ROCKY FLATS ENVIRONMENTAL
TECHNOLOGY SITE

Corrective Measures Study - Feasibility Study
Detailed Analysis of Alternatives

Technical Memorandum

Rocky Flats Environmental Technology Site
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Golden, CO 80403-8200

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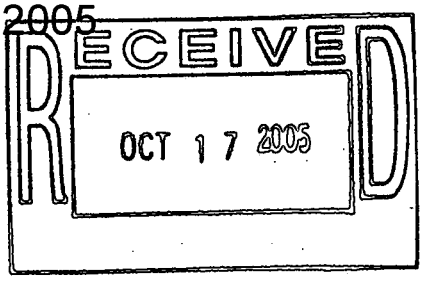

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ACRONYMS and abbreviations

ARARs	Applicable or Relevant and Appropriate Requirements
BZ	Buffer Zone
CAD	Corrective Action Decision
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CHWA	Colorado Hazardous Waste Act
CMS	Corrective Measures Study
COC	Contaminate of Concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EU	Exposure Unit
FS	Feasibility Study
FWS	U.S. Fish and Wildlife Service
IA	Industrial Area
IMP	Integrated Monitoring Plan
MCL	Maximum Contamination Limit
NPDES	National Pollutant Discharge Elimination System
O&M	Operating and Maintenance
OU	Operable Unit
PRG	Preliminary Remediation Goal
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI	RCRA Facility Investigation
RI	Remedial Investigation
ROD	Record of Decision
SVOC	Semi-volatile organic compounds
TM	Technical Memorandum
~~TMV~~	~~Toxicity, Mobility and Volume~~
VOC	Volatile organic compound
WRV	Wildlife refuge visitor
WRW	Wildlife refuge worker

1.0 INTRODUCTION

This Detailed Analysis of Alternatives Technical Memorandum (TM) has been prepared pursuant to Task 14 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigations/Feasibility Study (RI/FS) Report Work Plan (DOE 2002). Because remedial activities at the Rocky Flats Environmental Technology Site (RFETS) were also conducted under the Resource Conservation and Recovery Act (RCRA) and the Colorado Hazardous Waste Act (CHWA), the RI/FS Report also meets RCRA/CHWA requirements for a RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) report. For simplicity, the report is hereinafter referred to as the RI/FS Report. This TM will be incorporated into the RI/FS Report as Section 10.0.

This TM presents an evaluation of alternatives for final remedial actions to be implemented to assure that the residual contamination does not present an unacceptable risk to human health or the environment. In accordance with the Rocky Flats Cleanup Agreement (RFCA) paragraph 83, after the completion of all planned RFCA accelerated actions the Colorado Department of Public Health and Environment (CDPHE) and the Environmental Protection Agency (EPA) will evaluate site conditions and render a final Corrective Action Decision (CAD) and Record of Decision (ROD) for each operable unit (OU).

For RFETS, based on several previous OU reconfigurations and approved CAD/RODs to date, the final remedial decision will address the Buffer Zone (BZ) OU and the Industrial Area (IA) OU. A final reconfiguration of these OUs based on the results of the RI has been proposed (see Section 9.0 of the RI/FS Report) to consolidate all areas of the site that may require final remedial actions into the final reconfigured IA OU. The remaining portions of the site meet all remedial action objectives (RAOs) and applicable or relevant and appropriate requirements (ARARs) identified in development of the RI/FS and have been consolidated into the final reconfigured BZ OU.

The results of the RI were compared to RAOs and ARARs contained in the following technical memoranda:

- Surface Water Remedial Action Objectives Technical Memorandum;
- Groundwater and Soil Remedial Action Objectives Technical Memorandum; and
- Applicable or Relevant and Appropriate Technical Memorandum.

Since RAOs and ARARs are met without any further action in the BZ OU, a detailed analysis of alternatives is not required for the BZ OU (see Section 9.0 of the RI/FS Report).

Two RAOs are not met in the IA OU; however, ARARs are met in the IA OU. Section 2.0 of this TM summarizes the specific areas of soil and groundwater within the IA OU that do not meet all of the RAOs. With the completion of the accelerated actions, the experience and knowledge gained during those actions, and from evaluation of alternatives in the preparation of accelerated action decision documents, the number of available options and alternatives to address residual contamination are limited and well understood. Consequently, no formal screening of alternatives prior to the selection of alternatives that are evaluated in detail in this TM is deemed

necessary. Three alternatives for the IA OU are developed and evaluated in detail in accordance with the nine CERCLA evaluation criteria. First, the alternatives are analyzed individually against the criteria in Section 3.0 of this TM; a comparative analysis of all the alternatives against the criteria is then presented in Section 4.0 of this TM.

The following actions have been implemented in accordance with approved RFCA decision documents. The approved actions include monitoring requirements that will continue and will not be re-evaluated in the detailed analysis of alternatives:

- Post-closure care and monitoring of the Present Landfill and continued operation and maintenance of the Present Landfill seep treatment system;
- Post-closure care and monitoring of the Original Landfill; and
- Operation and Maintenance of three groundwater passive treatment systems and performance monitoring (East Trenches Plume Treatment System; Mound Plume Treatment System; and the Solar Ponds Plume Treatment System).

The Present Landfill was closed under the RCRA/CHWA; the Original Landfill was closed under CERCLA using RCRA closure ARARs. Each of the landfills has a Closure Plan approved by the CDPHE and EPA. A system to treat the Present Landfill seep was installed. A system to monitor groundwater up- and down-gradient of both landfills is in place.

The other actions involve groundwater remediation. Results of the RI indicate that continued operation of these three groundwater actions serves to protect surface water quality over short- and intermediate- term periods by removing contaminant loading to surface water. This protection also serves to meet long-term goals for returning groundwater to its beneficial use of surface water protection.

2.0 SPECIFIC MEDIA TO BE ADDRESSED IN THE DETAILED ANALYSIS OF ALTERNATIVES

Based on the results of the RI, two RAOs are not met in the IA OU: soil RAO 3 and groundwater RAO 3. This section identifies the specific areas within the IA OU that do not meet these RAOs.

2.1 Soil

To recall, soil RAO 3 is:

-"Prevent exposure resulting in unacceptable risk to wildlife refuge worker (WRW). The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives where 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 CFR 300.430 (e)(2)(i)(A)(2)). Prevent significant risk of adverse ecological effects."[1]

[1] Under CERCLA, it must be shown that risks for expected land uses at the site fall within the acceptable range of 1×10^{-6} to 1×10^{-4} cancer risks and below a hazard index of 1 for noncarcinogenic effects.

Results of the comprehensive risk assessment (CRA) calculate risk to a WRW of 2 x 10^{-6} for plutonium-239/240 in surface soil in the Wind Blown Area Exposure Unit (EU). A review of the RFETS data indicates that residual plutonium-239/240 surface soil contamination exceeds the WRW preliminary remediation goal (PRG) 1 x 10^{-6} risk target concentration of 9.8 pCi/g. This area of residual surface soil contamination is shown on Figure 2.1.[2]

Results of the RI indicate that other human health contaminants of concern (COCs) may have exceeded a 1 x 10^{-6} WRW PRG risk level; however, a feasibility study was not required for these COCs (see Section 8 of the RI/FS Report).[3]

Additionally, the CRA included an analysis comparing subsurface soil and groundwater data to indoor air volatilization PRGs. The area of subsurface soil contamination above the indoor air volatilization PRGs is shown on Figure 2.2. The area of groundwater contamination above the indoor air volatilization PRGs is shown on Figure 2.3. The area of groundwater contamination above the indoor air volatilization PRGs is included in the discussion of the soil RAO because the results of the CRA analysis indicate the possibility of an unacceptable risk to the WRW if a WRW were to spend 50 percent or more of their work day in an indoor office building constructed over the area.

Based on this RAO, the detailed analysis of alternatives for the IA OU will evaluate alternatives that will reduce exposure to surface soil residual plutonium-239/240 contamination above 9.8 pCi/g, in the area shown on Figure 2.1. The detailed analysis of alternatives will also evaluate alternatives that prevent buildings from being constructed over areas of the IA OU where the indoor air volatilization PRGs are exceeded, as shown on Figures 2.2 and 2.3.

2.2 Groundwater

To recall, groundwater RAO 3 is:

"Prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs."

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[2] The WRW PRG 1 x 10^{-6} risk target concentration for americium-241 is 7.7 pCi/g. The area of residual surface soil contamination above the americium-241 WRW PRG 1 x 10^{-6} risk target concentration is within the area shown on Figure 2.1. Removal of residual surface soil contamination for plutonium-239/240, as shown on Figure 2.1, would also remove residual surface soil contamination above the americium-241 WRW PRG 1 x 10^{-6} risk target concentration.

[3] In the Industrial Area EU and the Wind Blown Area EU the risk calculated to a WRW from arsenic in surface soil is
2 x 10^{-6}. This equals the background cancer risk from arsenic to a WRW; no further action is necessary for arsenic. In the Upper Woman Drainage EU, the risk calculated to a WRW from 2,3,7,8-TCDD TEQ is 2 x 10^{-6} and from benzo(a)pyrene is
7 x 10^{-6}. These risks were calculated without taking into account land surface contouring. After an accelerated action was completed, a confirmation sample was taken and the depth of the sample was noted. In the case of 2,3,7,8-TCDD TEQ, the sample was taken near the excavation of an old incinerator and the sample was marked "surface soil." When the accelerated action was confirmed as being complete, the area was backfilled and the land surface was contoured to match the surrounding geomorphology. The sample location was not changed from surface to subsurface. As identified in the RI, the sample location causing the risk from 2,3,7,8-TCDD TEQ is actually located approximately 20 feet below ground surface and the sample location causing the risk from benzo(a)pyrene is actually located beneath the Original Landfill cover. No complete pathway exists for direct contact to these COCs; no further action is necessary.

A review of the RFETS data comparing groundwater data to MCLs indicates that there are some areas where groundwater contamination exceeds MCLs. The area of groundwater contamination above an MCL is shown on Figure 2.4.

Based on this RAO, the detailed analysis of alternatives for the IA OU will evaluate alternatives that will prevent drinking water and irrigation use of the groundwater contaminated at levels above MCLs.

3.0 DETAILED ANALYSIS OF ALTERNATIVES

A detailed analysis of three alternatives will be evaluated 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
- 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
- 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
- Cost

The third group is the modifying criteria, which includes:

- State acceptance
- Community acceptance

State and community acceptance criteria will be addressed in the CAD/ROD once comments on the Proposed Plan have been received.

3.1 Alternative Definition

This section defines the three alternatives developed for the IA OU.

3.1.1 Alternative 1: No Further Action with Monitoring

Alternative 1: No Further Action with Monitoring, maintains and monitors the completed actions conducted at the Present and Original Landfills and the three groundwater treatment systems. Specific monitoring, and operations and maintenance requirements for these five actions will continue. Alternative 1 also includes the additional environmental monitoring as described in the FY2005 Integrated Monitoring Plan (IMP) (K-H 2005) and RFETS access control of the entire site through fencing and signage of the surrounding BZ OU.

This alternative assumes that the National Wildlife Refuge Act specifies the land use and that no institutional control is needed to maintain the land as a national wildlife refuge.

Alternative 1 also assumes the State environmental covenant ARAR will be met because the required covenant will be executed by the Department of Energy (DOE).

Alternative 1 will include the following specific quarterly maintenance and monitoring requirements:

1. Present Landfill Cover System and Landfill Seep Treatment System
   - Inspection of the cover and run-on and runoff controls with maintenance as identified in the inspections.
   - RCRA groundwater monitoring by analyzing 3 upgradient and 3 downgradient wells for metals and volatile organic compounds (VOCs) with a statistical evaluation of the data consistent with groundwater monitoring ARARs.
   - Inspection of the seep treatment system with maintenance as identified in the inspections.
   - Monitoring of the seep treatment system by sampling and analyzing the influent and effluent of the seep treatment system for metals and VOCs, and with a statistical evaluation of the data compared to the surface water standards.
   - Inspection of the East Landfill Pond dam and outlet structures with maintenance as identified in the inspections.
   - Inspections, maintenance actions and monitoring results will be reported annually to the regulatory agencies.
   - Institutional controls as required by the Present Landfill RFCA decision document.
2. Original Landfill Cover System
   - Inspection of the cover, run-on and runoff controls and the toe buttress with maintenance as identified in the inspections.

- RCRA groundwater monitoring by analyzing 1 upgradient and 3 downgradient wells for metals, semi-volatile organic compounds (SVOCs), VOCs and pesticides with a statistical evaluation of the data and a comparison of the downgradient groundwater quality with surface water standards.
- Monitoring of surface water quality at Woman Creek by surface water sampling upstream and downstream of the Original Landfill with a statistical evaluation of the data compared to surface water standards.
- Inspections, maintenance actions and monitoring results will be reported annually to the regulatory agencies.
- Institutional controls as required by the Original Landfill RFCA decision document.

3. Three Existing Groundwater Monitoring Systems (Mound Plume Treatment System, East Trenches Plume Treatment System and Solar Ponds Plume Treatment System)
   - Inspection of each system with maintenance as identified in the inspections.
   - Monitoring of upgradient and downgradient groundwater with a statistical evaluation of the data to determine the operating performance of the treatment system.
   - Periodic replacement of treatment system media as required based on inspection and monitoring results.
   - Inspections, maintenance actions and monitoring results will be reported annually to the regulatory agencies.

4. The following RFETS environmental monitoring as defined in the FY2005 IMP:
   - Surface Water Monitoring; and
   - Groundwater Monitoring.

   ~~Air Monitoring~~

   ~~Ecological Monitoring~~

The results of the IMP monitoring will be reported ~~annually~~ quarterly to the regulatory agencies.

The environmental monitoring required at the Present Landfill, Original Landfill and the three groundwater treatment systems is also included in the FY2005 IMP.

3.1.2 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 IA OU. Land use restrictions are limitations or prohibitions on specific activities within designated areas of the IA OU to ensure that the conditions remain protective for the WRW and wildlife refuge visitor (WRV). Physical controls are items such as signage monuments along the perimeter of the IA OU to notify the WRW and WRV that they are at the boundary of the Refuge maintained by USFWS. The DOE will retain

jurisdiction over the engineered structures and monitoring systems associated with the completed actions. Institutional controls will include the following:

1. Prohibition of construction and use of buildings in contaminated areas.

2. Prohibition on drilling wells into contaminated groundwater for water use (specifically, for drinking water or irrigation use).

3. Prohibition on the use of contaminated surface water, groundwater and/or pumping groundwater where the remedy may be impacted.

4. Restrictions on excavation in areas above subsurface contamination or intrusion into subsurface contamination.

5. Prohibition on excavation at the Present and the Original Landfills.

~~5.~~6. Restrictions on activities that cause soil disturbance in areas with residual surface soil contamination.

In the future, surface water or groundwater monitoring may indicate that some of these institutional controls may no longer be necessary if residual groundwater contamination is below MCLs or the indoor air volatization PRGs can be met. ~~This~~ The need for institutional controls will be evaluated as part of future CERCLA periodic reviews.

Physical controls will consist of signage installed along the perimeter of the IA OU to notify the WRW and WRV that they are at the boundary of the refuge maintained by the USFWS. Other physical controls could also be implemented, including installation and maintenance of fences, gates, locks and other security devices as needed for refuge management purposes. However, no other physical controls beyond the monument signage for remedy-related purposes are anticipated.

Institutional and physical controls will be inspected every three months. If evidence of activities that violate the restrictions or damage of the physical controls is found, a plan will be developed 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.

3.1.3 Alternative 3: Targeted Surface Soil Removal

Alternative 3: Targeted Surface Soil Removal, will remove the top 6- inches in areas of residual surface soil contamination that are above the plutonium-239/240 WRW PRG 10^{-6} risk target concentration of 9.8 pCi/g as shown on Figure 2.1. This figure shows that surface soil over an area of approximately 368 acres would be removed. Note that this alternative is not anticipated to completely remove all plutonium contamination since it is not technically feasible to remove all contamination. Previous excavation actions of a similar nature resulted in successful removal of the bulk of contamination, as verified through post-accelerated action confirmation sampling based on a 90 percent confidence level.

This alternative also includes the implementation of Alternative 2.

The scope of this alternative would be to excavate the contaminated soil in a defined area to a depth of approximately 6- 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 taken to verify that the contaminated soil was removed to below 9.8 pCi/g. The excavated area will not be backfilled, but graded as necessary to match existing, surrounding grades. The area would then be seeded for revegetation and mulched/matted for erosion control.

Temporary access roads, staging areas and other infrastructure to conduct the removal would be built to conduct the work. Temporary construction facilities like work trailers, equipment parking and fueling areas, and portable electrical power generators, would be used during the construction period.

With the excavation of 6- inches of soil within this area, the volume of soil to be removed and shipped to the permitted disposal facility is about 10,425,000 cubic feet. The duration of this removal operation is estimated at three years.

3.2 Detailed Analysis of Alternatives

This detailed analysis of the alternatives assembles and develops the rationale to understand the various alternatives. Each alternative is evaluated against the nine evaluation criteria as further described below:

1. 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.

2. 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 the RFETS.

3. 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.

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

5. Short-term Effectiveness – This analysis addresses the protection of the community and workers while implementing the alternative, the environmental impacts while implementing the alternative, and the time required to achieve the remedial action objectives.

6. Implementability – This analysis considers the ability to build and operate the alternative, the reliability of the alternative, the ability to monitor the effectiveness of the alternative, the

administrative feasibility of the alternative, and the availability of resources to implement the alternative.

7. Cost – This criterion presents order-of-magnitude capital, and operating 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 periodic reviews. A present worth analysis is also included for a period of 30 years with a discount rate of 5 percent (OMB 2005).

8. State Acceptance – This analysis will evaluate the technical and administrative issues and concerns the State regulatory agency may have on the alternative. Discussion of this criterion will be provided in the CAD/ROD.

9. Community Acceptance – This analysis will evaluate the technical and administrative issues and concerns that the community may have on the alternative. Discussion of this criterion will be provided in the CAD/ROD.

Table 3.1 summarizes the detailed analysis for each alternative.

3.3 Alternative 1: No Further Action with Monitoring

3.3.1 Overall Protection of Human Health and the Environment

Alternative 1 is protective of Human Health and the Environment because no unacceptable risks from residual contamination exist after the completion of all planned RFCA accelerated actions. In particular:

1. The CRA shows that the incremental risk to the WRW is at or below 1 X 10^{-6} or an HI of 1 for soil and sediment with residual contamination above background, except in the Wind Blown Area EU where the calculated risk to a WRW is 2 x 10^{-6} for plutonium-239/240.[4] Under CERCLA, the Wind Blown Area EU is still considered protective of human health since the risk falls within the acceptable range of 1 x 10^{-6} to 1 x 10^{-4} cancer risks and a hazard index of 1 for noncarcinogenic effects.

2. The CRA predicts that there is no significant ecological risk from the residual contamination within all media for all of the ecological receptors evaluated in the ecological risk assessment.

3. Results of the contaminant fate and transport analysis show:
   - Plutonium-239/240 has been compliant at the surface water points of compliance, even during periods of widespread soil disturbance in the former IA, based on historic surface water quality data. Removal of plutonium-239/240 surface soil sources during RFCA accelerated action, coupled with reduced runoff and erosion, should further benefit surface water quality.

[4] See Section 2.1 of the TM and Section 8 of the RI/FS Report for a discussion on where results of the CRA indicate a risk above 1 x 10^{-6} to the WRW, but the results of the RI conclude that a feasibility study is not required.

- The dominant migration process for arsenic at RFETS is via runoff and erosion of surface soil. Surface water concentrations of arsenic are below the surface water standard in the terminal ponds (upstream from the surface water points of compliance).
- The dominant migration process for benzo(a)pyrene at RFETS is via runoff and erosion of surface soil, although benzo(a)pyrene is not an analyte of interest or a COC in surface water. Surface water concentrations of benzo(a)pyrene are below the surface water standard in the terminal ponds (upstream from the surface water points of compliance).
- The dominant migration process for 2,3,7,8-TCDD TEQ at RFETS is via runoff and erosion of surface soil, although 2,3,7,8-TCDD TEQ is not an analyte of interest or a COC in surface water. Historic surface water concentrations of 2,3,7,8-TCDD TEQ are below the surface water standard in the terminal ponds (upstream from the surface water points of compliance). Reduced runoff and erosion should further benefit surface water quality for each of these analytes.

4. CRA results for the No Name Gulch Drainage EU, including the Present Landfill without the implementation of the accelerated action, indicate that residual contamination exhibits an incremental risk to the WRW that is less than 1×10^{-6}. However, the installed multi-layered geosynthetic cover and additional buttressing at the east face of the Present Landfill provide additional protection. The seep treatment system lowers the concentration of VOCs in the landfill seep to meet surface water quality standards with passive treatment.

5. CRA results for the Upper Woman Drainage EU, including the Original Landfill without the implementation of the accelerated action, indicate that residual contamination exhibits an incremental risk to the WRW that is less than 1×10^{-6}. However, the accelerated action provides for additional structural stability with a soil buttress and prevents direct contact with the landfill wastes and debris via placement of a soil cover.

6. Groundwater actions are operating ~~properly and successfully and~~ as designed to remove contamination in captured groundwater to meet appropriate surface water quality standards. Actions to address threats to groundwater quality, and therefore impacts to surface water quality, have included source removal, in-situ biodegration enhancements, phytoremediation, and passive groundwater collection and treatment. The passive groundwater collection and treatment systems will continue to operate and be monitored to protect groundwater and surface water quality.

7. Monitoring of the RFETS groundwater, surface water, sediments, ecology and air will provide the environmental data to verify that the site continues to be protective of human health and the environment. This monitoring will also include the environmental monitoring at the Present and Original Landfills and the operational monitoring of the three groundwater treatment systems.

3.3.2 Compliance with ARARs

Alternative 1 complies with ARARs as follows:

1. Colorado Basic Standards and Methodologies and Site Specific Standards for Surface Water: This ARAR is met since surface water at the points of compliance meet surface water quality standards.

2. Colorado Basic and Site Specific Standards for Groundwater: This ARAR is met since the groundwater at the groundwater area of concern wells and most sentinel wells meets the groundwater quality standards. At sentinel wells where groundwater data is above the groundwater quality standards, results of the RI conclude that based on the environmental conditions and type of residual contamination, no ~~further~~ additional feasible action can be taken. Monitoring will continue. In addition, contaminated groundwater has been addressed on a site-wide basis for three plume areas where groundwater treatment systems are installed and are performing as designed ~~operating properly and successfully~~ to improve groundwater quality that could adversely impact surface water quality. These systems will continue to be operated and monitored in accordance with their individual system monitoring and maintenance plans.

3. National Pollutant Discharge Elimination System (NPDES): This ARAR is met because the existing NPDES permit, which covered storm water discharges and sanitary sewage treatment plant discharges has been properly terminated. Point source and storm water sources covered by the permit have been removed as part of site closure. In addition, the discharge from the seep treatment system at the Present Landfill to surface water upstream of No Name Gulch meets NPDES substantive requirements for such discharges. As part of the accelerated action decision, the system discharge meets the CERCLA permit waiver provisions. The discharge will be monitored for VOCs and metals with effluent limitations that are the surface water quality standards for Walnut Creek, Big Dry Creek Segment 4a.

4. Federal and Colorado Noxious Weed Act: This ARAR is met because the alternative will not result in or exacerbate the growth of undesirable plant species nor create difficult measures to control noxious weeds.

5. National Wildlife Refuge System Administration Act: This ARAR is met because this alternative is consistent with the future RFETS land use in accordance with the Rocky Flats National Wildlife Refuge Act and will not interfere with Refuge purposes.

6. Atomic Energy Act, Radiation Protection Standards for Decommissioning Licensed Facilities; Colorado Regulations Pertaining to Radiation Control: This ARAR is met because residual levels of RFETS-related radiological contamination do not result in the exceedance of the annual radiation dose limits for the WRW under the future RFETS land use as a wildlife refuge. If this land became unrestricted in the future, annual dose limits for the unrestricted user would also be met (see Section 9.0 of the RI/FS Report).

7. Subtitle C: Hazardous Waste Management; Solid Waste Disposal Act; Colorado Hazardous Waste Act - Groundwater Protection and Monitoring: This ARAR is met because groundwater at the Present Landfill (including the landfill seep) and the Original Landfill will be monitored under 6 CCR 1007-3, as required under the approved accelerated action decision documents.

8. Subtitle C: Hazardous Waste Management; Solid Waste Disposal Act; Colorado Hazardous Waste Act - Closure and Post Closure: This ARAR is met because the Present and Original Landfills were adequately stabilized and covers were properly installed in accordance with regulatory agency approved designs and will be maintained and monitored in accordance with their individual landfill monitoring and maintenance plan under a post-closure care enforceable document to be determined by the RFCA parties.

9. Environmental Covenants: The ARAR is met under the assumption that DOE will execute a covenant in accordance with CHWA requirements.

While Alternative 1 meets all ARARs, it does not meet soil RAO 3: Prevent exposure resulting in unacceptable risk to WRW because of the risk related to indoor air volatilization, or groundwater RAO 3: Prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs. In addition, Alternative 1 does not require additional institutional controls to be put in place at the time of the CAD/ROD~~, which are requirements contained in the Present and Original Landfill RFCA decision documents~~.

3.3.3 Long-term Effectiveness and Permanence

Alternative 1 exhibits a high degree of long-term effectiveness and permanence for the following reasons:

1. All of the RFCA accelerated actions (except the landfills) included removal of contaminated structures and environmental media. Removal provides the highest level of long-term effectiveness and permanence; however, it is not technically feasible to remove all residual contamination. Soil disturbed during accelerated actions has been revegetated in accordance with the RFETS revegetation plan and temporary erosion controls have been implemented to reduce erosion while new vegetation is being established.

2. Where an accelerated action was not required for subsurface contamination, the contaminated structure or media is fixed and/or not considered mobile in the environment. Remaining building structures either meet free release standards or have fixed contamination that is 6 feet or more below ground surface. PRGs were based on exposure scenarios to subsurface contamination to eight feet below the surface. But, excavations below three feet are not likely unless mechanical excavation equipment is employed. Thus, inadvertent contact with subsurface soils deeper than three feet is considered unlikely.

3. Residual plutonium-239/240 persists indefinitely (for the purposes of this analysis), with radioactive half-lives for plutonium-239 and plutonium-240 of approximately 24,390 years and 6,537 years, respectively. The primary historic source of plutonium-239/240 in surface soil was remediated at the 903 Pad and Lip Area through a RFCA accelerated action, which should improve long-term surface water quality. In addition, removal of buildings and pavement has decreased runoff volumes and peak discharge rates, which will reduce soil erosion, thereby also reducing the associated plutonium-239/240 transport and impact on surface water and sediment. Improvement in surface water quality is based on the assumption that vegetation is established, soil is stabilized, and widespread soil disturbance does not occur in areas with residual plutonium-239/240.

4. Given published information and available data at RFETS, it is likely that residual VOC sources and associated downgradient groundwater concentrations will persist for decades to hundreds of years even with the source removals taken under accelerated actions. Although it is possible to reduce the long-term persistence of the source term with appropriate technology, it would be technically impracticable to attempt to locate and characterize each source, given the large number, and very localized impacted areas due to relatively small release volumes (many < 100 gallons). Long-term fate and transport modeling showed that assuming sources remain the way they are now, the impacts to surface water would be minimal due to the following: (1) many sources will not impact groundwater above surface water standards at discharge points; (2) where concentrations are above surface water standards, the total flux into streams is limited due to the ephemeral nature of baseflow and seep flow to streams; and (3) groundwater plume treatment systems and source area enhancements have been implemented in these areas.

5. The Present Landfill closure, as approved by the regulatory agencies, includes a multi-layered cover consisting of geosynthetic and natural materials that are permanent and provide long-term effectiveness. The geosynthetic layers of the cover are protected by native soil both under and on top of the geosynthetics, and the cover is further protected from burrowing animals by an additional rock layer above the geosynthetics. The entire landfill area is then covered with two feet of vegetated native soils for additional protection of the cover layers below. The seep treatment system is made of concrete, fiberglass and high-density polyethylene components to provide a permanent system with little maintenance.

6. The Original Landfill accelerated action, as approved by the regulatory agencies, consists of a native soil buttress and native soil cover to provide for permanent containment of the landfill wastes and debris.

7. The three passive groundwater collection and treatment systems are constructed of materials that, with some maintenance at the treatment cells, are expected to have a long working life with limited operating attention.

8. Monitoring of RFETS groundwater, surface water, sediments, ecology and air will provide the environmental data to verify the long-term effectiveness and permanence of the accelerated actions taken at RFETS.

3.3.4 Reduction of Toxicity, Mobility and Volume through Treatment

Alternative 1 exhibits a high degree of reduction of toxicity, mobility and volume ~~(TMV)~~ for the following reasons:

1. The three passive 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 closure, as approved by the regulatory agencies, includes a multi-layered cover consisting of geosynthetic materials that stop the infiltration of water from the surface of the landfill into the waste. In addition, a groundwater intercept system consisting

of a exterior groundwater collection system and slurry wall containment was installed to reduce the flow of groundwater into the landfill. The geosynthetic layers of the cover are protected by native soil both under and on top of the geosynthetics, and the cover is further protected from borrowing animals by an additional rock layer above the geosynthetics to retain the covers impermeable characteristics. The entire landfill area is then covered with two feet of vegetated native soils for additional protection of the cover layers below. This cover along with the groundwater intercept system greatly reduces the possibility of contaminants moving from the landfill. The landfill seep treatment system provides treatment to remove the VOC contamination from the landfill seep.

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

In addition, all of the RFCA accelerated actions (except the landfills) included removal of contaminated structures and environmental media. Removal provides the highest level of reduction of toxicity, mobility and volume. Where subsurface removal was not conducted, the contaminated material or media is fixed and/or not considered mobile in the environment.

~~1.All of the RFCA accelerated actions (except the landfills) included removal of contaminated structures and environmental media. Removal provides the highest level of reduction of toxicity, mobility and volume. Where subsurface removal was not conducted, the contaminated material or media is fixed and/or not considered mobile in the environment.~~

~~2.Experience and knowledge gained during accelerated actions have shown that it is not technically feasible to reduce TMV of residual plutonium in surface soil through treatment. Groundwater plume treatment systems have been implemented and remove contaminant loading to surface water.~~

~~3.The Present Landfill closure, as approved by the regulatory agencies, includes a multi-layered cover consisting of geosynthetic materials that stop the infiltration of water from the surface of the landfill into the waste. In addition, a groundwater intercept system consisting of a exterior groundwater collection system and slurry wall containment was installed to reduce the flow of groundwater into the landfill. The geosynthetic layers of the cover are protected by native soil both under and on top of the geosynthetics, and the cover is further protected from borrowing animals by an additional rock layer above the geosynthetics to retain the covers impermeable characteristics. The entire landfill area is then covered with two feet of vegetated native soils for additional protection of the cover layers below. This cover along with the groundwater intercept system greatly reduces the possibility of contaminants moving from the landfill. The landfill seep treatment system provides treatment to remove the VOC contamination from the landfill seep.~~

~~4.The Original Landfill accelerated action, as approved by the regulatory agencies, consists of a native soil buttress and native soil cover to prevent the direct contact with the landfill wastes. In addition, after more than 30 years of monitoring at the original landfill, the landfill has not shown an impact to downgradient groundwater or surface water quality.~~

~~5.The three passive 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.~~

~~6.Monitoring at the Present and Original Landfills, and at the three groundwater treatment system will verify that the waste is contained and that the treatment systems are operating properly.~~

3.3.5 Short-term Effectiveness

Alternative 1 exhibits a high degree of short-term effectiveness because ~~for the following reasons:~~

~~1.Implementation of site-wide accelerated actions has resulted in a high level of short-term effectiveness through the removal and containment of wastes and contaminated debris and soils.~~

~~2.Existing groundwater treatment systems are shown effective at reducing groundwater contamination.~~

~~3.Monitoring through the IMP provides additional assurance that accelerated actions are effective.~~

~~4.W~~workers and the public are not at risk since no additional action is required in this alternative.

3.3.6 Implementability

Alternative 1 is easily implemented since 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, groundwater, and air monitoring stations have been also been established.

3.3.7 Cost

Capital expenditures for Alternative 1 are 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 and maintenance of the IMP surface water, groundwater, and air stations.

7. Groundwater treatment system media replacement every five years

8. Preparation of materials for the CERCLA periodic review.

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 5 years. The estimated costs for preparing materials for the CERCLA periodic review is $153,000.

The present worth of these costs for 30 years at an annual interest rate of 5 percent is $41,350,000.

Details of this cost estimate are included in Attachment 1.

3.3.8 State Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

3.3.9 Community Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

3.4 Alternative 2: Institutional and Physical Controls

The evaluation of this alternative includes the evaluation presented for Alternative 1 and the additional assessment of adding institutional and physical controls to Alternative 1.

3.4.1 Overall Protection of Human Health and the Environment

Implementation of Alternative 2 is protective of human health and the environment by providing the following institutional and physical controls:

1. Prohibition of construction and use of buildings in contaminated areas.

2. Prohibition on drilling wells into contaminated groundwater for water use (specifically, for drinking water or irrigation use).

3. Prohibition on the use of contaminated groundwater and/or pumping groundwater.

4. Restrictions on excavation in areas above subsurface contamination or intrusion into subsurface contamination. No excavation is allowed at the Present and the Original Landfill.

5. Restrictions on activities that cause soil disturbance in areas with residual surface soil contamination.

Signage will also be installed as a physical control along the perimeter of the IA OU to notify the WRW and WRV that they are at the boundary of the Refuge maintained by the USFWS.

3.4.2 Compliance with ARARs

Alternative 2 meets all of the ARARs (see Section 3.3.2).

Alternative 2 meets soil RAO 3: Prevent exposure resulting in unacceptable risk to WRW and groundwater RAO 3: Prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs. Institutional controls required in Alternative 2 are consistent with the institutional controls required in the Present and Original Landfill RFCA decision documents.

3.4.3 Long-term Effectiveness and Permanence

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

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 (signage) will be constructed of materials, such as concrete and brass that are considered permanent.

3.4.4 Reduction in Toxicity, Mobility and Volume through Treatment

~~The implementation of Alternative 2 will help ensure that the Present Landfill, Original Landfill, groundwater treatment systems will not be damaged or disturbed. In addition, TMV will be reduced by institutional controls that prevent the potential for exposure to contamination by not allowing disturbance of contaminated media or engineered controls.~~ See Alternative 1.

3.4.5 Short-term Effectiveness

Alternative 2 exhibits a high degree of short-term effectiveness because institutional controls are easily implemented and become effective immediately.

Physical controls will effectively provide notice to the WRW and WRV that they are at the boundary of the Refuge maintained by the USFWS.

Workers and the public are not at risk to implement Alternative 2.

3.4.6 Implementability

Alternative 2 is easily implemented by a combination of administrative and physical controls, which are expected to include institutional controls, an environmental covenant, ~~legally enforceable deed restrictions~~ and limited construction work to install signage.

3.4.7 Cost

Capital expenditures for Alternative 2 are low and are associated with the preparation of specific written administrative controls, providing the personnel to implement and monitor the compliance with the institutional control requirements. Deed restrictions must be prepared and filed and the installation of signage completed and maintained.

The estimated capital cost of Alternative 2 is $1,120,000.

O&M costs associated with institutional controls aspect of Alternative 2 is estimated at $45,000 per year and includes the quarterly inspection of the site and signage, and a nominal amount of legal support.

The total O&M costs include Alternative 1 and inspection and maintenance of institutional and physical controls.

The estimated total annual O&M costs for these items are $2,575,000 per year less the media replacement costs and the CERCLA periodic review costs.

The total present worth of these estimated costs for 30 years at 5 percent annual interest is $43,170,000.

Details of this cost estimate are included in Attachment 1.

3.4.8 State Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

3.4.9 Community Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

3.5 Alternative 3: Targeted Surface Soil Removal

Alternative 3 will remove areas of surface soil within an EU that have ~~that have~~ been identified to have plutonium-239/240 contamination above the WRW risk target concentration of 9.8 pCi/g. This alternative also includes the implementation of Alternative 2.

3.5.1 Overall Protection of Human Health and the Environment

Alternative 3 increases the protectiveness of human health because targeted surface soil removal will reduce plutonium-239/240 contamination to below the WRW risk target concentration of 9.8 pCi/g.

However, implementing Alternative 3 would negatively impact the environment. The removal process would destroy the existing native vegetation within the excavation area~~, some of which is a rare species of xeric tallgrass~~. It would also destroy some areas that are designated as Preble's Meadow Jumping Mouse habitat. During and after the removal operations, the potential for large sediment loads into the Walnut Creek and Woman Creek drainage would be high. Thus, to comply with ARARs, special attention must be paid to surface run on and run off

controls. With the current extent of high quality vegetation in this area, the contaminated area currently does not result in any surface water exceedances at the surface water points of compliance.

3.5.2 Compliance with ARARs

Alternative 3 meets all the ARARs (see Section 3.3.2) and meets all of the RAOs. The disturbance of surface soil could temporarily increase the sediment loading in the surface water. However, it is anticipated that surface water standards would continue to be met at the surface water points of compliance. Any potential air impacts will be mitigated during implementation of the remedy.

3.5.3 Long-term Effectiveness and Permanence

Implementing this alternative increases the overall long-term effectiveness and permanence for the following reasons:

1. Removal of surface soils will permanently and effectively reduce residual plutonium-239/240 contamination to below the WRW risk target concentration of 9.8 pCi/g.

2. Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.

However, vegetation destroyed by the removal action could require up to 5 years to recover.

3.5.4 Reduction in Toxicity, Mobility and Volume through Treatment

Alternative 2 plus Alternative 3 will provide the following impact to ~~TMV~~toxicity, mobility and volume:

1. Removal of surface soil reducing plutonium contamination to below 9.8 pCi/g will reduce the toxicity, mobility and volume~~TMV~~.

2. Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.

However, the disturbance of surface soil in this expansive area could temporarily increase the sediment load to the natural drainage systems at RFETS.

3.5.5 Short-term Effectiveness

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 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.

3.5.6 Implementability

This alternative can be easily implemented since standard earthmoving and transportation equipment will be used to remove the areas of contamination that contribute risk to the WRW. However, the implementation of the removal of surface soils to reduce the risk to surface water quality is much more difficult. Weather, wind and precipitation will increase the potential for soil erosion and sediment loads to the RFETS 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, Department of Transportation, and disposal facility waste acceptance criteria is moderate to difficult.

3.5.7 Cost

Capital expenditures for Alternative 3 include the cost for the removal and disposal of the soil and the repair of the disturbed area (revegetation 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 revegetated. The O & M cost is estimated to vary over the first five years until the revegetation has been established. The O & M costs are estimated to vary from $206,000 (year 1) to $70,000 (per year, starting at year 5 through year 30).

The estimated total capital cost, including Alternative 2 costs, is $223,460,000.

The estimated total annual O&M cost, including Alternative 2 costs, is 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 is $265,510,000, including Alternative 2.

Details of this cost estimate are included in Attachment 1.

3.5.8 State Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

3.5.9 Community Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The following subsections present the comparison between the alternatives considered.

4.1.1 Overall Protection of Human Health and the Environment

Alternative 1 is protective of human health and the environment because no unacceptable risks from residual contamination exist after the completion of all planned RFCA accelerated actions; however, Alternative 1 is not the most protective of human health and the environment for the following reasons:

- While the Wind Blown Area EU is protective of human health since the risk falls within the acceptable range of 1×10^{-6} to 1×10^{-4} cancer risks, Alternative 1 does not reduce exposure to surface soil residual plutonium-239/240 contamination above 9.8 pCi/g.
- Groundwater contamination exists in the IA OU above MCLs. Alternative 1 does not actively prevent the use of this groundwater for drinking water or irrigation purposes. However, reliable sources of on site groundwater for use as drinking water or irrigation are doubtful based on extensive hydrogeologic studies.
- Subsurface soil and groundwater contamination exists above the indoor air volatilization PRGs. Alternative 1 does not actively prevent the possibility of an unacceptable risk of exposure to the WRW if a building were constructed over the area contaminated above the indoor air volatilization PRGs and the building was routinely occupied. However, future land use planning does not include occupied buildings in these areas.
- The Present Landfill RFCA decision document requires institutional controls to be put in place at the time the post-closure period begins. However, institutional controls for the Original Landfill will not be required until the CAD/ROD. Alternative 1 assumes that these controls will be in place but that no other institutional controls will be implemented.

Alternatives 2 and 3 provide overall protection to human health and the environment; however, Alternative 3 further prevents unacceptable risk to a WRW by removing areas of residual plutonium-239/240 surface soil contamination, but the environmental damage and cost of additional surface soil removal above 9.8 pCi/g is ~~prohibitively~~ high.

~~In conclusion for this criterion, Alternative 2 provides a high level of overall protection to human health and the environment at RFETS.~~

4.1.2 Compliance with ARARs

All of the alternatives meet the ARARs for RFETS~~; however, Alternative 1 meets all of the ARARs for the lowest cost~~.

Alternative 1 does not meet soil RAO 3: Prevent exposure resulting in unacceptable risk to WRW or groundwater RAO 3: Prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs. In addition, Alternative 1 would assume that the institutional controls required by the Present and Original Landfill RFCA decision documents are in place.

Alternatives 2 and 3 meet soil RAO 3 and groundwater RAO 3. Institutional controls required in Alternative 2 are consistent with the institutional controls required in the Present and Original Landfill RFCA decision documents. Alternative 2 reduces exposure resulting in acceptable risk to the WRW through institutional controls that prohibit the construction and use of buildings over areas contaminated above the indoor air volatilization PRGs and put restrictions on activities that cause soil disturbance in areas with residual plutonium-239~~0~~/240 surface soil contamination above 9.8 pCi/g. Institutional controls will prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs by prohibiting drilling into or using groundwater contaminated above MCLs.

4.1.3 Long-term Effectiveness and Permanence

With the completion of all RFETS actions, Alternative 1 achieves long-term effectiveness and permanence. The accelerated action closure of the Present Landfill and Original Landfill, and the operation of three groundwater passive treatment systems are designed for long-term physical integrity and use. Monitoring and maintenance plans are implemented to sustain the effectiveness and permanence of these actions. Alternative 2 increases the effectiveness and permanence of the actions by reducing exposures resulting in acceptable risk to the WRW through institutional controls that prohibit the construction and use of buildings over areas contaminated above the indoor air volatilization PRGs and by placing restrictions on activities that cause soil disturbance in areas with residual plutonium-23~~0~~9/240 surface soil contamination. Institutional controls will prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs by prohibiting drilling into or using groundwater contaminated above MCLs. Alternative 3 removes the surface soils with residual contamination of plutonium-239/240 above 9.8 pCi/g and provides, through removal, a permanent and long-term action.

In conclusion for this criterion, Alternative 3 provides the most permanent long-term action.

4.1.4 Reduction in Toxicity, Mobility and Volume through Treatment

~~With the completion of all RFETS actions, many of which were removal actions,~~ Alternative 1 accounts for a high degree of reduction in toxicity, mobility and volume through ~~. Closure of the Present and Original Landfills provide for a high degree of containment of landfill waste materials. T~~treatment of the Present Landfill seep and groundwater by passive treatment systems ~~further reduces the toxicity and volume of environmental contaminants. Alternative 2 provides additional protection of these actions by reducing exposures resulting in acceptable risk to the WRW through institutional controls that prohibit the construction and use of buildings over areas contaminated above the indoor air volatilization PRGs and by placing restrictions on activities that cause soil disturbance in areas with residual plutonium-230/240 surface soil contamination. Institutional controls will prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs by prohibiting drilling into or using groundwater contaminated above MCLs.~~ Alternative 3 reduces the surface soil with residual contamination by removal.

In conclusion for this criterion, Alternative ~~2~~1 provides for a cost effective and protective solution ~~with a high degree of TMV reduction~~.

4.1.5 Short-term Effectiveness

Alternatives 1 and 2 provide a high degree of short-term effectiveness since the alternatives will not pose a risk to the workers or the public during implementation. The removal of large areas of surface soil with residual contamination as described in Alternative 3 will entail ~~high~~ increased risks to workers from earth moving and waste transportation activities. Risks to the public are expected to be low, though higher than from Alternatives 1 and 2. This risk is due to the large volume of soil and waste materials to be excavated and transported off-site for disposal. Additionally, there will be a short-term impact to affected ecological resources that increase to the amount of sediment loading to the surface water.

In conclusion for this criterion, Alternatives 1 and 2 provides the highest short-term effectiveness.

4.1.6 Implementability

Alternative 1 is easily implemented since no further removal actions need to be implemented. In addition, the IMP, Landfills and groundwater treatment monitoring systems are already in place.

Alternative 2 is easily implemented by initiating deed restrictions and limited construction work to install the physical controls (signage). These activities are not expected to entail direct exposure to residual contamination.

Alternative 3 uses standard earthmoving and transportation equipment to remove the areas of residual surface soil contamination. However, the implementation of the surface soil removal is much more difficult due to the large extent and large volume of soil to be managed. Wind and precipitation will also increase the potential for soil erosion and sediment loads to the RFETS drainages during the removal process. Major construction to support the long duration of the work (for example, new temporary roadways ~~and possibly a new temporary railroad spur~~) would be required to implement Alternative 3.

In conclusion for this criterion, Alternative 1 is the most implementable alternative.

4.1.7 Cost

The costs of Alternative 1 is only slightly increased by the addition of Alternative 2 (5 percent increase in present worth cost). The removal of surface soil contamination in Alternative 3 adds a large increment of cost (750 percent increase in present worth cost). The high cost of Alternative 3, with only a small incremental benefit and high short-term risks, is not justifiable.

In conclusion for this criterion, Alternative 2 is the most cost-effective action.

4.1.8 State Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

4.1.9 Community Acceptance

~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

5.0 REFERENCES

K-H, 2005, FY2005 Integrated Monitoring Plan Revision 1, Rocky Flats Environmental Technology Site, Golden, Colorado, September.

OMB, 2005, Office of Management and Budget Circular A-94, Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, Appendix C, January.

Table 3.1
Analysis of Alternatives for the Proposed Reconfigured IA OU

	No Further Action with Monitoring (Alternative 1)	Institutional and Physical Controls (Alternative 2)	Targeted Surface Soil Removal (Alternative 3)
Alternative Description	Maintains and monitors the completed actions conducted at the Present and Original Landfills, and the groundwater treatment systems. Alternative 1 also includes the additional environmental monitoring as described in the Final Draft FY2005 Integrated Monitoring Plan (IMP), dated September 8, 2005. Note: This alternative assumes that the National Wildlife Refuge Act specifies the land use and that no institutional control is needed to maintain the land as a national wildlife refuge.	Includes Alternative 1 plus institutional and physical controls. Institutional controls include legally enforceable and administrative land use restrictions. Physical controls include signage.	Includes Alternative 2 plus targeted removal of surface soil within an Exposure Unit (EU) to reduce the residual plutonium-239/240 contamination to below 9.8 pCi/g, which is. ~~T~~the 1 x 10^{-6} WRW risk target concentration. ~~is equal to 9.8 pCi/g.~~
Evaluation Criteria			

Protection of Human Health and the Environment	This alternative is protective of human health and the environment because:
	• With all ~~RFETS~~ RFCA actions complete, the Comprehensive Risk Assessment (CRA) shows that the incremental risk to the WRW is at or below 1 X 10^{-6} or an HI of 1 for soil and sediment with residual contamination above background, except in the Wind Blown Area EU where the calculated risk to a WRW is 2 x 10^{-6} for plutonium-239/240. Under CERCLA, the Wind Blown Area EU is still considered protective of human health since the risk falls within the acceptable range of 1 x 10^{-6} to 1 x 10^{-4} cancer risks and a hazard index of 1 for noncarcinogenic effects.
	• With all ~~RFETS~~ RFCA actions complete, the CRA indicates that there is no significant ecological risk from residual contamination within all environmental media across RFETS.
	• Actions at the Present and Original Landfills provide protection of human health and the environment.
	• Groundwater actions are operating as designed to ~~properly and successfully and~~ remove contamination captured to meet appropriate surface water quality standards at surface water POCs.
	• The IMP monitoring of groundwater and surface water provides data to verify that RFETS continues to be protective of human health and the environment. The IMP also includes the environmental monitoring of the Present and Original Landfills, the Present Landfill seep treatment system, and the groundwater treatment systems.
		This alternative is protective of human health and the environment because:
		• See Alternative 1.
		• Alternative 2 increases the protectiveness of Alternative 1 because institutional controls will provide the following:
		  • Prohibition of construction and use of buildings in contaminated areas.
		  • Prohibition on drilling wells into contaminated groundwater for water use (specifically, for drinking water or irrigation use).
		  • Prohibition on the use of contaminated surface water, groundwater and/or pumping groundwater where the remedy may be impacted.
		  • Restrictions on excavation in areas above subsurface contamination or intrusion into subsurface contamination.
		  ○ Prohibition on excavation at the Present and the Original Landfills.
		  • Restrictions on activities that cause soil disturbance in areas with residual surface soil contamination.
		• In addition, Alternative 2 will prohibit construction of buildings for human occupancy, thereby eliminating the indoor air inhalation pathway.
		• Signage monuments will be installed as a physical control along the perimeter of the IA OU to notify the WRW and WRV that they are at the boundary of the Refuge maintained by the USFWS.
			This alternative is protective of human health and the environment because:
			• See Alternatives 1 and 2.
			• Alternative 3 increases the protectiveness of Alternatives 1 and 2 because targeted surface soil removal will reduce plutonium-239/240 contamination to below 9.8 pCi/g.
			• Surface soil removal will result in short-term adverse impacts to ecological resources, including potential impacts to PMJM habitat.
			• 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.

Compliance with ARARs and RAOs	• ~~C~~This alternative complies with all ARARs. • ~~M~~This alternative meets all RAOs except Soil RAO 3 (Prevent exposure resulting in unacceptable risk to WRW) because of the risk related to indoor air volatilization, and Groundwater RAO 3 (Prevent drinking water and irrigation use of groundwater contaminated at levels above MCLs). • The Present Landfill RFCA decision document requires institutional controls to be put in place at the time the post-closure period begins. However, institutional controls for the Original Landfill will not be required until the CAD/ROD. Alternative 1 assumes that these controls will be in place but that no other institutional controls will be implemented.	• ~~C~~This alternative complies with all ARARs. • ~~M~~This alternative meets all RAOs.	• ~~C~~This alternative complies with all ARARs. • ~~M~~This alternative meets all RAOs.
Long-term Effectiveness and Permanence	• Accelerated actions have removed contaminated wastes, materials, debris, and soils providing a high degree of long-term effectiveness and permanence. • Landfills have been closed in accordance with regulatory agency approved closure plans as long term solutions. • Remaining building structures either meet free release standards or have fixed contamination that is 6 feet or more below ground surface. • Groundwater treatment systems are permanent passive systems requiring limited operational attention.	• See Alternative 1 plus: • Institutional controls are designed to provide the mechanisms that permanently maintain the completed actions conducted at RFETS and the monitoring consistent with the requirements in all accelerated action decision documents. • In the very long term, institutional controls may fail. • An environmental covenant will increase the long-term permanence of institutional controls.	• See Alternative 2 plus: ○ Removal of surface soils will permanently and effectively reduce plutonium-239/240 contamination to below 9.8 pCi/g. • Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.

	No Further Action with Monitoring (Alternative 1)	Institutional and Physical Controls (Alternative 2)	Targeted Surface Soil Removal (Alternative 3)
	• Monitoring through the IMP provides additional assurance of permanence.		
Reduction of Toxicity, Mobility or Volume ~~(TMV)~~ through Treatment	• Groundwater treatment systems remove contaminants thereby reducing contaminant loading to surface water. o The Present Landfill seep treatment system provides treatment to remove the VOC contamination from the landfill seep. o 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. o All of the RFCA accelerated actions (except the landfills) included removal of contaminated structures and environmental media. Removal provides the highest level of reduction of toxicity, mobility, and volume. ~~Landfills have been closed in accordance with regulatory agency approved closure plans to provide containment of landfill wastes and debris.~~ ~~Groundwater treatment systems remove contaminants thereby reducing contaminant loading to surface water.~~ • Where subsurface removal was not conducted, the contaminated material or media is fixed and/or not considered mobile in the environment. • ~~Monitoring through the IMP provides additional assurance that accelerated actions and ongoing actions have reduced TMV.~~	~~See Alternative 1, plus:~~ • ~~TMV will be reduced by institutional controls that prevent the potential for exposure to contamination by limiting access and not allowing disturbance of environmental media.~~	• See Alternative 2 plus: • Removal of surface soil reducing plutonium-239/240 contamination to below 9.8 pCi/g, will reduce ~~TMV~~toxicity, mobility, and volume. • Surface soil removal reduces remaining residual surface contamination that could be mobilized in the future if disturbed.
Short-term Effectiveness	~~Implementation of site-wide accelerated actions has resulted in a high level of short-term effectiveness through the removal and containment of wastes and contaminated debris and soils.~~ ~~Existing groundwater treatment systems are shown effective at reducing groundwater contamination.~~ ~~Monitoring through the IMP provides additional assurance that accelerated actions are effective.~~ • Workers and the public are not at risk since no additional action is required in this alternative.	• See Alternative 1 plus: • Institutional controls are effective immediately once the controls have been established. ~~Physical controls will provide notice to the WRW and WRV that they are at the boundary of the Refuge maintained by the USFWS.~~ • ~~Workers and the public are not at risk to implement this alternative.~~	• See Alternative 2 plus: • Removal of surface soil will result in an incremental risk to the workers and the public through the removal and transportation operations. • Surface soil removal will result in short term adverse impacts to ecological resources, including potential impacts to PMJM habitat. • 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.
Implementability	• No further action is easily implemented since the all accelerated actions are complete. • Post-accelerated action monitoring of the Present and Original Landfills is easily implemented since the monitoring systems are established. • Monitoring through the IMP is easily implemented since the monitoring network is established.	• See Alternative 1 plus: • Institutional controls are easily implemented • Physical controls, such as signage, are easily implemented.	• See Alternative 2 plus: • Removal of surface soils is implementable with standard earthmoving and transportation equipment.
Cost*	Capital Cost: $0 Annual O & M Cost: $2,530,000 Present Worth Cost: $41,350,000 Groundwater treatment system medial replacement costs are estimated at $728,000 every 5 years. The estimated costs for preparing materials for the CERLCA periodic review is $153,000 every 5 years.	Capital Cost: $1,120,000 Annual O & M Cost: $45,000 (Alt. 2 only) Total Annual O & M Cost: $2,575,000 (includes Alts. 1 + 2), less the media replacement costs and CERCLA periodic review costs Present Worth Cost: $43,170,000 (includes Alts. 1 + 2)	Surface Soil Removal Capital Cost: $222,340,000 (assumes up to approximately 368 acres surface soil removal and disposal as low-level radionuclide contaminated soil) Total Capital Cost: $223,460,000 (includes Alts. 1,2 & 3) Annual O&M Cost: Varies from $206,000 to $70,000 (Alt. 3 only) Total Annual O&M Cost: $2,781,000 to 2,645,000 (includes Alts 1, 2 &3), less the media replacement costs and CERCLA periodic review costs Present Worth Cost: $265,510,000 (includes Alts. 1, 2 & 3)
State Acceptance	~~Reserved~~Discussion of this criterion will be provided in the CAD/ROD.	~~Reserved~~Discussion of this criterion will be provided in the CAD/ROD.	~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

	No Further Action with Monitoring (Alternative 1)		Institutional and Physical Controls (Alternative 2)		Targeted Surface Soil Removal (Alternative 3)
Community Acceptance	~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.		~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.		~~Reserved~~ Discussion of this criterion will be provided in the CAD/ROD.

*Capital costs are in 2005 dollars and O & M Costs are calculated for 30 years at a discount rate of 5 percent.

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