

**AN INTEGRATED BUILDING DEMOLITION
AND WASTE PLANNING MODEL FOR THE FERNALD SITE**

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Abstract

The Fernald DOE site will begin full-scale remediation of buildings under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) during the 1995 fiscal year pursuant to a signed Record of Decision. This effort is currently estimated to cost \$350 million and span a minimum duration of 8 years, if funding is not a constraint. The identification of the most viable sequence and schedule for the effort involved the development of an integrated planning model and the commissioning of a sitewide planning team. The resulting work product represents the best combination of assumptions and calculations possible at this time and provides information necessary for compliance with the CERCLA Remedial Design documentation requirements for the over 230 component structures governed by the decision.

Sequence and integrated schedule development for the decontamination and dismantlement (D&D) of Fernald structures has involved evaluation of current and future utilization of structures, availability of waste storage and staging space, the needs and impacts of other on-going Fernald projects, Resource Conservation and Recovery Act (RCRA) waste management and remediation projects, the layout of site utilities, site hydrology, and the potential sizing, location, and construction rates for an on-property disposal cell.

Background

Under a 1994 signed Record of Decision (1), the Fernald DOE site must initiate remediation of the site buildings before October 22, 1995 and maintain a continuous remediation program within the operable unit thereafter. The site currently plans to follow the completed remediation of Plant 7 (performed under an expedited response action) with the removal of Plant 4 (the former uranium hydrofluorination plant) followed by the removal of the majority of the Plant 1 complex (a multi-purpose sampling, milling, and staging facility). These facilities were chosen due to their availability, their relatively low amount of usefulness, and the need for additional cleared space within the former production area of the site.

During the identification of the Plant 4 and Plant 1 complexes as the initial set for remediation, it became clear that a sitewide integrated project planning effort would be required to support development of optimized sequencing for D&D projects. The approach would be required to fulfill EPA requirements, while integrating the D&D project with the other major CERCLA projects to be undertaken at the site, the waste management functions currently underway, and the RCRA driven actions mandated at the site.

Integrated Planning Team

In order to ensure a comprehensive understanding of the site situation and develop an integrated approach to the sequencing, a planning team, referred to as the Sequencing Design/Engineering/Construction (DEC) Team, was commissioned with members representing all major divisions of site management and the DOE Fernald project management staff. The major drivers and constraints were initially evaluated by the Sequencing DEC Team to determine the internal and external influences on the decision-making.

Schedules from other major projects at the site were reviewed to determine all planned uses for site facilities. Where no schedules were available, best assumptions were documented and initially considered constraints to building demolition. Date constraints for each facility were documented as milestones in a scheduling software to be used in developing a conforming schedule.

In addition to D&D constraints, several major site projects (e.g., the soil remediation and on-property disposal cell projects) assume that many of the site structures will be removed prior to their initiation or completion. Assumptions from these projects were handled as drivers for the D&D. Other drivers, major assumptions, and constraints considered by the Sequencing DEC Team for a preferred sequence are provided below:

- Site hydrology (above and below grade) drives the remediation to begin in the north and move southward to prevent recontamination of remediated soils and perched water zones.
- Soil use within the on-property disposal cell would require a minimum 3 to 1 ratio with respect to D&D debris to maintain adequate compaction capability.
- In the absence of adequate quantities of soil, debris such as concrete and steel would be bulk stored in piles until soil could be generated.
- On-property disposal cell construction is anticipated to begin receiving debris for burial in August 1997 and progress at an average rate of 95,600 cubic meters per year.
- Due to inclement weather, cell construction activities are assumed to cease for three months during the winter.
- D&D sequencing must progress to maximize availability of large zones for soil remediation, starting with the north and generally progressing to the south over the course of the action.
- Two adjacent structures of significant size cannot simultaneously undergo dismantlement, to avoid project interferences.
- No more than 5 major dismantlement projects can be undertaken simultaneously, since site construction management resources would be strained with more projects undertaken.
- Safe Shutdown (removal of equipment hold-up residues, utility disconnects, and gross surface decontamination) activities must be completed in each structure prior to initiation of dismantlement.
- Due to its importance in the mitigation of risks to human health and the environment, the Safe Shutdown Program is assumed to take budgeting priority over dismantlement.

Defining Remediation Complexes

Using the concept of economies of scale, the expenses for a decontamination and dismantlement project can be reduced significantly by addressing multiple components in a single project instead of remediating components as individual projects. The cost and time involved in the development, review, and submittal of contracts, work plans, health and safety plans, and other supporting project documentation are relatively independent of the number and sizes of structures within a D&D project. Other expenditures, such as subcontractor training, establishing control zones, mobilization and demobilization of construction equipment and crews, and air monitoring are also relatively independent of the number and sizes of structures within a project. Therefore, the above-grade portion of 165 individual structures were combined into twenty-three groups (called complexes) to reduce remediation costs. Similarly, the at- and below-grade portions of the operable unit was divided into three complexes (i.e., north, central, and south).

The structures were assembled into complexes based on many considerations, such as relative location of the structures to minimize impacts between dismantlement activities and the daily operations of the site. If possible, complexes were confined to a distinct area, such as a city block, that could be safely partitioned into a construction zone without adversely affecting other projects.

A second consideration for grouping structures into complexes was the current and/or future use of the facility. For example, components that support the distribution of electricity across the Fernald were combined into the Electrical Station Complex, although these components are not all located together. Two advantages to grouping structures based on their related use are that they have a high probability of becoming available altogether and are likely to be constructed of the same types of materials, making design and dismantlement activities more simple and, therefore, cheaper.

Prioritization of Complexes for Remediation

The prioritization of these complexes for remediation was initially performed by the Sequencing DEC Team without consideration of funding as a constraint. Since actual funding for a longer term project is dependent on many factors, the actual schedule of the D&D project is expected to follow the prioritized sequence, but at the rate that satisfies the funding constraints. Several average annual funding level estimates were utilized to test the viability of the preferred D&D sequence. However, since possible schedules may vary from as little as 8 years, if unconstrained by funding, to up to 30 years for minimal funding levels, the D&D sequence was required to demonstrate viability at each of the assessed funding levels. Since the preferred sequence is driven primarily by external project factors and structure reusability factors, the duration of the schedule for D&D was found to have relatively little impact on the determination of an optimal sequence.

The first step in developing a remediation schedule that is not constrained by funding is to establish the earliest possible starting date that the complex will be available for remediation. There were many structure-specific scheduling constraints that had to be factored into the schedule because many facilities are necessary to either support remediation activities or required site activities (e.g., wastewater treatment, RCRA warehouses, and ongoing maintenance) and cannot be scheduled for removal until these activities are relocated, replaced, or are no longer necessary. Although the objective is to first decontaminate and

dismantle the complexes that lie within the footprint of the proposed on-property disposal cell and to clear a path for at- and below-grade remediation to proceed from north to south, some of these complexes may not become available until remedial activities are well underway. If the highest priority complex is not immediately available, remediation of that complex will be deferred until it becomes available. The availability of the second highest priority complex would then be assessed, and so on.

The second step is to factor in the impacts of several logistical constraints. Reasonable limitations on the number of workers in a given area, traffic patterns, and waste handling routing must be established to prevent overcrowding and to minimize potential health and safety hazards during remedial activities while pursuing the overall goal of a timely, efficient, and cost-effective remediation. Therefore, it was assumed that no more than five construction projects would occur at the same time. Also, careful consideration was given to avoid two construction crews working on adjacent complexes at the same time.

The final step in developing a funding-unconstrained remediation schedule is to ensure that the prioritized sequence of remediation will not heavily impact the network of required site utilities. Fernald site utilities include electricity, plant air (used for air-supplied respirators), instrument air, natural gas, propane gas, fire protection water, sanitary water, process water, steam, sanitary sewers, storm water runoff systems, cooling water, roadways, and telephones. If the utilities are not required for the safe, efficient, and cost-effective removal of a complex, the utility lines will be capped or terminated near the boundaries of each complex (for above-grade activities) or remediation area (for at- and below-grade activities) before dismantlement begins. Utility connections to the occupied areas of Fernald will be maintained by temporary or rerouted connections, as needed.

Figure 1 shows the prioritized remediation of complexes that resulted from this approach. The dashed lines represent the division between the three below-grade remediation areas (i.e., north, central, and south).

A prospective project schedule using the preferred sequence and an anticipated minimal average annual project funding level was developed to support preparation of draft remedial action compliance milestones with USEPA and the Ohio EPA. The publication of the schedule as part of the Remedial Action Work Plan will represent the first use of many intended uses for the scheduling tool developed by the Sequencing DEC Team. Annual updates are expected to be prepared for submittal to the regulatory agencies and the schedule should also represent a powerful tool for projecting and evaluating annual budget scenarios for the D&D project.

A significant portion of the schedule evaluation was for determination of waste generation rates. As a means to evaluate the impacts of waste generation rates resulting from the schedule, the known and projected waste flows were compared to handling, storage, and disposition assumptions in a material balance model.

Material Balance Model

Continued management and disposition of the production products and wastes from the site, as well as D&D wastes is a significant facet of the current site mission, requiring the reutilization of many of the former production facilities to provide covered storage. The impact of the additional waste resulting from D&D projects and the net reduction of available facilities over the course of the project was evaluated to demonstrate material flows versus

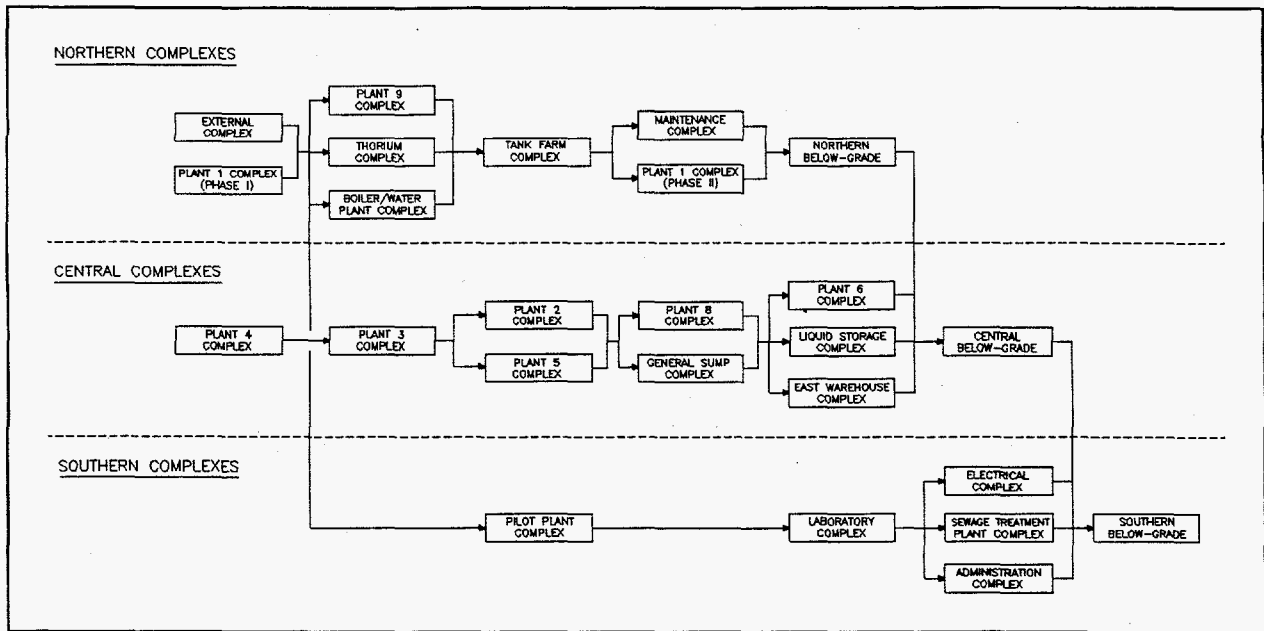


FIGURE 1. Prioritization of Complexes for Remediation

capacities throughout the project. Although much of the D&D waste is expected to be eligible for disposal in the proposed on-property disposal cell, the cell is not planned to be available for D&D wastes prior to late 1998. Under the most aggressive D&D schedule, 105,000 cubic meters of debris would be generated in advance of that availability, requiring the use of 44,600 square meters of existing storage space. Additionally, several facilities currently utilized for storage would be removed under the aggressive scenario to facilitate the construction of the disposal cell, thereby reducing the overall availability of covered storage facilities.

To determine the impact of the remediation schedule on Fernald's capacity to store materials, the material balance model uses a general mass balance equation. The general equation for determining mass balance for material that enters and leaves a system is as follows:

$$(In + Generation) - (Out + Consumption) = Accumulation$$

This general mass balance can be modified as follows to apply to material at Fernald:

$$(Off-Property Receipts + Material Generation) - (Off-Property Disposition + On-Property Disposal) = Material in Interim Storage$$

This mass balance equation considers volumetric material flow on a monthly basis.

The first term in the equation, Off-Property Receipts, represents the current DOE anticipation that Fernald will not receive off-property materials for on-property storage or disposition. Therefore, in the mass balance equation, the volume of material to be received from off-property sources drops out of the mass balance equation.

The Material Generation term represents the volume of generated material that may require on-property storage prior to on- or off-property disposition. The Material Generation term specifically does not include volume estimates for uncontaminated office trash and recycled materials because these materials are dispositioned off-property in a timely manner and, therefore, do not require temporary storage at Fernald. The Material Generation term represents the total material burden, current and future, that may potentially require storage facilities prior to disposal. Table I defines the types and quantities of materials to be generated and provides the information required to calculate the Material Generation term of the mass balance equation.

TABLE 1. Remedial Action Material Volume Estimates

Material Types	Unbulked Volume (m ³)	Stored Volume (m ³)
Non-Regulated/Non-Friable Asbestos-Containing Materials (includes floor tile, fire brick, gasket material, and feeder cable)	32	63
Construction Debris (includes general refuse, ceiling material, built-up roofing/substrate, doors, windows, filters, and wood)	2,739	5,478
Compactible Waste (includes personal protective equipment and fiberglass insulation)	3,256	3,908
Transite (includes wall panels and roof panels)	1,368	1,642
Masonry, Concrete, Asphalt	123,168	160,118
Acid Brick	92	120
Specialty Metals (includes nickel, copper, inconel, monel, stainless, and lead flashing)	3	6
Restricted Use Metals (includes equipment, roll-up/overhead doors, miscellaneous electrical components, metal wall panels, metal roof panels, louvers, and insulated wire with conduit)	52,894	183,542
Process Piping	1,978	3,955
Non-Process Piping	659	1,318
Ductwork	503	1,007
Unrestricted Use Metals (includes structural steel and decking)	1,694	40,144
Regulated/Friable Asbestos-Containing Materials (thermal system insulation)	317	1,266
Total Remedial Action Material Volumes	188,703	402,567

The Off-Property Disposition and On-Property Disposal terms represent the volumes of those materials listed in Table I that are anticipated to be either shipped off-property for disposal or recycling, or buried in the on-property disposal cell.

By using the estimated volumes in the mass balance equation, the difference between annual material generation and annual material disposition equals the amount of material that requires temporary storage at any point during the project. Storage is organized into three types: hazardous and mixed waste storage; covered storage of low-level radioactive materials; and uncovered storage of low-level radioactive materials. By comparing the need for these types of temporary storage on an monthly basis with the maximum on-property storage capacities, the resulting material balance determination will indicate whether or not there is a need to provide for additional temporary storage facilities during specific periods of the project.

By performing the material balance model at monthly intervals throughout the duration of the remediation, using the information available or estimated for each of the parameters, a set of waste generation/disposition and available storage space curves were generated and compared. Figure 2 provides an example waste curve that compares the amount of needed uncovered storage space with the projected available uncovered storage capacity for a 21-year project scenario.

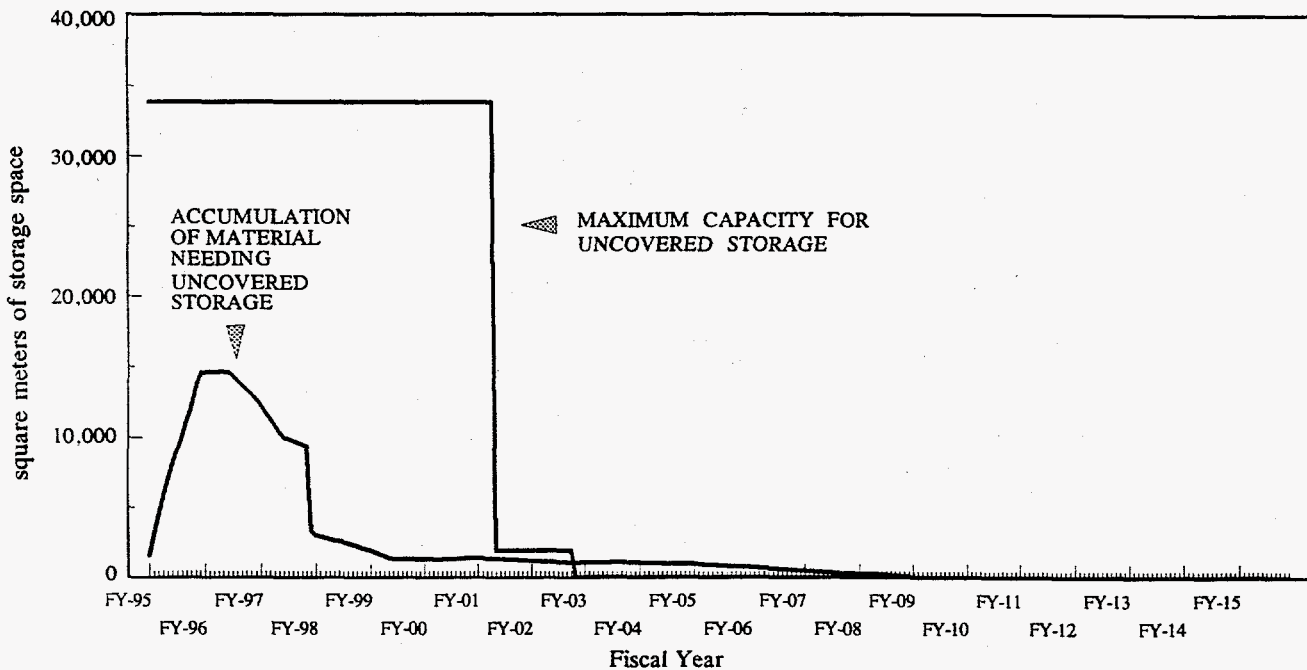


FIGURE 2. Material Balance Model Summary for Uncovered Storage

Rates of waste generation anticipated for each of the D&D projects were provided by evaluation of an aggressive D&D project schedule, since this scenario would arguably result in the most burdensome waste storage problem. Other waste generation activities, such as daily operation and maintenance activities, removal actions, and remedial actions of the four other operable units at Fernald, were also tracked in the model, since the resulting wastes

compete for the same available storage. Waste disposition rates were developed from existing planned disposition projects or estimated for waste streams with no detailed schedules for disposition. Existing stored waste quantities were known by waste type and storage footprints (floor space utilized) were also known at the start of this analysis. Waste disposition rates for materials anticipated to be destined for disposal in the proposed on-property disposal cell were reported by the cell design effort, underway as part of the remedial design in several of the CERCLA operable units at Fernald.

MODELING RESULTS

The aggressive D&D schedule used in the material balance model, derived from the work performed in the sequencing activity, that the entire D&D effort at Fernald could be performed in an 8-year period, if funding were not a limitation.

The 8-year schedule represented the highest waste generation rate prior to development of an on-property disposal cell, and also the case under which the most storage facilities would be removed most quickly, thereby resulting in a worst case for storage needs versus capacity at the site. The analysis of this worst case demonstrated that, although the site has severely limited current storage capacity, during the course of the action, sufficient storage capacity for covered, uncovered, and hazardous/mixed wastes exists to avoid construction of new facilities. The analysis also demonstrated that the preferred sequence, in combination with other existing planned and assumed activities, was viable with respect to material disposition issues.

Since the evaluation demonstrated the necessary storage capacity was available for this worst case, and since the sequence was determined to be relatively insensitive to schedule extension, no additional modeling would be required to demonstrate feasibility of any proposed D&D schedules with respect to storage, handling, and disposition capacity.

REFERENCES

1. United States Department of Energy, "Operable Unit 3 Record Of Decision for Interim Remedial Action and Responsiveness Summary," prepared by Fernald Environmental Restoration Management Corporation (June 1994).
2. Fernald Environmental Restoration Management Corporation, "Operable Unit 3 Remedial Design Prioritization and Sequencing Report, Draft," (January 1995).