

**The Role of Land Use in Environmental Decision Making at Three DOE Mega-Cleanup Sites:
Fernald, Rocky Flats, and Mound -11595**

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ABSTRACT

This paper explores the role that future land use decisions have played in the establishment of cost-effective cleanup objectives and the setting of environmental media cleanup levels for the three major U.S. Department of Energy (DOE) sites for which cleanup has now been successfully completed: the Rocky Flats, Mound, and Fernald Closure Sites. At each site, there are distinct consensus-building histories throughout the following four phases: 1) the facility shut-down and site investigation phase, which took place at the completion of their Cold War nuclear-material production missions; 2) the decision-making phase, whereby stakeholder and regulatory-agency consensus was achieved for the future land-use-based environmental decisions confronting the sites; 3) the remedy selection phase, whereby appropriate remedial actions were identified to achieve the future land-use-based decisions; and 4) the implementation phase, whereby the selected remedial actions for these high-profile sites were implemented and successfully closed out.

At each of the three projects, there were strained relationships and distrust between the local community and the DOE as a result of site contamination and potential health effects to the workers and local residents. To engage citizens and interested stakeholder groups - particularly in the role of final land use in the decision-making process, the site management teams at each respective site developed new public-participation strategies to open stakeholder communication channels with site leadership, technical staff, and the regulatory agencies. This action proved invaluable to the success of the projects and reaching consensus on appropriate levels of cleanup. With the implementation of the cleanup remedies now complete, each of the three DOE sites have become models for future environmental-remediation projects and associated decision making.

INTRODUCTION

In 1991, DOE decided to realign the Nation's nuclear weapons production program. The Secretary of Energy announced in a February 1992 Report to Congress that as part of this realignment, several DOE sites would no longer have a nuclear production mission. DOE's mission at these sites then became the safe deactivation of nuclear production facilities; decontamination, decommissioning, and demolition of building and infrastructure; cleanup; and closure.

All three of the projects we are going to discuss - Fernald, Rocky Flats, and Mound Closure Sites, were mega-environmental projects with total cleanup costs in the billions of dollars. A balanced view of on-site and off-site disposal decisions, coupled with consensus building for future land use conditions, was necessary to achieve successful cleanup in a timely manner. Each of the three projects progressed through the following steps:

1. Determining the extent of damage to the environment at, and adjacent to, the former Cold War production facilities.

2. Selecting appropriate environmental cleanup criteria – final land-use-based end states that had to be met to protect human health and the environment.
3. Selecting and implementing the remedial actions that would meet the cleanup criteria and achieve the intended future land use.
4. Doing the work to restore the sites – ultimately disposing of millions of cubic yards of radiological and chemically contaminated remediation wastes safely, compliantly, and cost-effectively.
5. Reaching agreement on final institutional controls and closing out the sites with the regulatory agencies.

Cleanup efforts for the three sites were designed to satisfy the Environmental Protection Agency's (EPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup obligations. Land use is an important factor in selecting cleanup remedies under these regulations. Remedial action objectives that are developed as part of the CERCLA remedial investigation and feasibility study process are to reflect the reasonably anticipated future land use(s). These future land-use assumptions allow the baseline risk assessment and the feasibility study (RI/FS) to focus on developing practical and cost-effective remedial alternatives. These alternatives should then support future site activities that are consistent with the reasonably anticipated future land use.

Three key EPA CERCLA policy directives describe how site managers are to employ future land use assumptions to assist in establishing health-protective cleanup objectives and criteria for a site:

1. *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions* [1]
2. *Land Use in the CERCLA Remedy Selection Process* [2]
3. *Reuse Assessments: A Tool To Implement The Superfund Land Use Directive* [3]

EPA has also formally recognized the CERCLA land use directive noted above within its RCRA Corrective Action Program framework, to assist in determining reasonably anticipated future land use for remedy selection purposes under RCRA. Thus, for purposes of this paper, the CERCLA and the RCRA Corrective Action remedy selection processes are viewed as essentially equivalent, as both draw from the same recognized administrative steps concerning the role of future land use in determining protectiveness requirements. The CERCLA process will therefore be used to describe the overall role of land use in the decision-making process from here forward, recognizing the equivalence of both programs.

The CERCLA remedy selection process uses a multi-step process that applies *nine criteria* (shown in Figure 1) to support remedy selection in a record of decision (ROD). The first two criteria, the *threshold criteria*, are used to eliminate non-viable alternatives, i.e., those that cannot meet protection and regulatory requirements. Remedies are screened out at this stage if they are unable to satisfactorily protect human health and the environment, which in part depends on future uses of the land. The next five criteria, *balancing criteria*, are used to compare each viable alternative against other important considerations. The final step of the process considers input from the public and other governmental stakeholders that are evaluated against the last two CERCLA criteria, *modifying criteria*. This final step may result in modification to the remedy to improve its overall public acceptance. The final remedy is described in the record of decision.

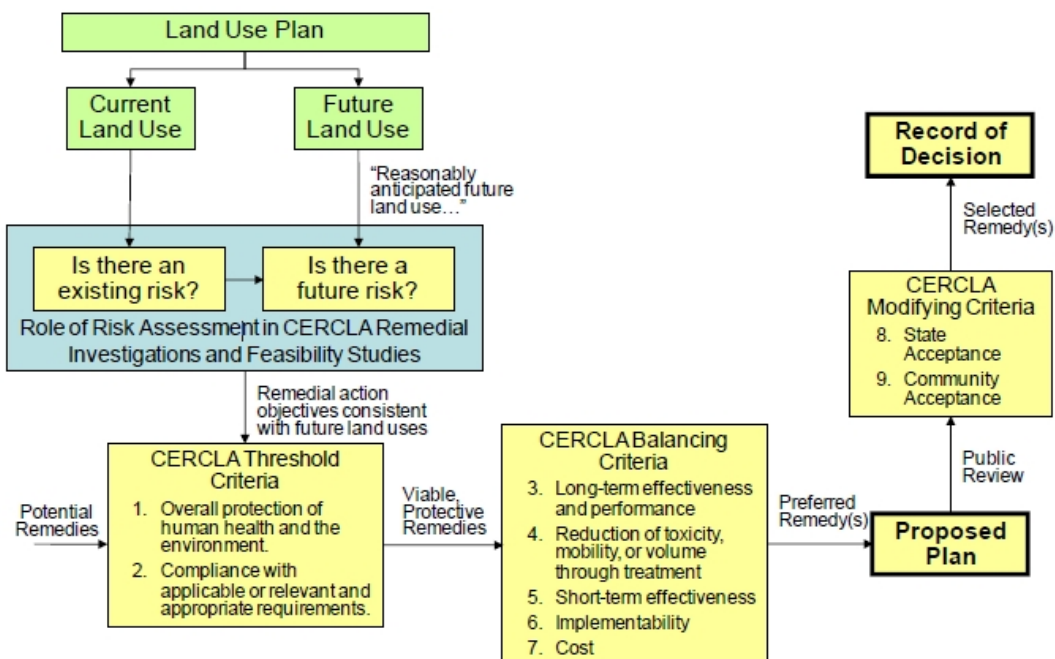


Fig. 1. Land Use and CERCLA Remedy Selection (adapted from EPA’s May, 1995 OSWER Directive No. 9355.7-04)

Alternate land uses are examined in the CERCLA process to compare how long-term effectiveness of remedies might vary under different hypothetical scenarios as part of the balancing criteria evaluations. For example, a residential or farming scenario, which differs from the anticipated land use, can be used to inform the decision maker about the potential impacts to specific populations from unexpected exposures. However, consistent with the Directive above, the remedial alternatives developed “...should lead to site activities which are consistent with the reasonably anticipated future land use.”

The consideration of future land use in the decision-making process generally results in the setting of environmental cleanup levels for contaminated soils and residual wastes that are deemed protective of potentially exposed individuals through the direct contact human health exposure pathway. This, however, is one prong of a three pronged protectiveness evaluation. In addition to the direct contact exposure pathway, soil cleanup levels must also be protective of underlying groundwater and its connection with surface water, and also ecological receptors. Generally, the lowest value for a given contaminant in soil (considering protection of the direct contact human health exposure pathway, groundwater/surface water protection requirements, and protection of ecological receptors) is used as the final cleanup value. Future land use is therefore a vital, but not the only, consideration in establishing protective final cleanup values for soil and residual wastes at a particular site.

Future land use influences the baseline risk assessment, the development of alternatives, and the cleanup remedy selection process including the selection of protective soil cleanup levels that must be achieved by the selected remedy. The sections below describe the role of future land use for each of the three DOE mega cleanup sites considered in this case study.

THE FERNALD CLOSURE PROJECT

The Fernald Closure Project, formally known as the Feed Materials Production Center, was a 1050-acre DOE facility located approximately 18 miles northwest of Cincinnati. The site was situated in a rural setting near the village of Fernald, Ohio. The site operated from 1952, until 1989, as a large-scale production facility extracting uranium ores and ore concentrates to yield high purity metal products in support of U.S. defense programs. During the 38-year production history, over 500 million pounds of uranium metal products were shipped from the site to other DOE sites across the country. In 1989, with a decline in product demand and increasing environmental concerns, production operations were permanently shut down. In 1991, the site was officially declared closed and the facility renamed to reflect its new mission.

The topography of the area includes gently rolling uplands with steep hillsides along major streams, such as the Great Miami River which is the principal surface water resource in the site area. Groundwater beneath the site is found in two principal geologic units: the glacial overburden (ranging in thickness from 0 to 50 feet), and the sand and gravel of the Great Miami Aquifer. The underlying Great Miami Aquifer is the principal drinking water supply for the region and is regulated as a sole-source aquifer under the Safe Drinking Water Act.

The Remedial Investigation/Feasibility Study (RI/FS) process was initiated at Fernald under a Federal Facility Compliance Agreement between EPA and DOE. The work plan for the study, prepared by DOE in 1988, identified 39 site areas for investigation. To enhance implementation of the RI/FS, the 39 areas were grouped into five operable units (OUs) by combining similar waste areas or related environmental concerns. The OU concept was incorporated into a new April 1990 Consent Agreement between EPA and DOE. Due to confirmed contaminant releases to the environment identified during the initial stages of the RI, the Fernald Site was placed on the National Priorities List in November 1989.

Operable Units 1-4 are termed “source” operable units and include the former production area and associated waste management areas that were the initial points of contaminant release to the environment. Operable Unit 5 addresses all environmental media on and off the Fernald property impacted by contaminants released from the facility. Each operable unit was managed in accordance with the schedules set forth in the Consent Agreement, with RODs for all operable units completed between 1994 and 1996.

The RI identified widespread contamination of surface soil, sediment, and groundwater both on and off the facility as a legacy of the 38-year production mission. The RI identified 89 contaminants of concern in the various environmental media and uranium as the predominant contaminant. Up to 11 square miles of off-property surface soil were found to be contaminated with uranium at concentrations exceeding background values. The source of these concentrations was emissions of dust particles to the atmosphere from plant stacks.

Radium, thorium, fission, and uranium activation products, and inorganic and organic contaminants were also observed in surface and subsurface soils on the Fernald property. The areas affected by these contaminants were localized, with the highest concentrations typically found associated with the on-site areas exhibiting the highest uranium concentrations.

To foster community input into the decision process, the DOE chartered the Fernald Citizens’ Task Force. The Task Force, which was comprised of local government officials and residents, labor leaders, Fernald employees, and community leaders, focused on making recommendations to decision makers on preferred cleanup levels, waste disposition strategies, and future land uses for the Fernald property. Throughout the development of the Operable Unit 5 FS and ROD, DOE considered the deliberations of the Task Force.

Fernald: Approach to Establishing Cleanup Levels

As is the case at many Superfund sites, remediation at Fernald required the removal, treatment, and disposal of hazardous source-area materials and the cleanup of environmental media (soil and groundwater) contaminated by the migration of materials from the source areas. There was little dispute over the need to remove, treat, and/or dispose of the source materials themselves; likewise there was little dispute over the need to restore the Great Miami Aquifer (a protected-sole source aquifer) to full beneficial use, including the use as a drinking water supply. Rather, as noted by the Fernald Citizen's Task Force, it was the cleanup of the contaminated soil that posed the difficult management problem because: 1) here are large volumes of contaminated material with associated high costs of cleanup; 2) the risk presented by contaminated soil is real but the harm is seldom imminent; 3) the technology for treating contaminated soil is often imperfect; and 4) the materials that are removed during cleanup must be disposed of somewhere and no place is eager to host them.

At Fernald, the environmental cleanup question confronting the site was summarized as: how much contaminated soil must be removed from the site to make it acceptably safe for persons on or near it? The answer to this question in turn, was driven by two considerations: protection of the groundwater under the site, and evaluation of risks to persons in contact with the surface soil. In the subsections below, the major steps in establishing safe, land-use specific, cost-effective cleanup levels for Fernald's soil are described. From these levels, estimates of the volumes and areal extent of affected soil were derived for a range of potential risk levels under consideration. The volumes and areas of affected soil then served as the foundation for the development and evaluation of remedial alternatives.

Fernald: Definition of Land Use Objectives and Associated Receptor Scenarios

A range of potential land uses was used as the foundation for the identification, initial screening, and detailed evaluation of viable remedial action alternatives. The same potential future uses also provided the framework for identifying risk-based exposure scenarios for which land-use-specific remediation levels were established. The land use objectives we developed to take into consideration the progressive deliberations of the Fernald Citizen's Task Force. The prevailing land use of the region, residential farming, was used as the point of departure for establishing the following land use objectives:

- **Land Use Objective 1** examined the viability of returning the entire on-property area to full unrestricted use following cleanup, including the potential for establishing a hypothetical family farm on any portion of the on-property area.
- **Land Use Objective 2** provided for the establishment of an on-property, consolidated management area for contaminated soil, with unrestricted use of all remaining areas of the property. This land use objective considered the potential for establishing a hypothetical family farm, following cleanup, on any portion of the Fernald property outside the area where the contaminated materials would be consolidated.
- **Land Use Objective 3** also provided for the consolidation of contaminated soil in a central area, but restricted potential uses of the remaining areas of the Fernald property through application of institutional controls. The objective considered the potential for establishing recreational, commercial/industrial, or undeveloped open space on any portion of the Fernald property outside the area where the contaminated materials are consolidated.
- **Land Use Objective 4** provided for minimum consolidation of contaminated soil with access and future use of the Fernald property restricted. This land use objective contemplated maintaining the entire 1050-acre Fernald property under restricted access for waste management purposes.

By using the land use objectives approach to formulate remedial action alternatives, decision makers were provided with a comprehensive, but manageable array of alternatives. From this array, decision makers were provided with the required information from which to evaluate technical site constraints, required administrative controls, and the overall cost implications of moving from totally restricted to progressively less restricted land use possibilities.

Fernald: Formulation and Evaluation of Remedial Alternatives

There were many remedial technologies and process options initially considered for the cleanup of each of the affected media at the Fernald site. Arraying these process options together produced in excess of 2000 remedial alternatives that could be applied at the site. Using the four land use objectives as a guide, 10 viable alternatives were identified from the long list for further consideration in the initial screening step of the FS. The alternatives were first compared with one another to identify meaningful differences and then evaluated with respect to implementability, effectiveness, and cost. Only the alternatives judged most promising on the basis of these evaluation factors were retained for further consideration and analysis. The screening process resulted in the selection of seven remedial alternatives that were sufficiently distinct, yet potentially implementable and effective. The seven alternatives along with the no-action alternative are summarized below.

- **No-Action Alternative** – This alternative was retained to provide a baseline for comparison in accordance with regulatory requirements.
- **Alternative 1 – Excavation and Off-Site Shipment** – Under this alternative, soil with contamination exceeding final remediation levels would be excavated and shipped to an off-site licensed disposal facility. Final remediation levels would achieve Land Use Objective 1 requirements for unrestricted use and permit the hypothetical development of all areas of the Fernald property as a family farm.
- **Alternative 2A – Engineered Disposal Facility** - Under this alternative, a consolidated waste management area would be established and the remaining areas of the property would be made available for unrestricted use. Contaminated soil exceeding final remediation levels would be excavated and placed in an engineered above-grade on-site disposal facility.
- **Alternative 2C – Consolidation with Off-Site Shipment** – Under this alternative, contaminated soil exceeding remediation levels for unrestricted use would be excavated and, depending on contaminant concentration levels, dispositioned in an on-site, earthen covered and re-vegetated consolidation area or at an off-site disposal facility if concentration levels exceed values associated with the trespasser exposure scenario.
- **Alternative 3A – Engineered Disposal Facility** – This alternative is identical in concept to Alternative 2A, except the area outside the disposal footprint is made available for restricted (nonresidential and non-farming) land use. The alternative individually considers use of the on-property area for commercial/industrial, developed park, and undeveloped park land uses.
- **Alternative 3C – Consolidation with Off-Site Shipment** – This alternative is identical in concept to Alternative 2C, except for the changes in land use and the receptor scenarios described for Alternative 3A.
- **Alternative 4A – Engineered Disposal Facility** – This alternative is identical in concept to Alternative 2A, except the area outside the disposal area footprint is not made available for productive use following remediation; i.e., the entire 1050-acre Fernald site is rendered off-limits to the general public. For this alternative, a trespasser receptor scenario is used to guide the development of cleanup levels.
- **Alternative 4C – Consolidation with Off-Site Shipment** – This alternative is identical in concept to Alternative 2C, except for the changes described above for Alternative 4A.

Fernald: Overview of the Selected Remedy and Its Implementation

In conjunction with the Fernald Citizen's Task Force recommendations, DOE, EPA, and the Ohio EPA selected Alternative 3A, excavation of contaminated soil and placement in an on-site engineered disposal facility, as the preferred remedy for contaminated soil at the Fernald site. This alternative was selected because it provides a remedy which is reliable over the long term, yields the lowest overall short-term risks, is cost effective when compared to the other alternatives, and employs proven technologies which are implementable.

During the solicitation of community and stakeholder input for the remedy decision, it became clear that virtually no stakeholders or members of the public were interested in seeing the on-property area of the Fernald site returned to residential farming following remediation. From this basis, and on the recommendations of the Fernald Citizen's Task Force, DOE, EPA, and Ohio EPA collectively agreed to adopt Land Use Objective 3 (i.e., the restricted, non-farming land use objective) for the setting of on-property soil cleanup levels. These cleanup levels were also evaluated for protection of the underlying Great Miami Aquifer and found to be protective for use of the aquifer as a potential drinking water supply. The cleanup levels were also evaluated for protection of ecological resources and found to be protective over the long term.

A key ingredient to the stakeholder's understanding of the tradeoffs and benefits of the various cleanup levels under consideration was the highly successful public-forum deliberations and presentations conducted by the Fernald Citizen's Task Force.

Fernald: Summary of Key Accomplishments

The strategy for establishing health-protective, land-use driven soil cleanup levels, as outlined in this paper, has led to a cost-effective, environmentally sound approach to site remediation at the Fernald Closure Site. Most notably, through the cross-media considerations adopted in this strategy, the site's top environmental priority – the long-term protection of the Great Miami Aquifer – will be realized, resulting in the unrestricted availability of groundwater from the aquifer for the foreseeable future following the cessation of remedial operations.

By shipping the most contaminated soil off site, and keeping the lightly-contaminated materials on site in an engineered disposal facility, the remedy presents a balanced, fair approach to site remediation. It is estimated that this element of the remedy, in conjunction with the realistic land-use-based cleanup levels that were selected, resulted in a cost savings of over \$3.6 billion when compared to the cost impacts of adopting the most stringent cleanup levels and adopting a full off-site shipment and disposal alternative. The selected land-use-based cleanup levels also eliminated the need for significant disturbance to on- or off-property wetlands, habitats, cultural resources, natural vegetative communities and cultivated croplands.

The soil cleanup levels that were established through the land-use-based process are each individually health protective, satisfy Applicable or Relevant and Appropriate Requirements (ARARs) under CERCLA, consider the incremental health risks attributable to naturally occurring background levels and, when considered collectively through all exposure pathways, fall within the acceptable risk range required for CERCLA sites by EPA's National Contingency Plan regulations. By arriving at these levels in an open public forum, in concert with the deliberations of the Fernald Citizen's Task Force, citizen trust and understanding of DOE's top cleanup objectives and priorities was gained. DOE could not be successful at Fernald – or anywhere else for that matter – without the continuing dialogue and understanding that was displayed among the various stakeholder groups during the Operable Unit 5 land-use-based remedy selection process.

As the final chapter in the effort, the Fernald cleanup was completed in the fall of 2006. Today, the site is a local wildlife sanctuary with unimpeded access for use by the general public across 950 acres of the original 1050-acre property. Approximately 100 acres has been dedicated to on-site disposal in a consolidated area just east of the former production area. More than 395 acres of woodlots, 327 acres of prairie, 81 acres of wetlands, 60 acres of open water, and 33 acres of savannah have been created as part of the sanctuary.

THE ROCKY FLATS CLOSURE PROJECT

Rocky Flats is located in the Denver metropolitan area, approximately 16 miles northwest of Denver, Colorado, and approximately 10 miles south of Boulder, Colorado. The Rocky Flats site is a 6,241-acre owned by the United States that was a top-secret, high security factory that processed and machined plutonium and enriched uranium into detonators, also called “triggers,” for nuclear weapons. From 1952 to 1989, the site produced 70,000 nuclear triggers. The site consisted of more than 700 structures located on an approximate 300-acre industrial area at the center of the property. The industrialized area was surrounded by a security buffer zone that contained some supporting activities, such as waste disposal, but was left mostly undisturbed.

Manufacturing activities, accidental industrial fires and spills, and support activities, including waste management, resulted in the release of CERCLA hazardous substances and RCRA hazardous wastes and hazardous waste constituents to air, soil, sediment, groundwater, and surface water at Rocky Flats. Some buildings and infrastructure systems also became contaminated. Known or suspected release locations - primarily in the soil, were delineated by 183 Individual Hazardous Substance Sites (IHSS) within 16 Operable Units, 146 Potential Areas of Concern, 31 Under Building Contamination Sites, and 61 Potential Incidents of Concern – all totaling 421 areas.

Risk analysis and cleanup actions were conducted in accordance with CERCLA and with the Colorado Hazardous Waste Act [4] (CHWA). RCRA is administered in Colorado through the CHWA, by the Colorado Department of Public Health and Environment (CDPHE). The key Applicable or Relevant and Appropriate Requirement for Rocky Flats was the Colorado Water Quality Control Commission Surface Water Standards [5].

Rocky Flats: Approach to Establishment of Cleanup Levels

DOE, EPA, and CDPHE were the signatories to the Rocky Flats Cleanup Agreement (RFCA) [7] which changed the regulatory approach in several significant respects. It incorporated an unenforceable Preamble recitation of the objectives for eight topics that influenced cleanup decision making that were developed in consultation with the community and local governments, resulting in a vision for the site. The vision was intended to provide a holistic view of key Rocky Flats activities in relation to the required cleanup of the Site. The following descriptions of the summary objectives are taken from the agreement Preamble:

1. Disposition of Weapons Useable Fissile Materials and TRU Wastes: DOE will stabilize, consolidate, and temporarily store weapons useable fissile materials and transuranic wastes on-site for removal; ultimate removal of weapons useable fissile material is targeted for no later than 2015.
2. On-Site and Off-Site Waste Management: Waste management activities for low-level, low-level mixed, hazardous, and solid wastes will include a combination of on-site treatment, storage in a retrievable and monitored manner, disposal, and off-site removal. Low-level and low level mixed wastes generated during cleanup will be stored in a safe, monitored and retrievable manner for near-

term shipment off-site, long-term storage with subsequent shipment off-site and/or long-term storage with subsequent disposal onsite of the remaining wastes.

3. Water Quality: At the completion of cleanup activities, all surface water on-site and all surface and ground water leaving the site will be of acceptable quality for all uses.
4. Cleanup Guidelines: Cleanup activities will be conducted in a manner that will:
 - reduce risk;
 - be cost-effective;
 - protect public health;
 - protect reasonably foreseeable land and water uses;
 - prevent adverse impacts to ecological resources, surface water, and ground water; and
 - be consistent with a streamlined regulatory approach.
5. Land Use: Cleanup decisions and activities are based on open space and limited industrial uses; the particular land use recommendations of the Future Site Use Working Group are not precluded; specific future land uses and post cleanup designations will be developed in consultation with local elected officials, local government managers, Rocky Flats Local Impacts Initiative, Citizen Advisory Board, other groups and citizens. The Parties recognize the legal authority of local government to regulate future land use at and near the site.
6. Environmental Monitoring: Environmental monitoring will be maintained for as long as necessary.
7. Building Disposition: All contaminated buildings will be decontaminated as required for future use or demolition; unneeded buildings will be demolished.
8. Mortgage Reduction: Weapons useable fissile material and transuranic wastes will be safely consolidated into the smallest number of buildings to reduce operating costs and shrink the security perimeter; contaminated and non-contaminated buildings will be decommissioned and either demolished or turned over for other non-DOE uses.

The Cleanup Guidelines from the agreement streamlined the old regulatory approach in several ways. Two new OUs were established: the Industrial Area OU with CDPHE as the Lead Regulatory Agency, and the Buffer Zone OU with EPA as the Lead Regulatory Agency. The previous OUs were realigned and consolidated to fit within these OUs, as was lead agency planning, investigation, and decision document review and approval authorities. The agreement also coordinated all of DOE's cleanup obligations under CERCLA, RCRA, and CHWA in a single agreement to streamline compliance with these three statutes. A consultative, accelerated action approach for the IHSSs was also delineated in RFCA. RFCA paragraph 79 provides, in part, the following:

To expedite remedial work and maximize early risk reduction at the Site, the Parties intend to make extensive use of accelerated actions to remove, stabilize, and/or contain IHSSs. Focusing on IHSSs rather than OUs will allow most remedial work to be reviewed and conducted through one of the accelerated review and approval processes described in Part 9, rather than the RI/FS process....

In addition, to aid in evaluation of accelerated action determinations for IHSSs, action levels (ALs) were established and used as described in RFCA paragraph 75:

The Action Levels and Standards Framework, Attachment 5, establishes action levels for ground water and soil as well as action levels and cleanup standards for surface water. Attachment 5 also establishes a deadline for setting additional action levels for soil and interim cleanup levels for soil. Action levels and standards are requirements of this Agreement, but exceedance of an Action Level is not subject to penalties. The Framework action levels describe numeric levels of contamination in ground water, surface water, and soils which, when exceeded, trigger an evaluation, remedial action and/or management action.

Both RFCA and the Action Levels Framework were developed in consultation with the stakeholders. Additionally, monitoring requirements were established based on input from the stakeholders. Reviews and updates were conducted in consultation with CDPHE, EPA, local cities staff, and other stakeholders. Consultative meetings were routinely held and quarterly monitoring information exchanges were conducted to consider monitoring results, the evolving nature of site condition, and changes to monitoring needs as cleanup progressed toward closure.

Rocky Flats: Land Use Objectives

As described above, RFCA established the Land Use objective that cleanup decisions and activities are based on open space and limited industrial uses. Characterization results were compared to RFCA soil action levels specified in ALF to evaluate whether the levels and extent of contamination triggered an accelerated action. Because of concerns by some in the community over the exposure parameters used to establish the radionuclide soil action levels (RSALs) in 1996, these levels were considered interim. The RFCA Parties conducted a review to determine whether the interim RSALs should be modified. During the period of review, the future land use as the Rocky Flats National Wildlife Refuge Act of 2001 became law. Thus, the RSAL review expanded to reconsider soil ALs for all analytes, using the WRW exposure scenario. As a result of the review, soil ALs and the evaluation and implementing criteria for RFCA accelerated actions required under ALF were modified in 2003.

The Refuge Act provides that future ownership and management of Rocky Flats shall be retained by the United States. Under the Refuge Act, upon completion of cleanup and closure of Rocky Flats, the Secretary of Energy shall transfer administrative jurisdiction over certain Rocky Flats lands to the Secretary of the Interior for the purposes of establishing the Rocky Flats National Wildlife Refuge (Refuge). The U.S. Fish and Wildlife Service (USFWS) is the Department of Interior agency responsible for wildlife refuge management. Under the Refuge Act [6], the Secretary of Energy will retain administrative jurisdiction over those Rocky Flats engineered structures 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. The final delineation of lands to be transferred to the Secretary of the Interior is identified in the Corrective Action Decision/Record of Decision.

A Final Comprehensive Conservation Plan and Environmental Impact Statement (CCP/EIS) related to the establishment of the Refuge was prepared by USFWS, in consultation with the public and the local communities as required by the Refuge Act. The Refuge Act also requires the Secretary of the Interior to provide a report to Congress on the impact of any existing property rights, including any mineral rights, on management of the Refuge, and identify strategies for resolving and mitigating the impacts. The CCP/EIS contains extensive information regarding the attributes and the plant and animal resources of the approximately 6,240-acre Rocky Flats property in relation to its designation as a National Wildlife Refuge.

Rocky Flats: Comprehensive Risk Assessment Results

The Comprehensive Risk Assessment (CRA) was designed to provide information to decision makers to help determine if the final remedy was adequately protective of human health and the environment. Because of the decision to take accelerated actions on an IHSS-by-IHSS basis, the RFCA Parties believed it was necessary to evaluate the site more holistically at the end of the process to ensure that there were no residual potential adverse cumulative impacts. The final CRA was completed under the methodology which specified the evaluation of concentrations of contaminants on an exposure unit (EU) basis rather than on an individual release site basis. The EUs were defined based on the land use decisions that had been made (i.e., size of the EUs was based on the activity patterns for a WRW or WRV). The CRA

Methodology contained the methods for conducting a human health risk assessment (HHRA) and an ecological risk assessment (ERA).

CDPHE guidance requires evaluation of contaminant concentrations on a release site basis. This was implemented at Rocky Flats on a site-by-site basis during the accelerated action process. By addressing cumulative impacts from multiple release sites, the CRA's EU approach complements, but does not supplant, the CHWA emphasis on individual release sites. Because the parties had anticipated using institutional controls consistent with the anticipated future use of the site, CDPHE determined that a post-remediation analysis of residual risk on a release site basis was not necessary.

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.

Soil and Sediment: Based on the CRA Methodology, no contaminants of concern (COCs) were identified for subsurface soil and subsurface sediment. COCs for surface soil and sediment were quantitatively evaluated for the Wildlife Refuge Worker and Wildlife Refuge Visitor receptor. The cancer risk estimates were at the low end of EPA's 1×10^{-6} to 1×10^{-4} risk range. The non-cancer health effects estimates (HIs) were all below 1, indicating non-cancer health effects are unlikely. Radiological dose estimates are less than 1 millirem per year (mrem/yr).

Surface Water: Potential exposure to surface water by WRW or WRV receptors was evaluated in the CRA on a site-wide basis. For this site-wide evaluation, surface water concentration organics, inorganics, and radionuclides in surface water exceeded their preliminary remediation goals (PRGs). Further analyses for each analyte indicated that (1) the exceedances were generally slight and infrequent, and (2) the exceedances were in data from 1998 or older, whereas no exceedances occurred in the more recent data.

Groundwater: The RFCA Vision states that on-site groundwater will not be used for any purposes unrelated to Rocky Flats cleanup activities. Therefore, the pathway for direct ingestion of groundwater is incomplete.

Indoor Air Pathway: The indoor air pathway was evaluated on a site-wide basis. Volatile chemicals have been detected in the subsurface in some subsurface soil and groundwater sampling locations of the site. In these locations, the indoor air inhalation pathway is potentially significant if buildings were constructed there.

Ecological Risk Assessment (ERA): The overall conclusions from the ERA indicate there is no significant risk of adverse ecological effects to receptors from exposure to site-related residual contamination.

CRA Summary: Ongoing monitoring and maintenance of accelerated actions along with institutional and physical controls were selected as part of the final remedy to address these residual risks and uncertainties.

Rocky Flats: Key Accomplishments

The final remedy selected in the CAD/ROD was No Action for the Peripheral OU and institutional controls and physical controls with continued monitoring for 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 Peripheral OU includes all other areas onsite

requiring no further action. Because remaining contamination in the Central OU does not allow for unlimited use and unrestricted exposure, periodic reviews are required by CERCLA to be conducted at least every five years to determine whether the Central OU remedial actions remain protective of human health and the environment. The offsite areas at Rocky Flats were addressed under a separate no action CAD/ROD dated June 3, 1997.

The majority of accelerated action remedial work was completed after RFCA was put in place in 1996. Since that time, all historical IHSSs, buildings, and identified contaminated groundwater plumes were dispositioned. All planned accelerated actions were implemented and signed off as completed by EPA and CDPHE by May 2006. Upon completion of the accelerated action remedial work, a RCRA Facility Investigation – Remedial Investigation/Corrective Measures Study – Feasibility Study Report (RFI/RI CMS/FS) was developed to support the Corrective Action Decision/Record of Decision (CAD/ROD) process. The final remedy for Rocky Flats was selected and documented in the CAD/ROD by EPA and CDPHE in September 2006, and was based on the results of the RFI/RI CMS/FS which included a Comprehensive (Human Health and Ecological) Risk Assessment and Proposed Plan.

The RFCA approach resulted in development of a credible planning and funding baseline from which enforceable regulatory milestones were established and almost always met. Implementation of RFCA resulted in reducing the projected time and funding needed to achieve required cleanup, and eventually line item, relatively level annual “closure project” congressional appropriations for Rocky Flats were approved. Site closure was completed in 2006, at which point the site was transitioned to DOE Legacy Management. In 2007, a portion of the site was transferred to the U.S. Department of the Interior and is managed by the USFWS as a National Wildlife Refuge.

THE MOUND CLOSURE SITE

The Mound Site, named for a nearby Native American burial ground, is located in Miamisburg, Ohio, approximately 10 miles southwest of Dayton. The plant, which was in operation from 1948 to 2003, was situated on 182 acres. In 1983, DOE purchased an additional 124 acres of land south of the original property (for a total of 306 acres), but that property remained undeveloped. At its peak, the Mound facility encompassed 116 buildings. The Great Miami River flows through Miamisburg and dominates the geography of the region surrounding the Mound Site. The river valley is highly industrialized; the rest of the region is a mix of farmland, residential area, small communities, and light industry. Many residential developments, five schools, the Miamisburg downtown area, and six city parks are located within a mile of the Mound Site.

The Dayton area supported secret operations for the War Department during World War II. Known only as the Dayton Project, extensive chemical and metallurgical research had been done in the support of the Manhattan Engineering District. At the end of the war, that work was moved from facilities in Dayton to permanent facilities in Miamisburg. During the Cold War, the plant produced polonium-beryllium initiators, which were used in early atomic weapons. The site also researched and manufactured radionuclides. The Mound Site was involved in a number of weapon and non-weapon programs until the late 1980s.

The cleanup contract scope of work required the decontamination, decommissioning and demolition of numerous nuclear facilities, remediation of major soil and groundwater contamination, disposition of mass waste, and the ultimate transfer of the land and nine facilities to the local community for industrial. To achieve cleanup and closure of Mound, CH2M HILL demolished 64 nuclear, radiological, and industrial facilities; characterized, packaged, certified, and shipped transuranic waste, low-level waste

(LLW), mixed low-level waste (MLLW), and hazardous wastes; and performed environmental remediation of the 306-acre site.

Mound had a substantial list of contaminants of concern; however the primary COCs included tritium, thorium, plutonium, trichloroethene, petroleum hydrocarbons, and polynuclear aromatic hydrocarbons. The Mound site was divided into a series of 22 areas for convenience in managing the characterization and cleanup. Preliminary assessments of contamination at the site identified 124 locations of actual or suspected releases of volatile organic compounds in the groundwater. The standard nomenclature in the CERCLA process was used to group these locations into nine operable units.

A Federal Facilities Agreement between DOE and EPA was signed in October 1990, and was reissued in 1993[8], to include the Ohio EPA (OEPA) because DOE decided to close and decommission the site. The agreement established a procedural framework and schedule for developing appropriate response actions and facilitated cooperation and exchange of information among the agencies.

Mound: Approach to Establishing Cleanup Levels

In 1995, as DOE and its regulators became more involved with the initiation of the cleanup process and began to evaluate data, they identified a significant quantity of historical data that had been maintained for the site. Such historical data are often rare and unreliable, but these data were consistent with site conditions, which led to development of a site-specific approach for making decisions about the environmental restoration of the Mound Site and its facilities. The process acknowledged the existence of historically accurate data, allowing a more economical and expedited cleanup which satisfied the requirements of CERCLA. With the new process, the nomenclature changed to include parcels and phases; only two original operable units remained.

Mound established a core team consisting of representatives of DOE, USEPA, and OEPA who evaluated each of the potential site contamination problems and recommend the appropriate response. The core team used site visits and existing data to determine whether or not any action was warranted concerning the possible problem area. If a decision could not be made, the core team identified specific information needed to make a decision (e.g., data collection, investigations). The core team also received input from technical experts, as well as, the general public and/or public interest groups. Thus, all stakeholders had the opportunity to express their opinions or suggestions involving each potential problem area. DOE has been able to expedite action by adopting this decision-based team approach.

A detailed Work Plan was developed to document how the approach applied to the environmental restoration activities at the Mound Plant. The Work Plan was considered a primary document under the existing Federal Facilities Agreement (FFA) and provided the basis for measuring performance of the environmental restoration of the Mound site by identifying the enforceable milestone events under Mound 2000.

The core team of representatives from EPA, Ohio EPA, and DOE reviewed the status of each building and potential release site and based their decisions regarding the necessity for remediation on historical and current assessment data. The team then used a binning process to determine a path forward for each building and potential release site. The buildings and potential release sites were binned as (1) no further action; (2) further action, not enough information to make a good decision, gather more data; or (3) remedial action. All wastes were disposed of in accordance with respective regulatory requirements – such as RCRA for off-site TSDFs, DOE O 435 for radiological waste management, DOT for transport of waste, etc.

Mound: Land Use Objectives

The final land use for the Mound facilities was determined by consultation between DOE, EPA, OEPA, and the Miamisburg community to be industrial use. The Miamisburg Mound Community Improvement Corporation (MMCIC) established a technology and industrial park to transition the Mound site for reuse. MMCIC was chartered with the vision of establishing the Mound Advanced Technology Center to diversify the region's economy and to generate new job opportunities for dislocated DOE contractor workers and other area residents. The Mound Advanced Technology Center currently houses 15 businesses with more than 286 employees.

In 1998, DOE established a sales contract to convey Mound property to the MMCIC by discrete parcels, subject to the CERCLA process. Land-use restrictions were conveyed with the property to ensure that it will always remain protective of human health and the environment. This sales contract was updated in August 2008.

DOE and MMCIC agreed on industrial use as the future land use for the site prior to performing risk analyses. Cleanup criteria were developed to support that decision. It was the core team's responsibility to evaluate the risk from exposure to residual contamination and justify the release of a portion of the site to the community. The core team identified the appropriate exposure pathways, parameters, and equations for performing the Residual Risk Evaluation for an industrial future land use. The Risk Assessment Guidance for Superfund [10], Part A recommends the evaluation of exposures based on a reasonable maximum exposure. The core team used this national guidance to produce the Mound residual risk evaluation methodology. The result provided a basis for evaluating site conditions and justifying the release of portions of the site to the community for industrial use. It also lists the exposure parameters for the two scenarios to be evaluated: commercial worker and construction worker. Sensitive subgroups such as children have not been considered in the exposure scenarios and generally are not allowed on the property for extended periods of time. By approving the methodology, the core team endorsed industrial use as the future land use.

Mound: Key Accomplishments

End of operations – Non-weapons work was ended in 1972. The DOE decommissioned Mound in 1993. The production of weapons components was ended in 1995. The last shipment of stable isotopes for commercial application was made in 1996. End of site closure – The final cleanup contract was commenced in January 2003 and concluded in July, 2006 at a total contract cost of \$314M (increased to \$402M with REA-amended contract).

DOE continues to work with local community groups to keep them informed about site activities. Stakeholder groups include MMCIC; the Mound Reuse Committee, a nonpartisan broadly representative, independent advisory organization with concerns related to the future use and cleanup of the site; Mound Environmental Safety and Health, devoted to environmental protection and safety and public health issues; and the Mound Museum Association that is working to preserve the history of the former Mound Site.

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