible risk even if exposure occurs.

The following exposure pathways were identified as potentially complete and significant in the SCM:

- Incidental ingestion of surface soil/surface sediment;
- Inhalation of dust released from surface soil/surface sediment;
- Dermal exposure to surface soil/surface sediment;
- External irradiation exposure from surface soil/surface sediment;
- Incidental ingestion of subsurface soil/subsurface sediment;
- Inhalation of particulates released from subsurface soil/subsurface sediment;
- Dermal exposure to subsurface soil/subsurface sediment; and
- External irradiation exposure from subsurface soil/subsurface sediment.

These pathways were quantitatively characterized for an EU if COCs were identified. The following exposure pathways were identified as insignificant in the SCM:

- Incidental ingestion of and dermal contact with surface water;

- Inhalation of volatiles released from subsurface soil/subsurface sediment or from groundwater to indoor air; and

- Ingestion of deer and/or grazing animals.

While the indoor air pathway was considered to be insignificant for most areas of the site, VOCs have been detected in the subsurface in some sampling locations, primarily in the Industrial Area EU.

The evaluation for the indoor air inhalation pathway was performed by comparing the maximum detected concentrations (MDCs) of VOCs in subsurface soil/subsurface sediment and groundwater to PRGs for indoor air. The PRGs were developed in the CRA Methodology using the Johnson and Ettinger Indoor Air Model, which has been endorsed by EPA (EPA 2000). The MDCs of volatile compounds in subsurface soil/subsurface sediment and groundwater were compared to the PRGs, and maps were created showing all locations where maximum concentrations (that is, maximum concentrations measured at a groundwater well or in a soil boring) exceeded the PRGs (Figures 23 and 24). In these locations, the indoor air inhalation pathway is potentially significant if buildings were constructed there. In locations where there are no exceedances of the volatilization PRGs, the indoor air inhalation pathway is assumed to be insignificant.

Exposure point concentrations (EPCs) were calculated for the COCs identified in surface soil/surface sediment. EPCs are an estimate of COC concentrations to which people may be exposed. Two types of concentration estimates were used to evaluate exposure at Rocky Flats: Tier 1 and Tier 2. It is usually assumed that the best estimate for the EPC is the average concentration for an area. Because there is some uncertainty in having measured the average concentration accurately, a value higher than the calculated average is used in risk assessments. This value is the upper confidence level (UCL) on the average or mean concentration within an area. The 95 percent UCL is defined as the value that equals or exceeds the true mean with 95 percent confidence. This is the Tier 1 concentration.

If most of the data for an EU were collected in areas associated with historic releases (for example, in the Wind Blown EU, where most samples were collected in association with the 903 Pad and Lip Area), and few data points are available for the non-impacted areas, the Tier 1 EPC is likely to overestimate the concentration for the EU as a whole. Therefore, a second approach was used for the Tier 2 EPCs that equally weighs the data for different sub-areas of an EU. In this approach, averages were first calculated for 30-acre sub-areas of an EU. These averages were then combined to calculate an EU-wide average. Due to the uncertainty in having accurately characterized the average, a UCL was again calculated using the 30-acre sub-area averages; this UCL is the Tier 2 EPC. In areas where the data were evenly spaced throughout the EU, there are only minor differences between the Tier 1 and Tier 2 EPCs. Risks for COCs in surface soil and surface sediment were calculated using both Tier 1 and Tier 2 EPCs.

Exposure assumptions are factors that describe how exposure is assumed to occur. Exposure assumptions describe, for example, how long exposure will occur (exposure duration), how often (exposure frequency), and how much air will be inhaled for every hour spent on the site (inhalation rate). Most assumptions used to evaluate WRW and WRV receptors at Rocky Flats followed EPA guidelines. In addition, several site-specific assumptions were developed. Overall, the exposure assumptions and estimates represent the maximum amount of exposure that the WRW and WRV receptors can reasonably be expected to come into contact with, and are summarized in Tables 12 through 15.

A toxicity assessment, which is an estimate of how much of a chemical it would take to cause adverse human health effects, was performed for the COCs at Rocky Flats. Different chemicals have different potencies, and these are reflected in the toxicity criteria that were used in the HHRA. Toxicity criteria for the COCs are shown in Table 16. These toxicity criteria were used in the risk calculations for the COCs. Two types of toxicity criteria were used: cancer slope factors and reference doses. The former are used to estimate cancer risks, while the latter are used to estimate non-cancer health effects. Because one of the COCs for one EU is a radionuclide (plutonium-239/240), a radionuclide dose was also calculated using the RESRAD computer code. RESRAD was developed by the Argonne National Laboratory for DOE. It is used to calculate radiation dose to a chronically exposed on-site individual, using exposure parameters based on an appropriate site exposure model. RESRAD has been widely applied in decommissioning and cleanup of radioactively contaminated sites in order to determine radiation dose for comparison to regulatory requirements. RESRAD is accepted by both EPA and CDPHE for this purpose.

In the human health risk characterization, the estimated exposures to COCs were combined with the toxicity criteria to calculate risks. For example, cancer risks are calculated by multiplying the exposure estimate for a COC by the cancer slope factor, as illustrated by the following equation:

Cancer risk (unitless) = Dose Estimate (milligrams per kilogram [mg/kg] - day x Cancer Slope Factor (mg/kg – day)

For this equation, an EPC is factored together with exposure duration, exposure frequency, body weight, intake rate, and averaging time to produce the dose estimate. The estimated cancer risk represents a probability of a person developing cancer. EPA considers 1 in 1,000,000 to 1 in 10,000 to be the acceptable risk range, where the acceptable risk for each site is determined based on site-specific conditions (in the results presented in Table 16, a 1-in-1,000,000 risk is written as 1E-06; elsewhere, it appears as 1×10^{-6}). Non-cancer health effects are calculated by dividing the exposure estimate by the reference dose. The ratio between the two levels is called a hazard quotient (HQ), and an HQ less than 1 indicates that people are unlikely to have adverse health effects. An HQ is based on a single contaminant while a hazard index (HI) is based on the summation of HQs of multiple contaminants. For Rocky Flats, risks were estimated for exposure to surface soil/surface sediment by workers and visitors in five EUs where COCs were identified.

A summary of cancer and non-cancer risks and dose estimates for future WRW and WRV receptors at Rocky Flats is presented in Table 17. The cancer risk estimates for the five EUs were at the lower end of EPA's 1×10^{-6} to 1×10^{-4} risk range (that is, less than 1×10^{-5}). The non-cancer health effect estimates (that is, HIs) were all below 1, indicating non-cancer adverse health effects are unlikely.

Radiological dose estimates were developed using RESRAD. The dose estimate for plutonium-239/240 for the WRW is 0.3 mrem per year and for the WRV child is 0.2 mrem per year. These dose estimates are well below the acceptable annual radiation dose of 25 mrem specified in the Colorado Standards for Protection Against Radiation.

More specific discussions for the five EUs which had COCs are as follows:

- No Name Gulch Drainage EU – Non-cancer health effects for this EU were estimated for vanadium; the HI for this EU was well below 1.

- Wind Blown Area EU – The cancer risk estimates for this EU derive from plutonium 239/240 and arsenic, both calculated at 2×10^{-6} for the WRW. The risk estimate for the WRV from plutonium-239/240 for this area is 1×10^{-6}. Arsenic concentrations in this EU are similar to background concentrations.

- Upper Woman Creek Drainage EU – The cancer risk estimate to the WRW in this EU derive from benzo(a)pyrene (7×10^{-6}) and dioxins (2×10^{-6}). The benzo(a)pyrene samples used to calculate the risk level are now buried under several feet of soil beneath the Original Landfill cover. The soil containing dioxins in this EU was subsequently buried during the re-grading of the site, and is now approximately twenty feet below ground surface.

- Industrial Area EU – The cancer risk estimates in this EU are associated with arsenic (2×10^{-6}) and benzo(a)pyrene (1×10^{-6}). Arsenic concentrations are comparable to site background. Benzo(a)pyrene is not associated with any known release in this area, but may instead be associated with historic traffic and pavement.

Background cancer risks and non-cancer health effects from naturally occurring metals at Rocky Flats were calculated on a site-wide basis. All detected metals for which toxicity criteria are available were included in this evaluation. Background cancer risks for WRWs and WRVs are approximately 2×10^{-6} and HIs are 0.3 for the WRW and 0.1 for the WRV. These estimates are similar to the results for the five EUs where COCs were identified and risks and non-cancer hazards were quantitatively evaluated.

Risk assessments are designed to be protective of human health and, as such, employ conservative EPC estimates, exposure assumptions, and toxicity criteria. Using the UCL rather than the average concentration, even when the site has been well characterized, helps ensure that the EPC is protective of human health. The exposure assumptions are expected to overestimate typical exposures at a site. In addition, there are safety factors

built into the toxicity criteria. Because many conservative assumptions were combined, it is expected that the calculated risk for Rocky Flats is protective of any potential future exposures for the anticipated future users.

Ecological Risk Assessment - - Two types of ecological receptors were evaluated as part of the ERA: terrestrial and aquatic. The terrestrial ecological analysis was conducted for the same EUs as defined for the HHRA. A site-wide analysis was also conducted for wide-ranging terrestrial receptors that may range over the entire site (that is, coyotes and mule deer). The aquatic ecological analysis was conducted on a watershed-specific basis using the AEUs.

The overall risk management goal identified for use in this ERA is:

> *Site conditions due to residual contamination should not represent significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination.*

Significant risk of adverse ecological effects implies toxicity that reduces survivorship or reproductive capability and thereby threatens populations or communities of wildlife at Rocky Flats. For species that have additional regulatory protection due to their rare or threatened status, such as Preble's meadow jumping mouse (PMJM), significant adverse effects can occur even if individuals are affected. Therefore, the assessment for the PMJM addresses the potential for individual mice to be adversely affected by contact with ecological contaminants of potential concern (ECOPCs). For other species with stable or healthy populations, the assessment focused on population-level effects, where some individuals may suffer adverse effects; however, the effects are not ecologically meaningful because the overall site population is not significantly affected.

The ERA risk conclusions are summarized in Table 18. The ERA consisted of a data evaluation, an ECOPC identification step, exposure assessments, toxicity assessments, and a risk characterization. Exposure and toxicity assessments and the risk characterization were only performed if ECOPCs were identified for at least one medium in an EU or AEU. Of the twelve EUs that were evaluated for potential risk to terrestrial ecological receptors, eight EUs had ECOPCs identified for surface soil during risk characterization for non-PMJM receptors. PMJM receptors were evaluated for eight EUs; of these EUs, five had surface soil ECOPCs for the PMJM receptor. No ECOPCs were identified for subsurface soil for any of the EUs. The HQs for the ECOPC/receptor pairs in the EUs indicate the potential for adverse effects to PMJM and non-PMJM receptors range from low to moderate in the EUs where ECOPCs were identified. No significant risks were identified for any ecological receptor in any EU, and no high levels of uncertainty were identified for the EU data sets. Therefore, no Ecological Contaminants of Concern (ECOCs) were identified for any of the EUs or for wide-ranging receptors at Rocky Flats.

Of the seven AEUs that were evaluated for potential risk to aquatic ecological receptors, five AEUs had ECOPCs identified for surface water and sediment. The ECOPCs were

evaluated in the risk characterization using multiple lines of evidence, including an HQ assessment using chemical data and review of drainage-specific conclusions from previous studies for ECOPCs. The previous studies included tissue analyses, aquatic population studies, toxicity bioassays, waterfowl and wading bird exposure studies, and contaminant loading analyses.

The AEU assessments indicate there are no continuing, significant risks to aquatic life from residual ECOPCs due to Rocky Flats historic operations. No aquatic ECOCs were identified. While significant risks to aquatic life are not expected, the RI/FS report recommended additional sampling to further reduce the uncertainties in this analysis.

As part of the characterization of risk, the ERA also considered the results of ecological monitoring studies that have been conducted at Rocky Flats since 1991. The purpose of this long-term program was to monitor specific habitats to provide a site-wide database from which to monitor trends in the wildlife populations at Rocky Flats. Although a comprehensive compilation of monitoring results has not been presented, the annual reports of the monitoring program provide localized information and insights on the general health of the Rocky Flats ecosystem. Data collected on wildlife abundance and diversity indicate wildlife species richness remains high at the site. Overall, low risk to survival, growth, and reproduction is predicted for the ecological receptors evaluated. These data appear to support conclusions that there are no significant risks to receptor populations at Rocky Flats.

Basis for Action - - From a risk management standpoint, only one human health COC, plutonium-239/240, required further evaluation. While the risk from exposure to plutonium-239/240 to the WRW was only 2×10^{-6} for the Wind Blown EU, an alternative was evaluated in the FS to remove surface soil to reduce the risk posed by residual plutonium-239/240 to less than 1×10^{-6}.

The indoor air pathway was evaluated on a site-wide basis, and was generally judged to be insignificant. However, this evaluation indicated that subsurface levels of VOCs in certain areas (primarily the Industrial Area EU) exceeded PRGs, making the indoor air pathway potentially significant. This was also further evaluated in the FS.

The overall conclusions for the ERA indicate that site conditions due to residual contamination do not pose a significant risk to ecological receptors. However, additional environmental sampling is indicated to reduce the uncertainties in the ERA.

11. SUMMARY OF THE RESULTS OF THE RI

This section summarizes the results of the RI by environmental medium, and presents the overall conclusions of the RI. Three major analyses were performed as part of the RI. An evaluation of the nature and extent of contamination considered soil, groundwater, surface water, sediment, and air, and showed the types of contaminants remaining at Rocky Flats and their extent, following the completion of accelerated actions under

RFCA. The contaminant fate and transport evaluation used information about the site physical characteristics, contaminant source characteristics, and contaminant distribution across the site to develop a conceptual understanding of the dominant transport processes that affect the migration of different contaminants in various environmental media. The primary focus, consistent with the RFCA objectives, was evaluating the potential for contaminants from any medium to impact surface water quality. The RI included a CRA. The CRA consisted of two parts: an HHRA an ERA. The CRA was designed to provide information to decision makers to help determine the final remedy that is adequately protective of human health and the environment. The CRA evaluated the risks posed by conditions at the site to the anticipated future users, those being the WRW and the WRV. The CRA did not evaluate an unrestricted use scenario, but did consider an indoor air pathway, if occupied structures were to be present at the site in the future.

Important results of these analyses, by environmental medium, are as follows:

- Surface Soil and Surface Sediment - - The nature and extent of contamination evaluation identified fourteen AOIs in surface soil and sediment, including metals (such as arsenic), PCBs, dioxin, SVOCs (including benzo(a)pyrene), and radionuclides (including plutonium-239/240 and americium-241). The fate and transport analysis showed that only two of these substances (plutonium-239/240 and americium-241) had complete pathways to surface water. The HHRA identified only one COC requiring further evaluation, that being plutonium-239/240 in the Wind Blown EU, which posed a risk to the WRW of 2×10^{-6}. While other COCs were identified in the HHRA, they were limited in extent and/or covered by soil (such as benzo(a)pyrene), or posed risks comparable to the Rocky Flats background (in the case of arsenic). All COCs posed risks that were well within or below EPA's accepted risk range. The overall conclusions from the ERA indicated there is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination. However, additional sampling was recommended to further reduce uncertainties in this analysis.
- *Subsurface Soil* - - Fourteen subsurface AOIs were identified in the nature and extent of contamination evaluation for subsurface soil. These included metals, PCBs, benzo(a)pyrene, VOCs and radionuclides. Five subsurface soil analytes had complete pathways to surface water (via groundwater); all were VOCs. The HHRA did not identify any subsurface COCs; however, the indoor air pathway analysis did reveal a number of areas at Rocky Flats where subsurface concentrations of VOCs exceeded the indoor air PRGs. In these areas, the potential for exposure resulting in an unacceptable risk to the WRW exists, if occupied structures were to exist there in the future. While contaminated subsurface structures exist in portions of the Central OU, the CRA did not evaluate exposure to this contamination, since it was assumed that the WRW would not dig below three feet. There is no significant risk of adverse ecological effects to receptors from exposure to site-related residual subsurface soil contamination.

- *Groundwater* - - The nature and extent evaluation identified nineteen AOIs in UHSU groundwater, but none in the LHSU. AOIs included uranium, metals (including nickel and chromium), VOCs, and water quality parameters including nitrate/nitrite. The fate and transport analysis showed that ten of these AOIs had the potential to affect surface water quality, including uranium isotopes, VOCs, and nitrate/nitrite. Five groundwater areas in the Central OU were identified as having the potential to impact surface water quality. The RI concluded that residual VOC sources are likely to persist in the environment at Rocky Flats for decades to hundreds of years, notwithstanding accelerated actions that included source removals, construction of passive treatment systems, and enhancements performed pursuant to the Groundwater IM/IRA (DOE 2005b). Groundwater contaminants exist in concentrations above MCLs in the UHSU in the Central OU. The HHRA did not identify any COCs in groundwater; however, the HHRA did not evaluate the use of UHSU groundwater as a drinking water source, since this was inconsistent with both the WRW and WRV use scenarios. As with subsurface soil, the indoor air pathway analysis did reveal a number of areas at Rocky Flats where concentrations of VOCs in shallow groundwater exceeded the indoor air PRGs. In these areas, the potential for exposure resulting in an unacceptable risk to the WRW exists, if occupied structures were to exist there in the future. Groundwater was not specifically evaluated in the ERA, but the only exposure pathway for ecological receptors to groundwater is where groundwater becomes surface water as seeps. The ERA concluded that there are no significant impacts to ecological receptors from surface water, and therefore there are no effects from groundwater.

- *Surface Water* - - The nature and extent evaluation identified eighteen surface water AOIs, including VOCs, metals, radionuclides (including plutonium-239/240, americium-241, and uranium sum of isotopes), and nitrate/nitrite. The fate and transport analysis compared AOI surface water data to surface water standards at non-background surface water locations, including the POCs established under RFCA. Four AOIs (plutonium-239/240, americium-241, uranium sum of isotopes, and nitrate/nitrite) were observed in excess of surface water standards at monitoring locations within the Central OU, although no exceedances of surface water standards occurred at the POCs. Surface water leaving Rocky Flats, downstream of the terminal ponds in each drainage, is suitable for all uses. Other AOIs were observed above surface water standards infrequently or not at all. The HHRA did not identify any COCs in surface water; however, the HHRA did not evaluate the use of UHSU surface water as a drinking water source, since this was inconsistent with both the WRW and WRV use scenarios. The aquatic exposure unit assessments in the ERA indicate that there are no significant risks to aquatic life from residual contamination at Rocky Flats. However, additional sampling was recommended to further reduce some uncertainties in this analysis.

- *Air* - - With the completion of accelerated actions under RFCA, sources of ongoing emissions to air include volatilization of VOCs from residual subsurface contamination and closed landfills, and re-suspension of residual radionuclide contamination associated with surface soils. However, sources of these contaminants were removed as part of the RFCA accelerated actions. VOC emissions present no health or environmental concerns. Historic concentrations of airborne radionuclides have presented radiation doses less that three per cent of the allowable ten millirem standard, based upon samples collected since 1999.

Considering the results of the RI, DOE, EPA and CDPHE concluded that the Peripheral OU was unaffected by site activities from a hazardous waste perspective; that is, no hazardous wastes or constituents have been placed in or migrated to the Peripheral OU. This determination is based on process knowledge including past waste management practices, research into evidence of disturbed areas, and results of extensive sampling in the former Buffer Zone OU. Historical IHSSs, Potential Areas of Concern (PACs), and Potential Incidents of Concern (PICs) in the Peripheral OU are identified on Figure 25, and investigation results are summarized in Table 19.

A small portion of the Peripheral OU was impacted by site activities from a radiological perspective; for example, plutonium-239/240 exists above background in surface soil in the Wind Blown EU. As illustrated on Figure 10, there are a few sampling locations within the Peripheral OU that exceed a level of 9.8 pCi/g. Of these few sampling locations, the highest result is approximately 20 pCi/g. If the highest concentration of 20 pCi/g were considered the average concentration over an appropriate EU, it would correspond to a risk of approximately 1×10^{-5} for a rural resident, which would be in the middle of the CERCLA risk range (10^{-6} to 10^{-4}). These levels of radioactivity are also far below the 231-pCi/g activity level for an adult rural resident[5] that equates to the 25 millirem per year dose criterion specified in the Colorado Standards for Protection Against Radiation.

Figure 26 includes groundwater sampling locations where composite MCLs are exceeded in the Peripheral OU. Figure 23 shows subsurface soil sampling locations where volatilization PRGs are exceeded in the Peripheral OU. Figure 24 shows groundwater sampling locations where volatilization PRGs are exceeded in the Peripheral OU. Details on the analyte(s) causing the exceedance(s) at each location are discussed in Table 20. Further evaluation of these locations is not required.

No ECOCs were identified in the CRA for the Peripheral OU. Therefore, the RI concluded that no action is required in the Peripheral OU and the Peripheral OU is determined to be acceptable for all uses. Further evaluation of the Peripheral OU is not required.

Other significant conclusions of the RI are as follows:

- Air emissions present no health or environmental concerns, and do not need to be evaluated further;

- Further evaluation of surface soil, subsurface soil, groundwater and surface water are warranted;

- Residual surface soil contamination, in particular from plutonium-239/240, may contribute to intermittent exceedances of radionuclide standards for surface water, and poses a potential risk of 2×10^{-6} for a WRW in the Wind Blown EU:

- Certain contaminants in subsurface soil have complete pathways (via groundwater) that may affect surface water, and may pose an indoor air risk in some locations;

- There are five areas where UHSU groundwater may contribute to surface water contamination, UHSU groundwater exceeds MCLs in certain locations, and in some locations groundwater contaminants may pose an indoor air risk;

- Surface water does not always meet standards in the Central OU for some contaminants, including radionuclides; and

- Additional sampling of surface water and sediments will be needed to further reduce uncertainties in the ERA.

Activities to address these conclusions in the Central OU were addressed in the FS, and the final remedial action is contained in this CAD/ROD.

12. REMEDIAL ACTION OBJECTIVES

This section identifies remedial action objectives (RAOs) and applicable or relevant and ARARs for contaminated groundwater, surface water, and soil in the Rocky Flats Central OU. The RAOs were used in developing and evaluating remedial alternatives. The RAOs are contaminant-specific cleanup goals for the final comprehensive response action and are based on:

- Human and ecological receptor exposure pathway scenarios for each contaminated medium, consistent with the reasonably foreseeable future land use as a National Wildlife Refuge;

- ARARs; and

- Target risk levels.

Where transport of contamination occurs between environmental media, the RAOs for each medium are interdependent and are developed with this understanding.

Section 121(d) of CERCLA and NCP Section 300.430(f)(1)(ii)(b) require that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate Federal and State requirements, standards, criteria and limitations, which are collectively referred to as ARARs. Each remedial alternative was evaluated for compliance with ARARs as part of the overall remedy selection process. ARARs for Rocky Flats are shown in Table 21.

RAOs were developed for groundwater, surface water and soils (surface and subsurface). They are discussed below, together with the status of each following the completion of RFCA accelerated actions.

Groundwater Remedial Action Objective 1

Meet groundwater quality standards, which are the Colorado Water Quality Control Commission surface water standards, at groundwater AOC wells.

Status: Groundwater RAO 1 is met. For the groundwater AOIs, most current data for those analytes measured in groundwater show concentrations below the highest of the surface water standard, background, or practical quantification level at all AOC wells with one exception (well 10594, which is located down-gradient of Pond A-1 in North Walnut Creek, for sulfate results from samples collected in 1995 and 1996).

Groundwater Remedial Action Objective 2

Restore contaminated groundwater that discharges directly to surface water as base flow, and that is a significant source of surface water, to its beneficial use of surface water protection wherever practicable in a reasonable timeframe. This is measured at groundwater Sentinel wells. Prevent significant risk of adverse ecological effects.

Status: The first part of Groundwater RAO 2 (restore contaminated groundwater to its beneficial use) is not met at all Sentinel wells. However, at this time no additional removal, containment or treatment actions can reasonably be taken in addition to the accelerated actions already completed under RFCA. The second part of Groundwater RAO 2 (that is, prevent significant risk of adverse ecological effects) is met.

Groundwater Remedial Action Objective 3

Prevent domestic and irrigation use of groundwater contaminated at levels above MCLs.

Status: This RAO is not met. There are some sampling locations within the Central OU where levels of groundwater contaminants exceed MCLs.

Surface Water Remedial Action Objective
Meet surface water quality standards, which are the Colorado Water Quality Control Commission surface water standards.

Status: This RAO is met at all RFCA surface water POCs. However, surface water in the Central OU does not always meet Colorado surface water quality standards, at monitoring points upstream of the Rocky Flats terminal ponds.

Soil Remedial Action Objective 1
Prevent migration of contaminants to groundwater that would result in exceedances of groundwater RAOs.

Status: This RAO is not met everywhere in the Central OU. Soil sources of contamination have been removed through RFCA accelerated actions. However, some subsurface AOIs with complete pathways from subsurface soils to surface water (via groundwater) may be above surface water standards at one or more Sentinel wells. However, at this time no additional removal, containment or treatment actions can reasonably be taken in addition to the accelerated actions already completed under RFCA.

Soil Remedial Action Objective 2
Prevent migration of contaminants that would result in exceedances of the surface water RAO.

Status: This RAO is met if residual contamination in surface soil is not disturbed, as the fate and transport evaluation found that two soil contaminants (plutonium-239/240 and americium-241) have complete pathways to surface water. Disturbance of residual soil contamination can cause migration via erosion, and some surface water samples in the Central OU have shown levels of plutonium-239/240 and americium-241 that exceed water quality standards as a result.

Soil Remedial Action Objective 3
Prevent exposures that result in an unacceptable risk to the WRW. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not sufficiently protective because of the presence of multiple contaminants at the site or multiple pathways of exposure (40 Code of Federal Regulations 300.430[e][2][i][A][2]). Prevent significant risk of adverse ecological effects.

Status: Soil RAO 3 was determined not to be met for human health. The CRA did not evaluate an unrestricted use scenario, but instead evaluated potential risk to the anticipated future user (the WRW and the WRV). Therefore, this RAO cannot be determined to have been met for surface soil unless all exposure assumptions inherent in the risk evaluation are met. In addition, for subsurface soil, the CRA concluded that the indoor air pathway is potentially significant if buildings were constructed and occupied in portions of the Central OU where there are exceedances of volatilization PRGs in subsurface soil and groundwater. The calculated risks from all surface soil and sediment COCs fell near the low end, or below, EPA's acceptable risk range. However, the Feasibility Study analyzed additional removal of plutonium-239/240 in surface soil the Wind Blown EU to below 9.8 pCi/g, corresponding to the 1×10^{-6} PRG for the WRW. The ERA indicated that soil conditions do not represent significant risk of adverse ecological effects, so this RAO is met for the environment.

In summary, four RAOs are not met for the Central OU, including groundwater RAO 2, groundwater RAO 3, soil RAO 1 and soil RAO 3. Two other RAOs (the surface water RAO and soil RAO 2), are met currently, but would not be met if site conditions changed. Remedial alternatives for the Central OU were developed and evaluated considering the status of each of these RAOs for each environmental medium.

13. DESCRIPTION OF REMEDIAL ALTERNATIVES

The FS developed three alternatives for the Central OU. As mentioned, the RI concluded that no further evaluation was required for the Peripheral OU, and no alternatives were developed or evaluated there. The major components of the three Central OU alternatives are discussed below.

Alternative 1, No Further Action with Monitoring - - This alternative continues environmental monitoring currently required under RFCA, along with operation and maintenance activities in accordance with approved RFCA decision documents. More specifically, the components of Alternative 1 are as follows:

- Management of the Present Landfill cover system and Present Landfill seep treatment system will continue in accordance with the approved Monitoring and Maintenance Plan (2006c). Activities will include regular inspection and maintenance activities for the landfill cover and runoff control systems; RCRA groundwater monitoring at six wells; inspection and maintenance of the passive seep treatment system (designed to treat low levels of benzene in the Present Landfill seep through passive aeration); monitoring of water quality at the seep treatment system; inspection and maintenance of the East Landfill Pond dam; regular reporting to the regulatory agencies; and, institutional controls as required by the Present Landfill IM/IRA.

- Management of the Original Landfill cover system will continue in accordance with the approved Monitoring and Maintenance Plan (DOE 2006d). Activities will include regular inspection and maintenance activities for the landfill cover, toe buttress, and runoff control systems; RCRA groundwater monitoring at four wells; monitoring of surface water in Woman Creek; regular reporting to the regulatory agencies; and, institutional controls as required by the Original Landfill IM/IRA.

- Management of the three existing groundwater treatment systems (the MSPTS, the ETPTS, and the SPPTS). These systems were designed to intercept shallow contaminated groundwater and divert it to underground cells containing treatment media specific to the contaminants in the respective plumes. The MSPTS and ETPTS treat VOCs, which constitute the principal threat wastes at Rocky Flats, by passing groundwater through a medium containing zero-valent iron. The SPPTS treats groundwater containing nitrate and uranium by passing it though media containing sawdust (to facilitate

nitrate removal) and zero-valent iron (for uranium removal). Activities will include regular inspection and necessary maintenance; monitoring to determine system performance; replacement of treatment system media as needed; and, regular reporting to regulatory agencies.

- Surface water and groundwater monitoring as defined in the Fiscal Year 2005 IMP for Rocky Flats will continue, in addition to the action-specific monitoring described above.

- Additional environmental sampling will be performed to further reduce uncertainties identified in the ERA.

DOE will report the results of environmental monitoring to the regulators on a quarterly basis, and will report adverse changes in site conditions in a timely manner.

Alternative 2, Institutional and Physical Controls - - Alternative 2, Institutional and Physical Controls, adds the implementation of institutional and physical controls to Alternative 1. Institutional controls include legally enforceable and administrative land use restrictions and physical controls including signage or other physical features to control access and activity within the Central OU. Land use restrictions are limitations or prohibitions on specific activities within designated areas of the Central OU to ensure that the conditions remain protective for the WRW and WRV, and to ensure the continued functioning of the remedy. Physical controls are items such as signage or monuments along the perimeter of the Central OU to notify the WRW and WRV that they are at the Central OU boundary. Physical controls also include measures that may be necessary to protect monitoring systems or other engineered portions of the remedy. DOE will retain jurisdiction over the engineered structures and monitoring systems associated with the completed actions. Institutional controls for the Central OU are described below.

1) The construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices) is prohibited. The construction and use of storage sheds or other, unoccupied structures is permitted, consistent with the restrictions contained in items 2 and 3 below, and provided such use does not impair any aspect of the response action at Rocky Flats.
2) Excavation, drilling, and other intrusive activities below a depth of three feet are prohibited, except for remedy-related purposes.
3) No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils is permitted, except in accordance with an erosion control plan approved by CDPHE or EPA. Any such soil disturbance shall restore the soil surface to preexisting grade.
4) Surface water above the terminal ponds may not be used for drinking water or agricultural purposes.
5) The construction or operation of groundwater wells is prohibited, except for remedy-related purposes.

6) Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions.
7) Activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap, or surveyed benchmark, are prohibited.

Physical controls will consist of signage installed along the perimeter of the Central OU to notify the WRW and WRV that they are at the Central OU boundary, and to notify them of the land use restrictions in place in the Central OU. Physical controls will also protect the remedy to ensure that it functions as designed.

Institutional and physical controls will be inspected periodically. If evidence of activities that violate the restrictions or damage of the physical controls is found, DOE will develop a plan to correct the condition and the correction will be implemented. Inspections and corrective actions will be documented in an annual report to the regulatory agencies. Institutional and physical controls will be incorporated throughout the Central OU in an environmental covenant granted by DOE to CDPHE.

Alternative 3, Targeted Surface Soil Removal - - Alternative 3, Targeted Surface Soil Removal, will remove the top six inches of soil in areas of residual surface soil contamination that have activities above the plutonium-239/240 WRW PRG (based on 1 x 10^{-6} target risk) concentration of 9.8 pCi/g, as shown on Figure 27. This figure shows that surface soil over approximately 368 acres would be removed. This alternative may not completely remove all plutonium contamination within the 368 acres, but the residual risk based on the EU is expected to be well below 1 x 10^{-6} if Alternative 3 is implemented. Previous RFCA accelerated actions of a similar nature (such as those performed in the 903 Pad and Lip Area) resulted in successful removal of contamination, as verified through post-accelerated action confirmation sampling based on a 90-percent confidence level.

The scope of this alternative would be to excavate the contaminated soil in a defined area to a depth of approximately six inches. The removed soil would be placed in shipping containers and then shipped for disposal at a permitted low-level radioactive waste disposal facility. Confirmation samples would be collected to verify that the contaminated soil was removed to below 9.8 pCi/g. The excavated area will not be back-filled, but graded as necessary to match existing surrounding grades. The area would then be seeded and mulched/matted for erosion control. Temporary access roads, staging areas, and other infrastructure would be built to conduct the work. Temporary construction facilities such as work trailers, equipment parking and fueling areas, and portable electrical power generators would be used during the construction period. With the excavation of six inches of soil within this area, the volume of soil to be removed and shipped to the permitted disposal facility is approximately 10,425,000 cubic feet. The duration of this removal operation is estimated at three years.

Alternative 3 also includes implementation of the features of Alternatives 1 and 2.

Common Elements, Distinguishing Features, and Expected Outcomes of Each of the Alternatives - - Each of the alternatives considered continues to treat groundwater contamination at Rocky Flats, including contamination from VOCs, which are principal-threat wastes. The alternatives also continue the containment of wastes in the Present and Original Landfills, and continue to monitor environmental conditions at the site. Each of the alternatives anticipates establishing the same boundary between the Central OU and Peripheral OU.

Alternative 2 is distinguished from Alternative 1 by adding institutional and physical controls, thereby preventing unacceptable risk if land use assumptions were to change. Alternatives 1 and 2 are similar in their ability to be implemented, in the time frame required to execute them, and in their overall costs.

Alternative 3 is distinguished from the other two alternatives in that it is the only one that contemplates additional contaminant removal actions at Rocky Flats. By removing additional contamination, it provides additional long-term effectiveness and reduces residual risk. However, Alternative 3 is also distinguished by its higher cost, relative difficulty of implementation, and longer time frame required for execution.

Regarding use of land and groundwater resources in the Central OU, each alternative will allow for land use by the anticipated future users, although Alternative 2 (as well as Alternative 3), provides additional protection by preventing changes in conditions that may present unacceptable risks to future users. For each alternative, shallow groundwater contamination will remain in the UHSU for a considerable period of time. A detailed analysis of the alternatives is presented in the ensuing section.

14. DETAILED ANALYSIS OF ALTERNATIVES

The NCP provides that a Record of Decision must explain how the nine CERCLA criteria were used to select the final remedy. Consequently, this section of the CAD/ROD presents an evaluation of alternatives for final remedial actions to be implemented to ensure that the residual contamination at the site does not present an unacceptable risk to human health or the environment. In accordance with the RFCA paragraph 83, after completion of all planned RFCA accelerated actions, CDPHE and EPA will evaluate site conditions and render a final CAD/ROD for each OU.

A detailed analysis of three alternatives developed for the Central OU were evaluated in the RI against the nine CERCLA criteria (40 CFR 300.430[e][9]). The nine evaluation criteria are:

- Overall protection of human health and the environment;
- Compliance with ARARs;

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability;
- Cost;
- State acceptance; and
- Community acceptance.

The evaluation criteria are divided into three groups based on the function of the criteria for remedy selection. The first group is the threshold criteria related to the statutory requirements that each alternative must satisfy in order to be eligible for remedy selection. These include:

- Overall protection of human health and the environment; and
- Compliance with ARARs.

The second group is the primary balancing criteria that are the technical criteria upon which the detailed analysis is based. These include:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The third group is the modifying criteria, which includes:

- State acceptance; and
- Community acceptance.

As discussed previously, no remedial actions are required for the Peripheral OU, since it is suitable for all uses in its current state. Therefore, no remedial alternatives were developed or analyzed for the Peripheral OU.

A discussion of how each alternative compares with the individual CERCLA criteria appears below, and in summary form in Table 22.

Overall Protection of Human Health and the Environment - - The analysis of this threshold criterion describes how the alternative achieves and maintains protection of human health and the environment.

Alternative 1 is protective of human health and the environment as long as the current land configuration is maintained, and as long as the assumptions embodied in the CRA continue to be met. With the completion of the RFCA accelerated actions, risks to the WRW and WRV from residual contamination were well within the EPA's acceptable risk range for all contaminants in all media. Groundwater treatment systems will continue to operate, the remedies at the Present and Original Landfills will continue to be monitored and maintained, and environmental monitoring will continue, to verify that the site remains protective of human health and the environment. Additional environmental sampling will be conducted as part of this alternative to further reduce uncertainties in the ERA analysis. However, Alternative 1 may not be protective of human health and the environment if the current conditions were to change. Specifically:

- if assumptions embodied in the HHRA were not met, unacceptable exposure of the WRW and WRV to residual contaminants could result;

- disturbance of residual surface soil contamination (particularly plutonium-239/240 and americium-241) could result in exceedance of surface water standards;

- VOCs are present in the subsurface in some areas that could present unacceptable exposures via indoor air if occupied structures were constructed in these areas;

- groundwater in certain areas contains contaminants exceeding MCLs, and consuming this groundwater could cause unacceptable exposure to these contaminants;

- surface water does not always meet standards at some locations above the POCs, and use of this water could result in unacceptable exposures to some contaminants; and

- certain engineered features of the remedy (such as the groundwater collection and treatment systems) do not have explicit controls preventing intrusion.

Additionally, certain RAOs are not met by Alternative 1.

Alternative 2 is protective of human health and the environment in an unqualified manner. It contains institutional and physical controls that will prevent changes in land use that could otherwise result in unacceptable exposure to residual contamination. It meets all RAOs.

Alternative 3 provides somewhat more protection of human health, in that it reduces the risk to the WRW from residual radionuclide contamination in the Wind Blown EU from

approximately 2×10^{-6} to less than 1×10^{-6}. Both Alternatives 2 and 3 incorporate the treatment, monitoring and remedy maintenance features of Alternative 1. *Compliance with ARARs* - - The analysis of this threshold criterion determines how the alternative meets the federal and state ARARs that have been identified for use in the evaluation of the alternatives and the selection of the final remedy at Rocky Flats.

Alternative 1 complies with most, but not all ARARs. Specifically, Alternative 1 does not incorporate an environmental covenant between DOE and CDPHE for the entire Central OU, and so does not meet this requirement throughout the OU. Additionally, while Alternative 1 is compliant with the Colorado Water Quality Control Commission stream standards at the POCs, and so is deemed to meet this ARAR, certain locations upstream of the POCs do not meet these standards at all times.

Alternative 2 achieves compliance with all ARARs. Alternative 2 incorporates an environmental covenant for the entire Central OU, thereby meeting this ARAR. Alternative 2 also incorporates restrictions against surface water use in the Central OU, providing additional human health protection in this regard.

Alternative 3 also achieves compliance with all ARARs.

Long-Term Effectiveness and Permanence - - This analysis considers the magnitude of residual contamination and/or risk after the alternative has been implemented and the adequacy, suitability, and reliability of the alternative to control/manage the residual contamination and risk.

Alternative 1, which incorporates and maintains the positive environmental impacts of the RFCA accelerated actions, provides a moderate degree of long-term effectiveness and permanence for the following reasons:

- Many RFCA accelerated actions included removal of contaminated structures and environmental media, providing a high degree of long-term effectiveness and permanence. It was not, however, technically feasible to remove all contamination.

- Remaining building and other structures either meet free release standards for residual contamination, or have residual contamination that is either fixed in place or otherwise considered to be immobile in the environment.

- Although plutonium-239/240 persists indefinitely in the environment (for the purposes of this analysis), the major historic source of this contaminant at Rocky Flats, the 903 Pad and Lip Area, was remediated through a RFCA accelerated action. In addition to lowering residual risk, this action is anticipated to provide a long-term benefit to surface water quality.

- It is likely that residual contaminant concentrations in subsurface soil and groundwater will persist in the environment for decade to hundreds of years at

Rocky Flats. However, groundwater treatment systems will continue to operate, and enhancements such as source removals were conducted as RFCA accelerated actions. These are anticipated to have positive impacts on surface water and groundwater quality over time; however, no additional actions are considered technically feasible. Therefore, none of the alternatives considered additional groundwater remedies at Rocky Flats.

- The covers constructed at the Present and Original Landfills will continue to be maintained.

- Environmental monitoring will provide data to ensure the continuing effectiveness of the remedy, and additional sampling will be performed to further reduce uncertainties associated with the ERA analysis.

Implementation of Alternative 2 will significantly increase the long-term effectiveness and permanence achieved by the RFCA accelerated actions because institutional controls are designed to provide the mechanisms that permanently maintain the completed actions.

In addition, an environmental covenant will be implemented that will increase the long-term permanence of institutional controls. This covenant will decrease the likelihood that institutional controls will fail in the very long term. Physical controls (such as signage) will be constructed of materials that are highly durable.

Implementation of Alternative 3 increases the overall long-term effectiveness and permanence for the following reasons:

1) Removal of surface soil will permanently and effectively reduce residual plutonium-239/240 contamination to below the WRW target risk-based concentration of 9.8 pCi/g.
2) Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.

Reduction of Toxicity, Mobility or Volume through Treatment - - This analysis considers the treatment of residual contamination to reduce the contaminant toxicity, mobility, or volume. The analysis will describe the treatment process, degree of treatment, degree to which the treatment is irreversible, and volume reduction achieved through treatment.

Alternative 1 exhibits a high degree of reduction of toxicity, mobility, or volume for the following reasons:

1) The three groundwater treatment systems provide for a reduction of VOCs, or uranium and nitrate, reducing the overall volume of contaminants in the groundwater, and protecting the adjacent surface water.
2) The Present Landfill seep treatment system provides treatment to remove the VOC contamination from the landfill seep.

Experience and knowledge gained during accelerated actions have shown that it is not technically feasible to reduce toxicity, mobility, or volume of residual plutonium in surface soil through treatment.

Alternatives 2 and 3 incorporate the groundwater treatment aspects of Alternative 1. Therefore, they also exhibit a high degree of reduction of toxicity, mobility, or volume.

Short-Term Effectiveness - - This analysis addresses the protection of the community and workers while implementing the alternative, environmental impacts while implementing the alternative, and time required to achieve the RAOs.

Alternative 1 exhibits a high degree of short-term effectiveness in that workers and the public are not at risk, since no additional action is required under this alternative. However, certain RAOs are not met under Alternative 1.

Alternative 2 exhibits a high degree of short-term effectiveness, since institutional controls are easily implemented and become effective immediately. Physical controls such as signs can be in place in a very short period of time. As with Alternative 1, workers and the public are not at risk with the implementation of Alternative 2. All RAOs are met under Alternative 2.

Alternative 3 has low short-term effectiveness because:

1) Removal of surface soil in Alternative 3 will result in an incremental risk to the workers and the public through the removal and transportation operations.
2) Removal of surface soil will result in significant short-term adverse impacts to ecological resources.
3) Removal of surface soil increases the potential to mobilize residual contamination, particularly if a large area of soil is removed, or if the removal is on a steep slope or in close proximity to a stream segment. It also increases the potential for wind erosion.
4) Alternative 3 will take approximately three years to complete, once the project is begun. However, RAOs will have already been met with the implementation of Alternative 2, which is a component of Alternative 3.

Implementability - - This analysis considers the ability to build and operate the alternative, reliability of the alternative, ability to monitor the effectiveness of the alternative, administrative feasibility of the alternative, and availability of resources to implement the alternative.

Alternative 1 is easily implemented because all of the accelerated actions are complete, post-accelerated action monitoring at the Present and Original Landfills has been established, and the IMP surface water and groundwater monitoring stations have also been established.

Alternative 2 is also easily implemented by a combination of administrative and physical controls, which are expected to include institutional controls, an environmental covenant, and limited construction work to install signage and other physical controls as needed.

Alternative 3 is moderately difficult to implement. Even though standard earthmoving and transportation equipment is readily available, implementing the alternative without impacting surface water quality is difficult. Weather, wind, and precipitation will

increase the potential for soil erosion and sediment loads to the Rocky Flats drainages. Major construction to support the long duration of the work (new temporary roadways and possibly a new temporary railroad spur) would be required to implement Alternative 3. Implementation of a low-level waste disposal program compliant with DOE, U.S. Department of Transportation, and disposal facility waste acceptance criteria is moderately difficult.

Cost - - This criterion considers order-of-magnitude capital and operation and maintenance (O&M) costs of the alternative. The O&M cost estimates will include the anticipated O&M costs along with administrative costs, replacement costs, and the cost of CERCLA periodic reviews of the remedy. A present-worth analysis is also included for a period of 30 years, using a discount rate of five per cent.

An estimate of capital expenditures for Alternative 1 is not required because all of the required systems were previously installed as part of the completed accelerated action. The O&M costs include the following:

1) Cost of cover inspection and maintenance at the Present Landfill and the Original Landfill;
2) Seep treatment system monitoring and maintenance at the Present Landfill;
3) Groundwater monitoring at the Present Landfill;
4) Groundwater and surface water monitoring at the Original Landfill;
5) Monitoring and maintenance of the three existing groundwater treatment systems;
6) Monitoring of surface and groundwater per the IMP, and maintenance of wells and surface water monitoring equipment;
7) Groundwater treatment system media replacement every five years; and,
8) Preparation of materials for the CERCLA periodic reviews.

The estimated total O&M costs for Items 1 through 6 are $2,530,000 per year. Groundwater treatment system media replacement costs are estimated at $728,000 every five years. The estimated cost for preparing materials for the CERCLA periodic reviews is $153,000. The present worth of these costs for 30 years at a discount rate of five per cent is $41,350,000.

Capital expenditures for Alternative 2 are low and are associated with the preparation of specific written administrative controls, the acquisition and installation of signs, and providing the personnel to implement and monitor compliance with the institutional control requirements. The estimated capital cost of Alternative 2 is $1,120,000.

O&M costs associated with the institutional and physical controls aspect of Alternative 2 are estimated at $45,000 per year and include the quarterly inspection of the site and signage, and a nominal amount of legal support. The total O&M costs for Alternative 2 include those associated with Alternative 1, plus inspection and maintenance of institutional and physical controls. The estimated total annual O&M costs for these items are $2,575,000 per year, not including the media replacement costs and the CERCLA

periodic review costs. The total present worth of these estimated costs for 30 years at a five per cent discount rate is $43,170,000, including the present-worth cost of Alternative 1.

Capital expenditures for Alternative 3 include the cost for the removal and disposal of the soil and the repair of the disturbed area (i.e., re-vegetation and erosion control). The estimated capital cost of Alternative 3 is $222,340,000.

The O&M costs for Alternative 3 include the cost of inspection and maintenance of the area where surface soil was removed and the area re-vegetated. The O&M cost is estimated to vary over the first five years until the new vegetation has been established. The O&M costs are estimated to vary from $206,000 in the first year following implementation, to $70,000 per year in years five through thirty. The estimated total capital cost of Alternative 3, including Alternative 2 capital costs, is $223,460,000.

The estimated total annual O&M cost, including Alternative 2 costs, ranges from $2,781,000 to $2,645,000 per year, less the media replacement costs and CERCLA periodic review costs. The present worth of these estimated costs for 30 years at a five per cent discount rate is $265,510,000, including the present-worth costs of Alternatives 1 and 2.

State Acceptance - - This analysis evaluates any technical and administrative issues and concerns the state regulatory agency may have on the alternatives.

Alternative 1 is not acceptable to the State of Colorado, because it does not meet all ARARs, nor does it achieve all RAOs. Alternative 2 is acceptable to the State, and is preferred over Alternative 3. The State has determined that, while Alternative 3 is acceptable, it is not preferred, owing to concerns relating to short-term effectiveness, implementability, and cost.

Community Acceptance - - This analysis evaluates the level of support and concerns expressed by the public on the alternatives.

The public did not express any support for Alternative 1. The public expressed substantial support for Alternative 2, although numerous comments were submitted on individual aspects of this alternative, including environmental monitoring, institutional and physical controls, and public involvement. Some public support was received for Alternative 3, and certain members of the public expressed support for additional cleanup or other remedial actions that were beyond the scope of the alternatives considered. The responsiveness summary to public comments appears as Section 20 of this CAD/ROD.

15. PRINCIPAL THREAT WASTES

The NCP establishes an expectation that EPA will use treatment to address the principal threats posed by a site wherever practicable (NCP Section 300.430(a)(1)(iii)(A)). The principal threat concept is applied to the characterization of so-called source materials at

a Superfund site. A source material is a material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir for migration of contaminants to groundwater, surface water, or air, or which act as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile that generally cannot be reliably contained, or would present a significant risk to human health or the environment should exposure occur.

At Rocky Flats, VOCs that occur in subsurface soil and groundwater, also referred to as Non-Aqueous Phase Liquids, or NAPLs, are considered to be principal threat wastes. A number of these chemicals (including tetrachloroethene, trichloroethene, and carbon tetrachloride) were identified as AOIs in subsurface soil and groundwater, and they were also identified as having complete pathways to surface water in the fate and transport evaluation in the RI/FS report. The CRA analysis indicated that VOC concentrations in subsurface soil and groundwater in portions of the Central OU could pose unacceptable exposures via the indoor air pathway if occupied structures existed in these areas. Residual VOC sources and their effects on groundwater are expected to persist in the Rocky Flats environment for decades to hundreds of years.

VOCs in subsurface soil and groundwater have been addressed in several ways through accelerated actions performed under RFCA. Two passive groundwater collection and treatment systems were constructed and continue to operate at the East Trenches and Mound Site plumes. Removal actions for subsurface VOCs were conducted at locations such as the 903 Pad and near former Building 771. Additional activities to enhance removal of VOCs from subsurface soils and groundwater were evaluated and implemented pursuant to the Groundwater IM/IRA. These enhancements included injection of a substance known as hydrogen release compound into subsurface soils at the 903 Pad to expedite biologically-mediated breakdown of VOCs. Beyond these enhancement actions, and the other accelerated actions taken to address subsurface VOCs at Rocky Flats, the Groundwater IM/IRA concluded that no additional actions could practically be taken.

All of the alternatives evaluated for Rocky Flats incorporate the accelerated actions already taken to mitigate subsurface VOC contamination, and all of them incorporate ongoing treatment of groundwater for VOCs. None of the alternatives proposes additional remedial actions for VOCs in subsurface soils or groundwater. Therefore, all of the alternatives are equivalent in their approach to principal threat wastes at Rocky Flats.

16. SELECTED REMEDY/CORRECTIVE ACTION FOR THE PERIPHERAL OU

The selected remedy/corrective action for the Peripheral OU is No Action. Considering the results of the RI, DOE, EPA and CDPHE concluded that the Peripheral OU was unaffected by hazardous wastes. They also concluded that the risk and dose from low levels of residual radionuclides in the Peripheral OU were well within the EPA's

acceptable risk range for a rural resident, and were far below the activities corresponding to the State of Colorado's 25-mrem dose criterion for rural residents. Conditions in the Peripheral OU are acceptable for unrestricted use and unlimited exposure.

17. SELECTED REMEDY/CORRECTIVE ACTION FOR THE CENTRAL OU

The selected remedy/corrective action for the Central OU at Rocky Flats is Alternative 2, Institutional and Physical Controls. This section of the CAD/ROD summarizes the rationale for selecting this alternative, describes the remedy and how it will be implemented, and presents a summary of the estimated remedy costs.

Summary of the Rationale for the Selected Remedy/Corrective Action - - Alternative 2 is selected over Alternative 1 (No Further Action with Monitoring), because Alternative 1 is not completely protective of human health and the environment (not all RAOs are accomplished under Alternative 1), especially if land use conditions were to change. Additionally, since Alternative 1 does not incorporate an OU-wide environmental covenant, it is judged not to meet all ARARs. Alternative 2 incorporates institutional and physical controls that will maintain protectiveness of human health and the environment, and accomplishes all RAOs in this manner. Since Alternative 2 incorporates an OU-wide environmental covenant, it meets all ARARs. Alternative 2 is marginally more difficult to implement and more costly than Alternative 1, but these differences are negligible. Additionally, the State of Colorado found Alternative 1 to be unacceptable, and Alternative 1 received no public support.

Alternative 2 is selected over Alternative 3 (Targeted Surface Soil Removal) because of concerns about cost, implementability, and short-term effectiveness associated with Alternative 3, combined with the negligible additional benefit derived from Alternative 3. While it would be protective of human health and the environment, and provides somewhat more long-term effectiveness than Alternative 2 (by virtue of additional removal of contaminants), Alternative 3 has a present-worth cost of $265,510,000 as compared to Alternative 2's present-worth cost of $43,170,000. The short-term effectiveness of Alternative 3 is compromised because of the risk posed to workers involved in the removal of contaminated soil (associated with the operation of heavy equipment), and the risk posed to the public from transportation of these soils to disposal sites. It would be more difficult to meet surface water standards for radionuclides during the excavation period. Implementation of Alternative 3 would be moderately difficult, requiring construction of substantial infrastructure and taking approximately three years to complete. The environmental benefits of Alternative 3 as compared to Alternative 2 are negligible. The Wind Blown EU, in which the excavation would take place, is already in a protective state in terms of surface soil exposure to the WRW from plutonium-239/240. Implementation of Alternative 3 would only result in an anticipated reduction of risk to the WRW from 2×10^{-6} to less than 1×10^{-6}, and the risk to the WRV in the Wind Blown EU is already at 1×10^{-6}. Alternative 2 is preferred by the State of Colorado over Alternative 3 for these reasons. Alternative 2 received substantial public support. Some members of the public supported additional removal of radionuclide

contamination at Rocky Flats, or other remedial actions that were beyond the scope of the alternatives analyzed.

In summary, Alternative 2 is selected over Alternative 1 because Alternative 2 is more protective of human health and the environment, accomplishes all RAOs and meets all ARARs. Alternative 2 is selected over Alternative 3 because Alternative 2 is protective of human health and the environment, and because Alternative 3 provides negligible additional benefits, notwithstanding substantial additional costs, along with difficulties and risks in implementation.

Description of the Selected Remedy/Corrective Action - - The selected remedy/corrective action consists of environmental monitoring and continued operation and maintenance of engineered structures such as landfill covers and groundwater treatment systems. These requirements generally derive from accelerated action decision documents, or from other RFCA-related requirements such as the IMP. To these requirements, the selected remedy/corrective action adds institutional and physical controls, which are generally intended to prevent unacceptable exposures to residual contamination, and to protect engineered components of the remedy. Additional environmental sampling will be performed to further reduce uncertainties associated with the ERA. DOE will perform regular reporting to CDPHE and EPA, and will maintain site data related to the remedy in a manner that is accessible to regulators and the public. The requirements of this remedy will be implemented through RFLMA, as well as through an environmental covenant for the Central OU that will be granted by DOE to CDPHE. Individual components of the remedy are discussed in more detail below.

DOE will continue to perform environmental monitoring for surface water and groundwater. No further, routine monitoring of air, soil, sediment, or ecological resources (plants and animals) will be required.

Surface water monitoring will be conducted, at a minimum, at POCs and POEs. Figure 14 shows current locations of these monitoring points. POCs are currently established in Walnut and Woman Creeks at Indiana Street and at the outfalls of the terminal ponds (Ponds A-4, B-5, and C-2). POCs will remain at these points unless changes in site configuration (such as removal of the terminal ponds or the construction of a new highway along Indiana Street) force their relocation. POCs are established for the purpose of monitoring compliance with surface water quality standards (derived from the stream standards established by the Colorado Water Quality Control Commission) of surface water leaving Rocky Flats, and will be monitored at a minimum for the radionuclides plutonium-239/240 and americium-241. POEs are currently established in major drainages (North and South Walnut Creeks and the South Interceptor Ditch above Pond C-2), and will remain at these points unless changes in site configuration force changes in their location. POEs are established for the purpose of monitoring the quality of water flowing from the former Rocky Flats Industrial Area. At a minimum, POEs will be monitored for those parameters monitored at the POCs, plus additional, drainage-specific contaminants. Monitoring points in addition to POEs and POCs will be

established as needed in surface water at points known to be affected by contamination from Rocky Flats activities, for the purpose of determining the effects of accelerated actions on surface water quality, with monitoring parameters selected as appropriate to the individual monitoring point. Details of the surface water monitoring network not established in this CAD/ROD, including parameters and monitoring frequency, will be based as appropriate upon the FY 2005 IMP, as well as the approved Monitoring and Maintenance Plans for the Original Landfill and Present Landfill. The substantive requirements for surface water monitoring at Rocky Flats will be incorporated as enforceable requirements in RFLMA.

Groundwater monitoring will be conducted, at a minimum, at the following types of locations:

- AOC wells: These wells are located within drainages and are located down-gradient of a contaminant plume or group of plumes. They are monitored to determine whether contaminant plumes are discharging to surface water. AOC wells are established in the following areas:
    - downgradient of the Original Landfill (monitored for VOCs and uranium);
    - downgradient of historic OU 1 at Woman Creek (VOCs);
    - downgradient of the historic 500 and 700 areas in the former IA (VOCs);
    - southeast of the 903 Pad/Ryan's Pit plume at Woman Creek (VOCs, uranium and nitrate);
    - in North Walnut Creek below Pond A-1 (VOCs, uranium and nitrate);
    - in South Walnut Creek above Pond B-5 (VOCs, uranium and nitrate); and,
    - in Woman Creek above Pond C-2 (VOCs and uranium).

  Note that no AOC wells are required for the Present Landfill, as this area is monitored through RCRA wells, discussed below.
- Sentinel wells: These wells are typically located near down-gradient edges of contaminant plumes, in drainages, and at and down-gradient of groundwater treatment systems. They are monitored to determine whether concentrations of contaminants are increasing, which may indicate plume migration or treatment system problems. Sentinel wells are established in the following areas:
    - below the East Present Landfill Pond (monitored for VOCs, uranium and nitrate);
    - in the vicinity of the MSPTS (VOCs);
    - in the vicinity of the ETPTS (VOCs, and in the case of well GW 23296, with the addition of uranium);
    - in the vicinity of the SPPTS (uranium and nitrate, and in the case of well GW P210089, with the addition of VOCs);
    - downgradient of the historic 500 and 700 areas in the former IA (VOCs);

  - in the vicinities of historic Buildings 371/374 (VOCs, uranium and nitrate, with the addition of plutonium-239/240 and americium-241 at wells GW 37405 and GW 37705), 444 (VOCs and uranium), 771/774 (VOCs, uranium, plutonium-239/240 and americium, and in the case of well GW 20705, with the addition of nitrates), 881 (VOCs and uranium), and 991 (VOCs, uranium and nitrate);
  - southeast of the 903 Pad/Ryan's Pit plume (VOCs); and,
  - downgradient of historic Oil Burn Pit No. 2 (VOCs).

- Evaluation wells: These wells are typically located within plumes and near plume source areas, or in the interior of the former Industrial Area. Data from these wells will help determine when monitoring of an area or plume can cease.

- RCRA Wells: Dedicated to monitoring the Present Landfill and Original Landfill to determine the influence on groundwater quality resulting from these areas.

In addition, groundwater monitoring will be conducted as appropriate to meet the requirements of RFCA decision documents. Representative monitoring well locations and types are shown in Figure 14. The specific locations, parameters to be monitored and monitoring frequency for groundwater wells at Rocky Flats will be based on RFCA decision documents, RCRA post-closure requirements and the FY 2005 IMP. The substantive requirements for groundwater monitoring at Rocky Flats will be incorporated as enforceable requirements in RFLMA.

The surface water quality standards for Rocky Flats (against which surface water data will be evaluated) are the site-specific and Statewide standards listed in 5 CCR 1002, including:

- Statewide surface water radioactive materials standards in Section 31.11(2);

- Statewide surface water interim organic pollutant standards in Section 31.11(3); and

- Site-specific surface water quality standards for segments 4a, 4b, and 5 of Big Dry Creek in Section 38.6 of the South Platte Basin Classifications and Standards.

In all cases, the surface water standard is defined as the greater of the lowest surface water standard or PQL. The Colorado Water Quality Control Commission established the Rocky Flats groundwater use classification as surface water protection (5 CCR 1002-42.7[1]). The groundwater standards associated with that use classification are the surface water standards.

The ERA concluded that residual contamination in the Central OU does not represent a significant risk of adverse effects to ecological receptors. However, the RI/FS report

identified the need to perform additional environmental sampling to reduce particular uncertainties in this analysis. DOE will perform additional sampling of aquatic exposure units for this purpose; sampling may include both water and sediment. Specific sampling requirements will be evaluated among DOE, EPA and CDPHE, and will be incorporated as enforceable requirements of RFLMA. Further monitoring of ecological receptors at Rocky Flats will not be required.

DOE will inspect and maintain engineered components of the remedy so as to ensure their continued effective operation. Engineered components of the remedy include:

- the Present Landfill Cover and Seep Treatment System;
- the Original Landfill Cover;
- the Mound Site Plume Treatment System;
- the East Trenches Plume Treatment System; and
- the Solar Ponds Plume Treatment System.

Requirements for the inspection and maintenance of the landfill covers will be derived from the *Monitoring and Maintenance Plan for the Present Landfill* and the *Monitoring and Maintenance Plan for the Original Landfill*, respectively. The substantive requirements of these documents will be incorporated as enforceable requirements in RFLMA. Specific monitoring, inspection and maintenance requirements for the plume treatment systems will be derived from the respective RFCA accelerated action decision documents (i.e., *Decision Document for the Mound Site Plume (DOE 1997b)*, *Proposed Action Memorandum for the East Trenches Plume (DOE 1999)*, and *Final Solar Ponds Plume Decision Document (DOE 1999a)*), as well as the FY 2005 IMP. The substantive, relevant requirements of these documents will be incorporated as enforceable requirements in RFLMA.

As part of the selected remedy/corrective action, DOE will institute a series of institutional controls. These controls will extend throughout the Central OU (see Figure 3). In general, these controls are needed so that the assumptions incorporated into the risk assessments for the likely future users (the WRW and WRV) are not violated, and in turn these users do not receive unacceptable levels of exposure to residual contamination. Certain controls are also needed to prevent damage to engineered components of the remedy. The institutional controls that will be applied to the Central OU, and the objective and rationale for each, are as follows:

1) The construction and use of buildings that will be occupied on a permanent or temporary basis (such as for residences or offices) is prohibited. The construction and use of storage sheds or other, non-occupied structures is permitted, consistent with the restrictions contained in controls 2 and 3 below, and provided such use does not impair any aspect of the response action at Rocky Flats. *(Objective: prevent unacceptable exposures via the indoor air*

pathway. Rationale: The analysis of the indoor air pathway in the CRA indicated that subsurface VOCs were at levels in certain portions of the Central OU that could pose a risk of unacceptable exposure to the WRW if occupied structures were built in these areas.)

2) Excavation, drilling, and other intrusive activities below a depth of three feet are prohibited, except for remedy-related purposes and routine or emergency maintenance of existing utility easements, in accordance with pre-approved procedures. *(Objective: prevent unacceptable exposure to residual subsurface contamination. Rationale: Contaminated structures, such as building basements, exist in certain areas of the Central OU, and the CRA did not evaluate the risks posed by exposure to this residual contamination. Thus, this restriction eliminates the possibility of unacceptable exposures. Additionally, it prevents damage to subsurface engineered components of the remedy.)*
3) No grading, excavation, digging, tilling, or other disturbance of any kind of surface soils is permitted, except in accordance with an erosion control plan (including Surface Water Protection Plans submitted to EPA under the Clean Water Act) approved by CDPHE or EPA. Any such soil disturbance will restore the soil surface to preexisting grade. *(Objective: prevent migration of residual surface soil contamination to surface water. Rationale: Certain surface soil contaminants, notably plutonium-239/240, were identified in the fate and transport evaluation in the RI as having complete pathways to surface water if disturbed. This restriction minimizes the possibility of such disturbance and resultant impacts to surface water. Restoring the soil surface to preexisting grade maintains the current depth to subsurface contamination or contaminated structures.)*
4) Surface water may not be used for drinking water or agricultural purposes. *(Objective: prevent unacceptable exposure to local surface water contamination above the terminal ponds. Rationale: While the CRA did not evaluate the risks posed by the use of surface water for drinking or agricultural purposes, the nature and extent of contamination evaluation in the RI showed that certain contaminants were found at levels exceeding standards above the terminal ponds. This restriction reduces the possibility of unacceptable exposures to the future users from this source.)*
5) The construction or operation of groundwater wells is prohibited, except for remedy-related purposes. *(Objective: prevent unacceptable exposure to contaminated groundwater. Rationale: While the CRA did not evaluate the risks posed by the use of ground water for drinking or agricultural purposes, the nature and extent of contamination evaluation in the RI identified areas in the Central OU where groundwater contaminants exceeded water quality standards or MCLs. This restriction reduces the possibility of unacceptable exposures to future users from this source. Additionally, it prevents the disruption of groundwater flow paths so as to avoid impacts to groundwater collection and treatment systems.)*

6) Digging, drilling, tilling, grading, excavation, construction of any sort (including construction of any structures, paths, trails or roads), and vehicular traffic are prohibited on the covers of the Present Landfill and the Original Landfill, except for authorized response actions. *(Objective: ensure the continued proper functioning of the landfill covers. Rationale: This restriction helps ensure the integrity of the landfill covers.)*

7) Activities that may damage or impair the proper functioning of any engineered component of the response action, including but not limited to any treatment system, monitoring well, landfill cap, or surveyed benchmark, are prohibited. (*Objective: ensure the continued proper functioning of engineered portions of the remedy. Rationale: This restriction helps ensure the integrity of other engineered components of the remedy, including monitoring and survey points.)*

In addition to the specific rationales set forth in the text for the various use restrictions, imposing the institutional controls discussed in the text also results in achieving compliance with the CDPHE risk management policy of ensuring that residual risks to the site user are at or below 1×10^{-6}. CDPHE guidance requires evaluation of contaminant concentrations on a SWMU or release site basis. This was implemented at Rocky Flats on an IHSS-by-IHSS basis during the accelerated action process, when hazardous constituents were remediated to a residual risk level of 1×10^{-5} to the anticipated future user. Imposing the institutional controls obviates the need to conduct a post-remediation analysis of residual risk on a release site basis.

DOE shall notify EPA and CDPHE 45 days in advance of any proposed land use changes that are inconsistent with the objectives of these institutional controls or the selected remedy/corrective action. DOE shall not modify or terminate institutional controls, implementation actions or modify land use without approval by EPA and CDPHE. DOE shall seek prior concurrence before any anticipated action that may disrupt the effectiveness of these institutional controls or any action that may alter or negate the need for institutional controls. For the purposes of this CAD/ROD, DOE may not modify or terminate these institutional controls without the approval of EPA and CDPHE, by formal amendment to this CAD/ROD. These institutional controls will be contained in an environmental covenant for the Central OU that will be granted by DOE to CDPHE. DOE will notify easement holders at Rocky Flats of these controls when the covenant is granted. DOE will also record the covenant with Jefferson County, Colorado, incorporating these institutional controls.

These institutional controls will be maintained by DOE until the concentrations of hazardous substances in soil and groundwater are at such levels so as to allow for unrestricted use and unlimited exposure, and until such time as engineered components of the remedy are no longer needed. DOE is responsible for implementing, maintaining, reporting on and enforcing these institutional controls.

DOE will inspect the Central OU on a regular basis, but no less than annually, to ensure that these institutional controls are maintained. Any activity that is inconsistent with the

objectives of these institutional controls, or any other action that may interfere with their effectiveness will be addressed by DOE as soon as practicable. DOE will notify EPA and CDPHE within two days of discovering any such activity, and at that time will initiate the consultative process to address the situation. In no case will DOE notify EPA and CDPHE more than ten days after the discovery of a situation that may interfere with the effectiveness of the institutional controls. DOE will notify EPA and CDPHE, within ten days after beginning the process to address the situation, of the actions it is taking. Specific provisions for inspection, response and notification regarding institutional controls will be incorporated as enforceable requirements in RFLMA. In addition, a comprehensive list of the institutional controls, a description of the internal procedures for implementing the institutional controls and a commitment by the DOE to notify EPA and CDPHE in advance of any changes to the internal procedures that would affect the institutional controls will be incorporated as enforceable requirements in RFLMA.

The Refuge Act provides that future ownership and management of Rocky Flats shall be retained by the United States. Under the Refuge Act, the Secretary of Energy shall retain administrative jurisdiction over those engineered structures at Rocky Flats used for carrying out a response action, and any lands or facilities related to a response action or other actions to be carried out by the Secretary of Energy at Rocky Flats. Pursuant to the Refuge Act, DOE will retain administrative jurisdiction over the Central OU, as the Central OU contains the engineered structures relating to response actions and, by virtue of the institutional controls that will be in place, the entire Central OU constitutes lands that are related to a response action.

The Refuge Act precludes transfer of ownership of any portion of the Central OU. Should this law be changed and this restriction be removed, and should DOE decide to transfer any portion of the Central OU out of Federal ownership, DOE will provide notice to EPA and CDPHE at least six months prior to any transfer or sale of the Central OU, so that EPA and CDPHE can be involved in discussions to ensure that appropriate provisions are included in the transfer terms or conveyance documents to maintain effective institutional controls. If it is not possible for DOE to notify EPA and CDPHE at least six months prior to any transfer or sale, then DOE will notify DOE and CDPHE as soon as possible but no later than 60 days prior to the transfer or sale of any property subject to institutional controls. In addition to the land transfer notice and discussion provisions above, DOE further agrees to provide EPA and CDPHE with similar notice, within the same time frames, as to federal-to-federal transfer of property. DOE shall provide an executed copy of any instrument transferring the property to EPA and CDPHE. Any property transfer will take place consistent with the terms of the environmental covenant granted to CDPHE by DOE.

DOE will install and maintain physical controls for two purposes. First, DOE will install signs along the perimeter of the Central OU to notify the WRW and WRV that they are at the boundary of the Central OU. These signs will state that the Central OU is land retained by DOE and will forbid trespassing. They will be placed at intervals consistent with standard land management practices and the requirements of CHWA. DOE will

also place signs at the major access points to the Central OU that will notify the WRW and WRV of the land use restrictions in place there. (DOE intends to construct a three- or four-strand barbed wire fence around the perimeter of the Central OU for land management purposes; this fence is not part of the selected remedy/corrective action and is not, therefore, a requirement of this CAD/ROD.) Second, DOE will protect engineered components of the remedy, monitoring locations and survey points so as to ensure that they continue to function as designed. Specific provisions for inspection, maintenance and notification regarding physical controls will be incorporated as enforceable requirements in RFLMA.

DOE will provide regular reports on remedy performance and site conditions to EPA and CDPHE. These reports will include, at a minimum, an annual report describing environmental monitoring data, inspection results, status of institutional controls (including whether the use restrictions and controls described above were referenced in any instrument transferring ownership of the affected property, whether state and local agencies were notified of the use restrictions and controls affecting the property, and whether use of the property has conformed with such restrictions and controls), and maintenance actions taken by DOE. In addition to the annual report, DOE will submit quarterly reports consisting of environmental monitoring data and inspection forms. Specific provisions for reporting will be incorporated as enforceable requirements in RFLMA. Reports provided pursuant to the CAD/ROD will be available to the public.

The substantive requirements of this CAD/ROD will be implemented through RFLMA. The Parties to RFLMA will be DOE, EPA and CDPHE. The purpose of RFLMA is to establish the regulatory framework for implementing the final response action, serve as the enforceable agreement for post-closure requirements, and ensure that the final response action remains protective of human health and the environment. The RFLMA will be a single document that will have the purposes of serving as a CERCLA Section 120 Interagency Agreement and a CHWA corrective action order and enforceable mechanism for post-closure requirements. Specific objectives of RFLMA will be as follows:

- Coordinate all of DOE's post-CAD/ROD obligations under CERCLA, RCRA, and CHWA in a single agreement to streamline compliance with these three statutes;

- Specify how the performance standards in the final response action will be met;

- Specify the requirements for management of the Central OU, including monitoring, operation and maintenance of the final response action selected and approved in this CAD/ROD;

- Specify processes for review, implementation, monitoring, modification, creation, and termination, as appropriate, of response actions; and

- Provide for public information and involvement.

RFLMA will supersede RFCA, and subsume applicable RFCA requirements, including those incorporated in RFCA accelerated action decision documents. The Parties to RFLMA will make the agreement available for public review prior to entering into RFLMA. RFCA shall remain in effect until RFLMA is signed by all Parties, at which point RFCA will be terminated.

As a requirement of this CAD/ROD, DOE will grant an environmental covenant to CDPHE for the entire Central OU, pursuant to Section 25-15-321, Colorado Revised Statutes. The covenant will incorporate use restrictions for the Central OU, and will run with the Property in perpetuity and be binding on DOE and all parties having any right, title or interest in the Property, or any part thereof, their heirs, successors and assigns, and any persons using the land. The covenant granted by DOE to CDPHE for the Central OU will supersede the covenant already granted by DOE to CDPHE for the Present Landfill, and will subsume applicable requirements of the Present Landfill covenant. The Present Landfill covenant will remain in effect until DOE grants the covenant for the Central OU, at which time the Present Landfill covenant will be terminated.

Summary of the Estimated Remedy Costs - - Detailed cost estimates for the selected remedy/corrective action are provided in tables in Attachment 2. The estimated present-worth cost of the selected remedy/corrective action is $43,170,000 for 30 years, assuming an annual discount rate of five per cent. The largest single cost component of the selected alternative is ongoing environmental monitoring, which accounts for approximately $32,700,000 of the estimated present-worth costs. Other significant sources of cost associated with the selected remedy/corrective action, on a present-worth basis, include routine maintenance of landfill covers and groundwater treatment systems (approximately $6,200,000), groundwater treatment system media replacement (approximately $2,000,000), and CERCLA periodic reviews (approximately $425,000). The estimated annual operating cost for the primary, ongoing components of the selected remedy/corrective action (that is, routine maintenance of the landfill covers and groundwater treatment systems and routine environmental monitoring) is $2,530,000, using 2005 as the base year. Environmental monitoring constitutes the majority of the annual cost, and is estimated at $2,130,000, again using 2005 as the base year.

Capital costs for the selected alternative are estimated to be approximately $1,120,000. Most of this cost is associated with construction of physical controls.

The information in this cost estimate summary is based upon the best available information regarding the anticipated scope of the selected remedy/corrective action. Changes in cost estimates are likely to occur as a result of new information collected during the long-term operation of the selected remedy/corrective action. Major changes in costs may be documented as a memorandum in the Rocky Flats Administrative Record file, or as an amendment to this CAD/ROD should changes in scope or costs be sufficiently significant. The estimates presented in this CAD/ROD are order-of-magnitude engineering cost estimates expected to be within +50 to -30 per cent of actual costs.

Expected Outcomes of the Selected Remedy/Corrective Action - - Implementation of the selected remedy/corrective action, which considers the accelerated actions that have been conducted at Rocky Flats under RFCA, is expected to have the following outcomes in the Central OU:

- The land surface of the Central OU will not pose a risk of unacceptable exposure to residual contamination to the WRW or the WRV. Although DOE will not open the Central OU for visitor use, the area is safe for such use, consistent with the assumptions made in the CRA.

- Subsurface contamination remains in certain areas of the Central OU, in soils and associated with remaining structures such as basements. While this contamination does not pose a risk to the anticipated future user, restrictions against accessing the subsurface and constructing occupied buildings will need to remain in place for the foreseeable future in the Central OU.

- Groundwater contamination will remain in the UHSU in the Central OU for decades to hundreds of years, although the accelerated actions performed under RFCA will ultimately lead to improvements in groundwater quality. Restrictions against the use of groundwater in the Central OU will need to remain in place for the foreseeable future.

- Surface water leaving the Central OU (that is, downstream of the Rocky Flats terminal ponds) is anticipated to be suitable for all uses. Limited areas of surface water upstream of the terminal ponds are currently affected by inflow of contaminated groundwater, and do not always meet surface water quality standards. The groundwater accelerated actions performed under RFCA are anticipated to lead to improvements in surface water quality, although restrictions on the use of surface water in the Central OU will be needed for some period of time.

- Residual contamination in the Central OU does not pose a significant risk of adverse effects to ecological receptors.

18. STATUTORY DETERMINATIONS

Under CERCLA Section 121 and the NCP, the lead agency (in this case, DOE) must select a remedy that is protective of human health and the environment, complies with ARARs, is cost-effective, and utilizes permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element of the remedy. The section describes how the selected remedy/corrective action meets these statutory requirements.

Protection of Human Health and the Environment - - The selected remedy/corrective action (Alternative 2 – Institutional and Physical Controls), which takes into account the accelerated actions that have been taken at Rocky Flats under RFCA, is protective of human health and the environment. This degree of protectiveness is achieved through treatment, contaminant removal, engineered controls and institutional controls. Passive groundwater treatment systems and the seep treatment system at the Present Landfill will continue to operate and treat contaminants in UHSU groundwater, including VOCs, uranium and nitrate, and this has been enhanced through actions taken pursuant to the Groundwater IM/IRA. Surface and subsurface removal actions have removed soils contaminated with radionuclides (notably plutonium-239/240) and VOCs, and these have been transported and disposed off-site. Engineered covers at the Present Landfill and Original Landfill have isolated contaminants in these locations, and will continue to be maintained as part of the selected remedy/corrective action. Institutional and physical controls will be in place to ensure that no unacceptable exposures occur to the future site users, and to protect engineered structures from damage. Finally, environmental monitoring will continue, to ensure that the remedy remains protective.

Results of the CRA demonstrate that the risks posed by residual contamination at the site are within the EPA's accepted risk range of 1×10^{-4} to 1×10^{-6} or below. For non-carcinogenic human health effects, all hazard indices are less than 1, and the calculated radiation doses posed by residual contamination are well below the acceptable annual radiation dose of 25 mrem specified in the Colorado Standards for Protection Against Radiation. Residual contamination at Rocky Flats poses no significant risk of adverse effects to ecological receptors.

Compliance with ARARs - - The ARARs to be met at Rocky Flats are listed in Table 21. The selected remedy/corrective action complies with all ARARs. No other advisories, criteria or guidance were included as To Be Considered for this action.

Cost-Effectiveness - - The selected remedy/corrective action is cost-effective and represents a reasonable value for the money to be spent. In making this determination, the following definition was used: "A remedy shall be considered cost-effective if its costs are proportional to its overall effectiveness." (NCP Section 300.430[f][1][ii][D]) This was accomplished by evaluating the overall effectiveness of those alternatives that were both protective of human health and the environment and met all ARARs, in this case the selected alternative and Alternative 3, Targeted Soil Removal. The costs of these two alternatives were then compared.

Overall effectiveness was evaluated by comparing the long-term effectiveness and permanence; reduction in toxicity, mobility and volume through treatment; and short term effectiveness of the selected alternative to Alternative 3. Alternative 3 has somewhat more long-term effectiveness and permanence than the selected alternative, but this is marginal, as implementation of Alternative 3 only results in a reduction in risk to the WRW from 2×10^{-6} to less than 1×10^{-6} in the Wind Blown EU. The selected alternative is already protective, with residual risks to the anticipated future users that are well

within the EPA's acceptable risk range. These two alternatives are equivalent as regards the criterion relating to the use of treatment, as both incorporate the long-term operation of groundwater and seep treatment systems. The selected remedy/corrective action is effective in the short term, while Alternative 3 poses concerns in this regard relating to the potential for surface water standards exceedances and risks to workers and the public.

The estimated present-worth cost of the selected remedy/corrective action is $43,170,000, compared to the estimated present-worth cost of Alternative 3, which is $265,510,000. The selected remedy/corrective action provides a comparable level of overall protection to Alternative 3 at a substantially lower cost. The selected alternative is, therefore, cost-effective.

Utilization of Permanent Solutions and Alternative Treatment Technologies (or Resource Recovery Technologies) to the Maximum Extent Practicable - - The selected remedy/corrective action represents the maximum extent to which permanent solutions and treatment technologies can be used in a practicable manner at Rocky Flats. Of the two alternatives that are protective of human health and the environment, and which comply with ARARs, the selected remedy/corrective action provides the best balance as regards the five balancing criteria under CERCLA, which are:

- Long-term effectiveness and permanence;
- Reduction of toxicity, mobility, or volume through treatment;
- Short-term effectiveness;
- Implementability; and
- Cost.

The selected remedy/corrective action also considers the statutory preference for treatment as a principal element of the remedy, as well as State and community acceptance. While CERCLA incorporates a bias against off-site treatment and disposal, removal of contamination for off-site disposal was in many cases the only practicable approach for reduction of residual risks posed by Rocky Flats.

The selected remedy/corrective action, which takes into account the accelerated actions previously performed under RFCA, treats the source materials constituting principal threats at the site, through the treatment of VOCs in passive groundwater and seep treatment systems. The engineered soil covers at the present Landfill and the Original Landfill will effectively reduce the mobility of and the potential for direct exposure to contaminants remaining in those areas. There are no practicable approaches for the treatment or immobilization of radionuclides (including plutonium-239/240) in soils. The RI/FS report and the Proposed Plan concluded that there were no additional, practicable technologies available for treatment of subsurface contamination, apart from

those already undertaken as accelerated actions under RFCA. The selected remedy/corrective action poses no short-term risks, and can be readily implemented.

Preference for Treatment as a Principal Element - - By treating VOCs in UHSU groundwater and at the Present Landfill using passive groundwater and seep treatment systems, the selected remedy/corrective action addresses the principal threats at the site through the use of treatment technologies. Groundwater treatment systems at Rocky Flats also treat nitrate and uranium in UHSU groundwater, and incorporate additional enhancements pursuant to the Groundwater IM/IRA. By using treatment as a significant portion of the remedy, the selected remedy/corrective action satisfies the statutory preference for remedies that employ treatment as a principal element.

Five-Year Review Requirements - - Because the selected remedy/corrective action will result in hazardous substances, pollutants or contaminants remaining in the Central OU above levels that allow for unlimited use and unrestrictive exposure, a statutory review within five years of the date of this CAD/ROD to ensure that the selected remedy/corrective action remains protective of human health and the environment. In order to coordinate this review with the schedule for periodic review already established at Rocky Flats, the next remedy review will be completed by September 2007.

19. DOCUMENTATION OF SIGNIFICANT CHANGES

The Rocky Flats Environmental Technology Site Proposed Plan was released for public comment in July 2006. The Proposed Plan identified Alternative 2, Institutional and Physical Controls, as the preferred alternative. DOE, EPA and CDPHE reviewed all written, verbal, and e-mail comments received during the public comment period, and determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

While this CAD/ROD does not contain significant changes from the Proposed Plan, it does provide additional detail in areas that were of concern to the public, as reflected in the comments received. The following subject areas are notable in this respect:

1) *Institutional Controls* - - The CAD/ROD contains more detail on the objectives and rationale for the specific institutional controls. It also contains more information on how DOE will implement, monitor, and report on the status of institutional controls at the site.
2) *Signs* - - The CAD/ROD contains more information on the signs that will be installed at the boundary of the Central OU, and the language to be used on these signs. The CAD/ROD specifies two types of signs. One type will be posted at intervals around the Central OU boundary, notifying the WRW and WRV that they are at the Central OU boundary, and prohibiting trespassing. The second type of sign will be posted at access points to the Central OU, and will notify the WRW and the WRV of the restrictions in place there.
3) *Post-CAD/ROD enforceable agreement* - - The CAD/ROD contains more information on the purpose and content of the post-CAD/ROD regulatory

agreement (RFLMA) that will be entered into among DOE, EPA and CDPHE to implement the requirements of the CAD/ROD. The CAD/ROD notes that many of the specifics as regards environmental monitoring, maintenance, inspection and reporting will be contained in RFLMA. The CAD/ROD also requires that RFLMA be submitted for formal public comment.

4) *Central OU Boundary* - - The boundary of the Central OU (the lands to be retained by DOE for remedy-related purposes) was changed slightly from the version appearing in the Proposed Plan. Some additional areas of Woman Creek near the Original Landfill were incorporated into the Central OU in order to better facilitate maintenance of physical controls, and other, minor adjustments were made to accommodate surveying the area. No areas formerly included were removed, and the additional land included in the Central OU totals about 100 acres.
5) *Inspections* - - The Proposed Plan included quarterly inspection of institutional and physical controls. The CAD/ROD requires periodic inspection, with institutional controls inspected not less than annually. Specific requirements for inspection and maintenance of institutional and physical controls will be contained in RFLMA.

While providing more detail on these and other aspects of the selected remedy/corrective action, the remedy selected in this CAD/ROD is consistent with the preferred alternative described in the Proposed Plan.

20. RESPONSIVENESS SUMMARY

Comments were received from USFWS, City and County of Broomfield, Cities of Arvada, Northglenn, and Westminster, Rocky Flats Stewardship Council, environmental activist groups and private citizens. The name of the commenter, comments made and the responses are contained in Attachment 3, Responsiveness Summary.

DOE solicited comments regarding the Proposed Plan during a 60-day public comment period (July 14, 2006 to September 13, 2006). The Proposed Plan and the supporting Remedial Investigation/Feasibility Study, which included the Comprehensive Risk Assessment, was available for the entirety of the public comment period. These documents were available in six city and county public libraries in the area, as well as at the EPA Region 8 library, the Colorado Department of Public Health and Environment and on the Rocky Flats web page. Electronic copies of the documents were also available on CDs upon request from the Rocky Flats Public Affairs office. The Administrative Record was also available on the Rocky Flats and the Office of Legacy Management websites. A series of public meetings were held in association with the Proposed Plan.

The first meeting to roll out the release of the documents was held on May 30, 2006 in Broomfield, Colorado to announce what documents were to be released and to discuss a general description of their contents. Following the release of the Proposed Plan, two public meetings were held two weeks apart, in Golden, Colorado and Westminster,

Colorado, to explain how the document was laid out, where information upon which the document was based could be found, and to answer questions regarding the Proposed Plan. Finally, a public hearing was held from 3:00 pm to 5:00 pm and 6:00 pm to 9:00 pm in Arvada, Colorado. Those in attendance included representatives from DOE, DOE's contractor, EPA, CDPHE, USFWS, city and county officials, public interest groups, and citizens. A Court Reporter transcribed the proceedings. A short presentation was made available to the attendees along with the Proposed Plan. All meetings were announced in the legal announcement section of both major newspapers. In addition, a display ad in both major newspapers was run two days prior to the public hearing.

DOE public involvement activities at the Rocky Flats were initiated in the early 1990s and were designed to inform the public of the nature of the environmental issues associated with Rocky Flats, involve the public in the decision-making process, involve the public in the responses under consideration to remedy these issues, and inform the public of the progress being made to implement the remedy.

Every aspect of the site cleanup, including the plans for site management following closure, received the benefit of early, extensive public involvement dialogue among state and federal regulators, stakeholder organizations, elected officials and members of the general public. The RFCA Parties (DOE, CDPHE and EPA) worked collaboratively with local governments and the community on public input and community perspectives on issues related to the cleanup and closure of the Site.

In addition, Rocky Flats provided opportunities for input in the decision-making process in areas not specified by statutes and regulations. In such cases, DOE initiated a consultative process, inviting the general public, special interest groups, and local governments to participate early in the formulation of policies and prioritization of RFETS activities. The consultative process supplemented the public comment periods required by law.

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ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

AEU	aquatic exposure unit
AOC	area of concern
AOI	analyte of interest
ARAR	applicable or relevant and appropriate requirement
BZ	buffer zone
CAD	Corrective Action Decision
CAD/ROD	Corrective Action Decision/Record of Decision
CCP	Comprehensive Conservation Plan
CCR	Code of Colorado Regulations
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CHWA	Colorado Hazardous Waste Act
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRS	Colorado Revised Statutes
CWQCC	Colorado Water Quality Control Commission
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
ECOC	ecological chemical of concern
ECOPC	ecological chemical of potential concern
EPA	U.S. Environmental Protection Agency

ERA	Ecological Risk Assessment
ETPTS	East Trenches plume treatment system
EU	exposure unit
FS	Feasibility Study
FY	Fiscal Year
HAER	Historic American Engineering Record
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measure/Interim Remedial Action
IMP	Integrated Monitoring Plan
K-H	Kaiser-Hill Company, LLC
LHSU	lower hydrostratigraphic unit
LRA	Lead Regulatory Agency
m3	cubic meters
MCL	maximum contaminant level
MDC	maximum detected concentration
Mrem/yr	Millirems per year
MSPTS	mound Site plume treatment system
NAPL	non-aqueous phase liquid

NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OU	Operable Unit
PAC	Potential Area of Concern
PAM	Proposed Action Memorandum
PCB	polychlorinated biphenyl
pCi	picoCurie
pCi/g	picoCuries per gram
pCi/l	picoCuries per liter
PIC	Potential Incident of Concern
PMJM	Preble's meadow jumping mouse
POC	Point of Compliance
POE	Point of Evaluation
PQL	practical quantification level
PRG	preliminary remediation goal
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity
RFA	Rocky Flats Alluvium
RFCA	Rocky Flats Compliance Agreement
RI	Remedial Investigation
ROD	Record of Decision
RSOP	RFCA Standard Operating Protocol

SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SID	South Interceptor Ditch
SPPTS	Solar Ponds plume treatment system
SVOC	semi-volatile organic compound
SWMU	Solid Waste Management Unit
U.S.	United States
UBC	Under Building Contamination
UCL	upper confidence limit
UHSU	upper hydrostratigraphic unit
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
VOC	volatile organic compound
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

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ATTACHMENT 1

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE ACTION LEVELS FOR SURFACE WATER, GROUNDWATER, AND SOIL

May 28, 2003

ATTACHMENT 2

DETAILED COST ESTIMATES FOR THE SELECTED REMEDY/CORRECTIVE ACTION

ATTACHMENT 3

RESPONSIVENESS SUMMARY