RAS 11052

(STP-04-003, January 2004, Other, Remediation, Financial Analysis Methodology)

January 16, 2004

ALL AGREEMENT STATES, MINNESOTA, PENNSYLVANIA

NRC PROCESS TO IDENTIFY DECOMMISSIONING SITES WITH INADEQUATE FUNDING FOR REMEDIATION (STP-04-003)

The U.S. Nuclear Regulatory Commission (NRC) conducted a financial analysis of formerly licensed and currently licensed decommissioning sites in non-Agreement States to determine whether responsible parties are capable of funding site decommissioning. Because NRC regulations require licensees to have adequate financial assurance for decommissioning, this evaluation was limited to sites with unique circumstances indicative of the potential for inadequate funds for decommissioning (*e.g.*, non-licensed sites for which financial assurance is not required). The evaluation enabled NRC to identify sites with higher financial risk (*i.e.*, sites that may not have the resources to fund remediation), which accordingly require additional attention with regard to decommissioning costs. NRC is currently working to identify paths forward to facilitate remediation at the sites identified in this effort.

The purpose of this letter is to provide NRC's assessment methodology, which may be helpful for State regulators wishing to identify Agreement State sites with potentially inadequate decommissioning funding. The enclosed document, "Financial Analysis Methodology," provides the methodology employed by NRC to: (1) estimate site-specific unrestricted and restricted release decommissioning costs; and (2) evaluate the financial capabilities of responsible parties to determine if they are capable of funding estimated decommissioning costs. Note that this document does not supercede NRC guidance regarding financial assurance and decommissioning cost estimates contained in Volume 3 of NUREG 1757. Rather, this document serves the limited purpose of a technique for regulators to determine whether responsible parties are expected to have adequate funding for site decommissioning.

For additional information regarding the enclosed methodology contact Eric Pogue, Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555, telephone (301) 415-6064, e-mail ERP@nrc.gov.

/RA/
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Office of State and Tribal Programs

Enclosure:
As stated

U.S. NUCLEAR REGULATORY COMMISSION
In the Matter of Louisiana Energy Services, L.P.
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Financial Analysis Methodology

1. Introduction

The U.S. Nuclear Regulatory Commission (NRC) has identified sites contaminated with radioactive material exceeding NRC's criteria for unrestricted use that require special attention to ensure timely decommissioning. The purpose of this methodology is to assess whether the entities responsible for each of these sites are financially capable of funding a cleanup that meets NRC's criteria either for unrestricted release or for restricted release. The report is presented in four sections: Section 1 is this introduction; Section 2 estimates the cost of decommissioning assuming unrestricted release; Section 3 estimates the cost of decommissioning sites under each of two restricted release scenarios; and Section 4 presents a methodology for analyzing the financial capabilities of the entities responsible for the sites to determine whether they are capable of funding the decommissioning costs estimated in Sections 2 and 3.

2. Estimated Decommissioning Costs Assuming Unrestricted Release

This section estimates the costs of decommissioning sites under the unrestricted release scenario. Section 2.1 explains the basic equation used to determine total cost. Next, Section 2.2 details the various equations that provide the component cost estimates that feed into the main equation. Section 2.3 presents a sensitivity analysis.

2.1 Overview of Cost Estimating Methodology

The cost of decommissioning each site under the unrestricted release scenario is estimated by summing the applicable component costs using the following equation:

$$\begin{aligned} \textit{Total Cost} = \; & \textit{Cost of Planning and Preparation} + \textit{Cost of Building Decontamination} + \\ & \textit{Cost of Excavation} + \textit{Cost of Restoration} + \textit{Cost of Transportation} + \\ & \textit{Cost of Disposal} + \textit{Cost of Final Survey} + \textit{Contingency} \end{aligned}$$

The applicability and calculation of individual component costs are discussed in the sections below. In general, however, the component costs are estimated by applying various unit costs to site-specific data. All contaminated soils and decontamination waste are assumed to be disposed at the Envirocare facility in Utah. All costs are escalated as necessary to present the estimates in current dollars.[1]

This methodology should be adequate to capture most of the significant decommissioning costs at each site. However, the methodology constitutes only a screening level analysis and is not intended to capture all costs. Omitted cost elements are not believed to be material to the

[1] Costs are updated to 2001 dollars using adjustment factors derived from government-prepared GDP deflators.

purpose at hand.[2] Other purposes (e.g., where greater accuracy is necessary) may require the application of more detailed or sophisticated cost estimation techniques.

2.2 Estimation of Component Costs

As implied by the previous equation, the analysis must estimate each of the eight component costs before the total decommissioning cost estimate can be calculated. This section explains how the analysis estimates component costs and identifies the data, unit costs, and assumptions needed to complete the analysis. Unit cost figures shown below are unadjusted for inflation in order to correspond to the figures in the cited references.

2.2.1 Planning and Preparation

The cost of planning and preparation are calculated using the following equation:

Cost of Planning and Preparation = 15 percent x (Cost of Building Decontamination + Cost of Excavation + Cost of Restoration + Cost of Transportation + Cost of Disposal)

The analysis assumes that an amount equal to 15 percent of other costs (which are discussed further in the sections below) will be required for planning and preparation.[3] This cost includes, but is not limited to, the following tasks: preparation of documentation for regulatory agencies, submittal of a decommissioning plan to NRC when required, development of work plans, procurement of special equipment, staff training and characterization of radiological condition of the facility.

Estimates do *not* include any costs or fees charged by NRC as a reimbursement for NRC services that may be associated with a site's decommissioning.

2.2.2 Building Decontamination

The estimated cost of building decontamination is calculated using the following equation:

Cost of Building Decontamination = (Total Surface Area of Building Floors in Square Meters x Decontamination Cost per Square Meter of Floor) + (Total Surface Area of Building Walls in Square Meters x Decontamination Cost per

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[2] The sensitivity analysis (presented in Section 2.3) considers sources of uncertainty that may have a more substantial bearing on the results of the analysis.

[3] Based on figures used in past independent cost estimates prepared by ICF in coordination with NRC.

Square Meter of Wall) + (Total Surface Area of Building Ceilings in Square Meters x Decontamination Cost per Square Meter of Ceiling)

Required Site Data and Related Assumptions

Total Surface Area of Building Floors, Walls, Ceilings.

Assumed Unit Costs

The estimated *Decontamination Cost per Square Meter of Floor* is $160.61 per square meter; the estimated *Decontamination Cost per Square Meter of Wall* is $172.67 per square meter; the estimated *Decontamination Cost per Square Meter of Ceiling* is $206.89 per square meter.[4] These figures include the cost of labor (including overhead), supplies and equipment, and the cost of packaging, transporting, and disposing of associated decontamination waste.

Other Assumptions

The analysis assumes that buildings will not be demolished and disposed.

The analysis assumes that buildings at each site are empty and that, as a consequence, only the buildings themselves will require decontamination.

2.2.3 Excavation of Contaminated Areas on Facility Grounds

The estimated cost of excavation of contaminated areas on facility grounds is calculated using the following equation:

Cost of Excavation = (Cubic Yards of Contaminated Soil x Excavation Cost per Cubic Yard of Contaminated Soil)

Required Site Data and Related Assumptions

Data on *Cubic Yards of Contaminated Soil* should be developed using site characterization data and best professional judgement.

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[4]Based on information from rates provided in NUREG-6477, *Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities,* July 1998, p. C.14-C.16.

Assumed Unit Costs

The *Excavation Cost per Cubic Yard of Contaminated soil* is $4.75.[5] This rate assumes that excavation of the radioactively contaminated sites will not entail additional worker safety precautions beyond those applicable at environmental remediation projects in general.

2.2.4 Restoration of Excavated Areas on Facility Grounds

NRC does not require that sites be restored beyond what is necessary to allow for a site's unrestricted release. Facility grounds with soil contamination should qualify for unrestricted release once the contaminated soils have been excavated, transported, and disposed, as addressed in Sections 2.2.3, 2.2.5, and 2.2.6. Consequently, for sites where all contaminated soils are already contained in piles, the analysis assumes a zero cost for further restoration activities. However, for other sites where below-ground excavation is required, the analysis assumes that some additional restoration cost will be incurred to backfill excavated areas with noncontaminated soils, in order to avoid leaving open trenches at the site.

Where applicable, the estimated cost of restoration of contaminated areas on facility grounds is calculated using the following equation:

Cost of Restoration = (Cubic Yards of Backfill Material x Cost per Cubic Yard of Backfill Material, Delivery, and Placement)

Required Site Data and Related Assumptions

The number of *Cubic Yards of Backfill Material* needed is assumed to be equal to the number of cubic yards of contaminated soil that is removed. (Data on *Cubic Yards of Contaminated Soil* are available or are estimated as described in Section 2.2.3.) As discussed above, the analysis assumes that backfilling will not be necessary to replace contaminated soils that are already in piles.

Assumed Unit Costs

The *Cost per Cubic Yard of Backfill Material, Delivery, and Placement* is $9.62.[6]

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[5]Based on the average rates associated with using either a 1-cubic yard or a 2-cubic yard capacity hydraulic excavator; RS Means, *2001 Environmental Remediation Cost Data - Unit Price,* 7th Edition, p. 4-12 and 4-15.

[6]Based on rates for borrow material plus trench backfill with 3-cubic yard wheel loader plus excavate and load for delivery plus delivery using a 12-cubic yard truck for 6 miles; RS Means 2001, p. 4-23.

2.2.5 Transportation

The cost of transportation of excavated materials is calculated using the following equation:

Cost of Transportation = *Number of Miles per Shipment x Transport Cost per Mile x Number of Shipments*

where the *Number of Shipments* is calculated using the following equation:

Number of Shipments = *Cubic Yards of Contaminated Soil / Cubic Yard Capacity of a Truck*

Required Site Data

The *Number of Miles per Shipment* between the site and the disposal facility is estimated using an online service that calculates the shortest driving mileage between two locations.[7]

Data on *Cubic Yards of Contaminated Soil* are available or have been estimated as described in Section 2.2.3.

Assumed Unit Costs

The *Transport Cost per Mile* is $3.49 per mile.[8]

The *Cubic Yard Capacity of a Truck* is assumed to be 20 cubic yards.[9]

2.2.6 Disposal

The cost of disposal of contaminated soil is calculated using the following equation:[10]

Cost of Disposal = *Cubic Yards of Contaminated Soil x Disposal Cost per Cubic Yard*

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[7]Expedia Driving Directions, www.expedia.com.

[8]Based on the rate for radioactive truck hauls over 500 miles; RS Means 2001, p. 9-181.

[9]This figure is based on information about truck capacity from RS Means 2001 and the assumption that approximately one cubic yard of material weighs about one ton.

[10]Disposal of building decontamination wastes is addressed in Section 2.2.2.

Required Site Data

Data on *Cubic Yards of Contaminated Soil* are available or have been estimated as described in Section 2.2.3, both for low-level radioactive waste and for mixed waste.

Assumed Unit Costs

The *Disposal Cost per Cubic Yard* charged by Envirocare is assumed to be:[11]

- $300 per cubic yard for low-level radioactive waste; and
- Three times as high, or $900 per cubic yard, for mixed waste.

Other Assumptions

The analysis assumes that no demolition debris will be generated or disposed during decommissioning (see Section 2.2.2).

2.2.7 Final Survey

The cost of the final survey is calculated using the following equation:

Cost of Final Survey = *7 percent x (Cost of Building Decontamination + Cost of Excavation + Cost of Restoration + Cost of Transportation + Cost of Disposal)*

The analysis assumes that an amount equal to 7 percent of these other costs will be required for the final survey.[12] The final survey includes a final characterization of the radiological condition

[11] The assumed costs for low-level waste disposal and the increase for mixed waste correspond to a DOE web site that describes the range of disposal costs for DOE and commercial sites (http://emi-web.inel.gov/contracts/range.html). This information also corresponds directly with input from NRC staff based on contacts with the U.S. Corps of Engineers (USACE) and a review of licensee decommissioning funding plans and other available documents. NRC confirmed that ~$11/ft^3 is an "average" low-level waste disposal rate at Envirocare and that a range of $5-$17/ft^3 (as modeled in the sensitivity analysis) adequately describes the anticipated low-level waste disposal costs. Furthermore, NRC confirmed with USACE that mixed waste disposal at Envirocare should be assumed to be three times the cost of low-level waste disposal.

[12] Based on figures used in past independent cost estimates prepared by ICF in coordination with NRC.

of the facility that will ensure that it can meet the unrestricted release standards. Activities might include sampling, soil tailings or analysis, and groundwater analysis, if applicable.

2.2.8 Contingency

A contingency factor is calculated using the following equation:

Cost of Contingency = *25 percent x (Cost of Planning and Preparation + Cost of Building Decontamination + Cost of Excavation + Cost of Restoration + Cost of Transportation + Cost of Disposal + Cost of Final Survey)*

The analysis applies a contingency factor of 25 percent to the total of all estimated costs to address unforeseen circumstances that could increase decommissioning costs. Use of a contingency factor is consistent with common cost estimating practice as well as the guidance contained in NUREG/CR-6477, which applies a 25 percent contingency factor to all estimated costs associated with decommissioning various reference facilities.[13]

2.3. Results and Sensitivity Analysis

In addition to developing a "best estimate" using this method, a sensitivity analysis was performed to bound the estimate with a "low estimate" and "high estimate" of the total cost for each site. The sensitivity analysis reflects changes in the following variables:

Area of contaminated buildings: plus/minus 10 percent of baseline area;

Volume of contaminated soil: plus 100/minus 25 percent of baseline volume;

Excavation cost per cubic yard of contaminated material: plus/minus 15 percent of baseline unit cost;

Volume of backfill material: minus 30 percent under baseline volume;

Truck capacity: plus 5 percent/minus 15 percent of baseline capacity;

Transportation cost per mile: plus 15/minus 50 percent of baseline transportation unit cost; and

Disposal unit cost per cubic yard: plus/minus 55 percent of baseline disposal unit cost.

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[13] NUREG-1727, NMSS Decommissioning SRP, Appendix F, Rev 0, September 15, 2000, p. F-26.

The percentage variation considered for the above inputs and unit costs are intended to reflect probable (and not absolute) upper and lower bound estimates of the cited cost variables.

It also is worth noting that the preceding methodology represents a screening level analysis. As such, the results should be used only for purposes that are consistent with this type of analysis. Other purposes (e.g., where greater accuracy is necessary) may require the application of more detailed or sophisticated cost estimation techniques. This analysis should be adequate to capture most of the significant decommissioning costs, but it is not intended to capture all costs. For example, certain unit costs taken or derived from RS Means data do not reflect overhead;[14] these omitted costs are not believed to be material to the analysis. The sensitivity analysis (discussed above) considers sources of uncertainty that may have a more substantial bearing on the results of the analysis.

3. Estimated Decommissioning Costs Assuming Restricted Release

This section estimates the costs of decommissioning the sites under two restricted release scenarios, as discussed below. Section 3.1 explains the basic equation used to determine total cost. Next, Section 3.2 details the various equations that provide the component cost estimates that feed into the main equation.

3.1 Overview of Cost Estimating Methodology

The cost of decommissioning each site under the restricted release scenario is estimated by summing the applicable component costs using the following equation:

Total Cost = *Cost of Planning and Preparation + [Cost of Building Decontamination or Cost of Building Demolition] + [Cost of Engineered Cell or (Cost of Excavation + Cost of Restoration + Cost of Transportation + Cost of Disposal)] + Cost of Fencing and Signs + Cost to Transfer to DOE Under NWPA §151B + Cost of Final Survey + Contingency*

A key issue for each site is whether an engineered cell will be needed to achieve restricted release and, if so, whether such a cell is technically feasible from an engineering standpoint. Other issues that must be considered for each site include whether the most highly contaminated waste (i.e., hot spots) will be shipped off-site for disposal and whether any contaminated buildings would be demolished or decontaminated. The applicability of these issues depends upon the level of contamination at the site and what methods are used to meet the restricted release criteria. In the absence of adequate site contamination data, this analysis assumes that 10 percent of the volume of contaminated material on site is sufficiently contaminated to result in

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[14]In contrast, unit costs for estimating decontamination costs have been taken from NUREG-6477 and do reflect overhead.

exposure levels greater than 100 or 500 mrem/person/year. Two possible restricted release scenarios are costed out for each site:

(1) Dispose of *all* contaminated material in an on-site cell, establish site controls, and transfer the site to DOE under NWPA §151B.

(2) Remove and dispose off site any hot spots (i.e., the 10 percent of material assumed to result in exposure levels greater than 100 or 500 mrem/person/year), establish site controls, and transfer the site to DOE under NWPA §151B.

The cost estimate assumes the on-site cell will be the shape of a truncated cone engineered as follows. Three feet of "clean" soil will be excavated and used later to cap the cell. A one foot clay liner will be placed in the excavation area to reduce the potential for groundwater contamination from the contaminated soil and demolition debris, if applicable. The contaminated material will be placed to a height of approximately 15 feet with the most contaminated portions placed near the center of the cell. About two feet of the clean soil will be placed over the contaminated material for shielding. Two feet of clay will be placed over the soil as a cap to minimize infiltration of water into the cell. More clay is used in the cap than in the liner to minimize the potential for water to "pond" on the liner. Finally, the remaining excavated soil will be placed over the clay as a base for 12 inches of rock cover to reduce erosion over the long term, minimize the cost of long-term maintenance and major repair, and minimize any effects should maintenance cease due to the potential failure of institutional controls.

This cell design is assumed to provide adequate shielding to achieve exposure levels of less than 25 mrem/person/year outside the restricted area, and levels of less than 100 or 500 mrem/person/year inside the restricted area.

The following equation is used to calculate the cost of building an engineered cell:

Cost of Engineered Cell = *Cost of Excavating the Cell Area + Cost to Lay the Clay Liner + Cost of Excavating, Moving, and Placing the Contaminated Material into the Cell Area + Cost of Capping the Cell*

For sites with buildings, the analysis calculates the cost of decontaminating versus demolishing the buildings assumes the lower cost option applies.

The applicability and calculation of individual component costs are discussed in the sections below. In general, however, the component costs are estimated by applying various unit costs to site-specific data. All costs have been escalated as necessary to present the estimates in current dollars.[15]

This methodology should be adequate to capture most of the significant decommissioning costs at each site. However, similar to the method for unrestricted release, this methodology constitutes only a screening level analysis and is not intended to capture all costs. Omitted cost elements are not believed to be material to the purpose at hand.[16] Other purposes (e.g., where greater accuracy is necessary) may require the application of more detailed or sophisticated cost estimation techniques.

3.2 Estimation of Component Costs

As implied by the previous equations, the analysis must estimate each of the component costs before the total decommissioning cost estimate can be calculated. This section explains how the analysis estimates component costs and identifies the data, unit costs, and assumptions needed to complete the analysis. Unit cost figures shown below are unadjusted for inflation in order to correspond to the figures in the cited references.

3.2.1 Planning and Preparation

The cost of planning and preparation is calculated using the following equation:

$$\textit{Cost of Planning and Preparation} = \textit{15 percent x \{ [Cost of Building Demolition or Cost of Building Decontamination] + [Cost of Engineered Onsite Cell or (Cost of Transportation + Cost of Disposal)] + Cost of Fencing and Signs\}}$$

The analysis assumes that an amount equal to 15 percent of other costs (which are discussed further in the sections below), with the exception of the cost to transfer the site to DOE and the cost of a final survey, will be required for planning and preparation.[17] This cost includes, but is not limited to, the following tasks: preparation of documentation for regulatory agencies, submittal of decommissioning plan to NRC when required by statute, development of work

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[15]Costs have been updated to 2001 dollars using adjustment factors derived from government prepared GDP deflators.

[16]The sensitivity analysis (discussed in Section 3.3) considers sources of uncertainty that may have a more substantial bearing on the results of the analysis.

[17]Based on figures used in past independent cost estimates prepared by ICF in coordination with NRC.

plans, procurement of special equipment, staff training and characterization of radiological condition of the facility.

Estimates will *not* include any costs or fees charged by NRC as a reimbursement for NRC services that may be associated with a site's decommissioning. Estimates also will not include any costs associated with public participation processes related to restricted release.

3.2.2 Building Decontamination

The estimated cost of building decontamination is calculated using the following equation:[18]

Cost of Building Decontamination = (Total Surface Area of Building Floors in Square Meters x Decontamination Cost per Square Meter of Floor) + (Total Surface Area of Building Walls in Square Meters x Decontamination Cost per Square Meter of Wall) + (Total Surface Area of Building Ceilings in Square Meters x Decontamination Cost per Square Meter of Ceiling)

Required Site Data and Related Assumptions

NRC has provided figures for the total contaminated area of each site's buildings.

Assumed Unit Costs

The estimated *Decontamination Cost per Square Meter of Floor* is $160.61 per square meter including labor (including overhead), supplies and equipment, and the cost of packaging, transporting, and disposing of associated decontamination waste.

The estimated *Decontamination Cost per Square Meter of Wall* is $172.67 per square meter including labor (including overhead), supplies and equipment, and the cost of packaging, transporting, and disposing of associated decontamination waste.

The estimated *Decontamination Cost per Square Meter of Ceiling* is $206.89 per square meter including labor (including overhead), supplies and equipment, and

[18]The analysis assumes that a site will conduct the less expensive choice between building decontamination or demolition, but will not undertake both. In both cases where contaminated buildings are an issue, decontamination related costs are less than demolition-related costs.

the cost of packaging, transporting, and disposing of associated decontamination waste.[19]

Other Assumptions

Decontamination costs are included in the cost estimate only if they are less than demolition-related costs.

The analysis assumes that buildings at each site are empty and that, as a consequence, only the buildings themselves require decontamination.

3.2.3 Building Demolition

The cost of building demolition is calculated using the following equation:[20]

Cost of Building Demolition = *Total Volume of Building x Nonexplosive Building Demolition per Cubic Foot*

Required Site Data and Related Assumptions

Demolition costs are included only if demolition-related costs (including disposal) are less than decontamination-related costs.

Type of building materials. Contaminated buildings considered in the analysis are assumed or known to be single-level steel buildings.

Volume of each building (undemolished) that has contamination.

Assumed Unit Costs

The estimated *Demolition Cost per Cubic Foot for a multi-level concrete building* is $0.09 per cubic foot including labor and equipment (RS Means Unit Price, 2001).

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[19]All decontamination unit costs are based on information from rates provided in NUREG- 6477, *Revised Analyses of Decommissioning Reference Non-Fuel-Cycle Facilities,* July 1998, p. C.14-C.16.

[20]The analysis assumes that a site will conduct the less expensive choice between building decontamination or demolition, but will not undertake both.

The estimated *Demolition Cost per Cubic Foot for a single-level concrete building* is $0.16 per cubic foot including labor and equipment (RS Means Unit Price, 2001).

The estimated *Demolition Cost per Cubic Foot for single-level steel or wood buildings* is $0.12 per cubic foot including labor and equipment (RS Means Unit Price, 2001).

3.2.4 Excavating the Cell Area

Under the on-site cell restricted release scenario, the estimated cost of excavating the cell area is calculated using the following equation:

Cost of Excavating the Cell Area = *Area of Cell x Depth of the Cell x Unit Cost of Excavating the Soil*

Required Site Data and Related Assumptions

The *Area of Cell* is calculated based on the volume of contaminated material that needs to be disposed in it and upon the design shape of the cell (assumed to be a 15-foot high truncated cone).

The *Depth of the Cell* is assumed to be 3 feet.

Assumed Unit Costs

The *Unit Cost of Excavating the Soil* is $4.75 per cubic yard, which includes labor and equipment.[21]

Other Assumptions

The "clean" soil excavated for the cell will be used in the cap of the cell.

3.2.5 Laying the Clay Liner

Under the on-site cell restricted release scenario, the estimated cost to lay the clay liner of the cell is calculated using the following equation:

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[21]Based on the average rates associated with using either a 1-cubic yard or a 2-cubic yard capacity hydraulic excavator; RS Means, *2001 Environmental Remediation Cost Data - Unit Price,* 7th Edition, p. 4-12 and 4-15.

Cost of Laying Clay Liner = Unit Cost of Laying the Clay Liner x Cubic Yards of Clay

Required Site Data and Related Assumptions

The total number of *Cubic Yards of Clay* is calculated based on the dimensions of the cell area (described above) and the depth of clay, which is assumed to be one foot.

Assumed Unit Costs

The *Unit Cost of Laying the Clay Liner* is $18.63 per cubic yard of clay, which includes labor, materials, and equipment (RS Means Unit Price, 2001).

3.2. 6 Excavating, Moving, and Placing the Contaminated Materials into the Cell Area

Under the on-site cell restricted release scenario, the estimated cost to excavate, move, and place the contaminated materials into the cell area is calculated using the following equation:

Cost of Excavating, Moving, and Placing the Contaminated Material into the Cell Area = [(Unit Cost to Excavate Soil + Unit Cost of Short Haul + Unit Cost of Placing the Material) x Cubic Yards of Contaminated Soil] + [(Unit Cost of Loading and Hauling the Demolished Buildings + Unit Cost of Placing the Material) x Cubic Yards of Demolished Buildings][22]

Required Site Data and Related Assumptions

The number of *Cubic Yards of Contaminated Soil* at each site.

The *Cubic Yards of Demolished Buildings* is assumed to be 5 percent of total (undemolished) building volume.

Assumed Unit Costs

The *Unit Cost to Excavate Soil* is $4.75 per cubic yard, which includes labor and equipment (RS Means Unit Price, 2001).

The *Unit Cost of Short Haul* is $2.70 per cubic yard of soil and includes the labor and equipment necessary to haul the materials one mile or less (RS Means Unit Price, 2001).

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[22]The cost related to the demolished buildings will only be incurred if the cost analysis determines that demolition of the contaminated area of the buildings is less expensive than decontamination.

The *Unit Cost of Placing the Material* is $1.17 per cubic yard of soil or buildings and includes labor and equipment (RS Means Unit Price, 2001).

The *Unit Cost of Loading and Hauling the Demolished Buildings* is $5.37 per cubic yard of building material and includes labor and equipment necessary to haul the materials five miles or less (RS Means Unit Price, 2001).

Other Assumptions

The contaminated soil is placed on top of the clay liner of the cell.

Costs also are included to restore areas on facility grounds where below-ground excavation is required (i.e., the analysis assumes that below ground excavations will be backfilled with non-contaminated soil in order to avoid leaving open trenches at the site). Estimation of these costs is identical to that described in Section 2.2.4 (for unrestricted release).

3.2.7 Capping the Cell

Under the on-site cell restricted release scenario, the cost of capping the cell is calculated using the following equation:

Cost of Capping the Cell = Cost of Soil Layer + Cost of Clay Layer + Cost of Soil and Rock Cover

Where:

Cost of Soil Layer = Unit Cost of Placing the Soil Layer x Cubic Yards of the Soil Layer

Cost of Clay Layer = (Unit Cost of Placing the Clay Layer + Material Unit Cost) x Cubic Yards of the Clay Layer

Cost of Soil and Rock Cover = (Unit Cost of Placing Soil Cover x Cubic Yards of Soil Cover) + (Unit Cost of Rock Cover x Cubic Yards of Rock Cover)

Required Site Data

The surface area of the filled cell, which is calculated based on the size and shape of the cell, as described earlier.

Assumed Unit Costs

The *Unit Cost of Placing the Soil Layer* is $1.17 per cubic yard and includes labor and equipment (RS Means Unit Price, 2001).

The *Unit Cost of Placing the Clay Layer* $18.63 per cubic yard of clay, which includes labor, materials, and equipment (RS Means Unit Price, 2001).

The *Unit Cost of Placing Soil Cover* is $1.17 per cubic yard and includes labor and equipment (RS Means Unit Price, 2001).

The *Unit Cost of Rock Cover* is $39 per cubic yard and includes labor, materials, and equipment to machine place the stone (RS Means Heavy Construction Cost, 2000).

Other Assumptions

The soil that was excavated for the cell area will be used in the cap of the cell.

No additional soil will be required.

The first soil layer is assumed to be two feet.

The clay layer is assumed to be two feet.

The soil cover is assumed to be 0.75 feet.

The rock cover is assumed to be one foot, using rock with an average diameter of 6 inches (for 50 percent).

The *Cubic Yards of the Soil Layer, Clay Layer, Soil Cover and Rock Cover* are all calculated based on the surface area of the filled cell.

3.2.8 Excavation of Highly Contaminated Materials, Restoration of Facility Grounds, Transportation, and Disposal

Under the restricted release scenario in which the most highly contaminated materials are shipped off site for disposal, the site will incur costs of excavation, restoration of facility grounds, transportation, and disposal.[23] In general, the analysis estimates these costs in the same

[23] Under the on-site cell restricted release scenario, the costs of transporting and disposing of contaminated materials at Envirocare does not apply. Excavation and restoration costs under

way they are estimated assuming unrestricted release (as described in Sections 2.2.3, 2.2.4, 2.2.5, and 2.2.6 of this report). The estimates differ, though, in that they cover smaller amounts of contaminated materials (that is, only contaminated materials that would result in exposure levels greater than 100 or 500 mrem/person/year). Therefore, relative to unrestricted release, less of each site must be excavated and restored, and less material needs to be transported and disposed. Specifically, the volume of highly contaminated soils that are excavated, transported, and disposed at Envirocare by each site is calculated as 10 percent of the total volume of contaminated soils.[24] Because a smaller portion of each site will be excavated under this scenario, there also is a reduced cost to restore facility grounds. Finally, transportation and disposal costs also reflect the assumption that 10 percent of the volume of any demolished buildings are highly contaminated.[25]

3.2.9 Fencing and Signs

The cost of the fence that will be placed around the cell is calculated using the following equation:

Cost of Fence = *(Perimeter of the Site x Unit Cost of Fencing) + [Cost of a Sign x (Perimeter of the Site / Site Placement Factor)]*

Required Site Data

The *Perimeter of the Site* is calculated for each site based on information provided by NRC on the area of the site and the assumption that each site is square.

Assumed Unit Costs

The *Unit Cost of Fencing* is $28.31 per linear foot and includes labor and materials for a seven foot chain link fence (RS Means Unit Price, 2001).

The *Cost of a Sign* is $44.82, and includes the labor and materials for placing a twelve inches by eighteen inches reflectorized sign (RS Means Unit Price, 2001).

Other Assumptions

The *Site Placement Factor* is 20 feet, to account for placing a sign on the fence every 20 feet.

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the on-site cell option are discussed in Section 3.2.6.

[24]The assumption that 10 percent of contaminated materials will be shipped off site for disposal is discussed in Section 3.1.

[25]Disposal of building decontamination waste is addressed in Section 3.2.2.

3.2.10 Transfer to DOE Under NWPA §151B

The site is assumed to be transferred to DOE under NWPA §151B. As the transfer must be at no cost to DOE, each site must provide for ongoing site control and maintenance, including institutional control. The associated costs are calculated using the following equation from NRC's *Draft Regulatory Guide DG-4006, Demonstrating Compliance with the Radiological Criteria for License Termination, p. 33*:

$$Funding\ Required = C_o \times 50\ yrs$$

where:

C_o, the annual cost, is assumed to be $25,000 based on figures applicable to UMTRCA Title II site disposal cells.

Therefore, the cost associated with transfer of the site to DOE under NWPA §151B is estimated at $1,250,000.

3.2.11 Final Survey

The cost of the final survey is calculated using the following equation:[26]

$$Cost\ of\ Final\ Survey = 7\ percent \times \{ [Cost\ of\ Building\ Demolition\ or\ Cost\ of\ Building\ Decontamination] + [Cost\ of\ Engineered\ Onsite\ Cell\ or\ (Cost\ of\ Transportation + Cost\ of\ Disposal)] + Cost\ of\ Fencing\ and\ Signs \}$$

The analysis assumes that an amount equal to 7 percent of these other costs will be required for the final survey. [27] The final survey includes a final characterization of the radiological condition of the facility that will ensure that it can meet the restricted release standards. Activities might include sampling, soil tailings or analysis, and groundwater analysis, if applicable.

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[26]Certain costs may not be included depending on the restricted release scenario used at the site.

[27]Based on figures used in past independent cost estimates prepared by ICF in coordination with NRC.

3.2.12 Contingency

A contingency factor is calculated using the following equation:[28]

Cost of Contingency = *25 percent x {Cost of Planning and Preparation + [Cost of Building Demolition or Cost of Building Decontamination] + [Cost of Engineered Onsite Cell or (Cost of Transportation + Cost of Disposal)] + Cost of Fencing and Signs + Cost to Transfer to DOE Under NWPA §151B + Cost of Final Survey}*

The analysis applies a contingency factor of 25 percent to the total of all estimated costs to address unforeseen circumstances that could increase decommissioning costs. Use of a contingency factor is consistent with common cost estimating practice as well as the guidance contained in NUREG/CR-6477, which applies a 25 percent contingency factor to all estimated costs associated with decommissioning various reference facilities.[29]

3.3. Results and Sensitivity Analysis

In addition to developing a "best estimate" using this method, a sensitivity analysis was performed to bound the estimate with a "low estimate" and "high estimate" of the total cost for each site. The sensitivity analysis reflects changes in the following variables:

Volume of contaminated soil: plus 100/minus 25 percent of baseline volume;

Excavation cost per cubic yard of contaminated material: plus/minus 15 percent of the baseline unit cost;

Building demolition costs per cubic foot of building: plus/minus 15 percent of the baseline unit cost;

Building decontamination disposal costs for decontamination fluids and materials: plus 150 percent;

Volume of demolished buildings: plus/minus 20 percent of the baseline volume;

Area of contaminated buildings: plus/minus 10 percent of baseline area; and

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[28]The contingency will cover all costs applicable under the restricted release scenario used at the site.

[29]NUREG-1727, NMSS Decommissioning SRP, Appendix F, Rev 0, September 15, 2000, p. F-26.

Disposal unit cost per cubic yard of soil: plus/minus 55 percent of baseline disposal unit cost.

The percentage variation considered for the above inputs and unit costs are intended to reflect probable (and not absolute) upper and lower bound estimates of the cited cost variables. Exhibits 3-3 and 3-4 present a more detailed set of cost results, showing estimated costs of individual cost components.

The results show that, for the sites considered, restricted release is achieved most cost-effectively by disposing of all contaminated materials in an on-site cell, as opposed to shipping only the most contaminated materials off-site for disposal. This is true regardless of whether the best, low, or high estimate is considered.

As was the case for the estimates that assumed unrestricted release, the methodology used to estimate costs of restricted release represents a screening level analysis. See Section 2.3 for additional discussion of the limitations of the methodology.

4. Financial Analysis

The first objective of this financial analysis is to answer the question, "Is the responsible party financially capable of funding the cleanup of the site to meet NRC's unrestricted release criteria?" In cases where adequate financial capability is not clear, the analysis also addresses a second objective and question, "Is the responsible party financially capable of funding the cleanup of the site to meet NRC's restricted release criteria?" To answer these questions, each entity's financial capability is first evaluated relative to the decommissioning cost estimate for unrestricted release. If necessary, the analysis also considers the entity's decommissioning cost estimate under the restricted release scenario.[30]

To evaluate financial capability, this study identified and obtained financial data on the entities responsible for decommissioning the sites. It then applied various financial tests contained in NRC's financial assurance requirements, using the appropriate financial data along with the decommissioning cost estimates calculated earlier in this study or other estimates provided by NRC. The financial tests and test criteria applied include the following:

NRC's self guarantee financial test for commercial companies that issue bonds (10 CFR Part 30, Appendix C)

(i) Tangible net worth at least 10 times the current decommissioning cost estimates for all decommissioning activities for which the company is responsible; and

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[30] For purposes of this financial analysis, the lower cost restricted release scenario is the one considered.

(ii) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates for all decommissioning activities for which the company is responsible; and

(iii) A current rating for its most recent bond issuance of AAA, AA, or A as issued by Standard & Poor's, or Aaa, Aa, or A as issued by Moody's.

(In order to pass the financial test, a commercial licensee that issues bonds also must have at least one class of equity securities registered under the Securities Exchange Act of 1934.)

NRC's self guarantee financial test for commercial companies that do not issue bonds (10 CFR Part 30, Appendix D)

(i) Tangible net worth greater than $10 million, or at least 10 times the current decommissioning cost estimates, whichever is greater, for all decommissioning activities for which the company is responsible; and

(ii) Assets located in the United States amounting to at least 90 percent of total assets or at least 10 times the current decommissioning cost estimates for all decommissioning activities for which the company is responsible; and

(iii) A ratio of cash flow divided by total liabilities greater than 0.15 and a ratio of total liabilities divided by net worth less than 1.5.

NRC's parent company guarantee financial tests (10 CFR Part 30, Appendix A)

Alternative 1:

(i) Two of the following three ratios: A ratio of total liabilities to net worth less than 2.0; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; and a ratio of current assets to current liabilities greater than 1.5; and

(ii) Net working capital and tangible net worth each at least six times the current decommissioning cost estimates; and

(iii) Tangible net worth of at least $10 million; and

(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates.

Alternative 2:

(i) A current rating for its most recent bond issuance of AAA, AA, A, or BBB as issued by Standard & Poor's, or Aaa, Aa, A, or Baa as issued by Moody's; and

(ii) Tangible net worth at least six times the current decommissioning cost estimates; and

(iii) Tangible net worth of at least $10 million; and

(iv) Assets located in the United States amounting to at least 90 percent of total assets or at least six times the current decommissioning cost estimates.

The study then examined each firm's results on the above test criteria. Entities that meet the criteria in either of NRC's financial tests *for self-guarantors* (i.e., the tests in Appendix C or D to 10 CFR Part 30) are presumed capable of paying for the decommissioning. In all other cases, each firm's results on the test criteria have been evaluated within the context of other readily available information addressing the company's financial health and strength, including information on financial trends, industry trends, environmental liabilities, and other aspects of financial condition. Based on this analysis, the study classifies each company with respect to its financial capability to fund the full amount of its estimated costs.

It is worth noting that any company's financial condition is likely to change over time – sometimes dramatically. Changes may be gradual or sudden, and the reasons for change may be specific to a given firm or to an entire industry, or they may relate to the national or the global economy. Any financial analysis, therefore, represents a "snapshot" of an entity's constantly changing financial picture as of a given point in time. The analyses presented below are based primarily on financial data for each entity's most recently completed fiscal year for which data are available.[31] Consequently, these snapshots generally do not reflect the recessionary economic conditions present throughout much of 2001 including, in particular, the economic after-effects of the September 11, terrorist attacks. This study assumes that any resulting downturns will not affect the basic conclusions regarding financial capability.

Also, this study evaluates the question of financial capability under the assumption that each responsible party will continue as "a going concern" – that is, will continue to operate in its current line of business. Consequently, the study does not evaluate, for example, the likelihood

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[31]This is usually, but not always, December 31, 2000. The fiscal periods covered by each company's financial statements are noted in the write-up for the company. Financial statements addressing fiscal years ending on December 31, 2001, were not yet available but should become available as of March or April, 2002. Where noted, this study also made use of interim financial data for periods subsequent to those covered by the most recent financial statements. However, a detailed analysis of quarterly data is beyond the scope of this study.

that the decommissioning might be prioritized and funded over other claims in the event of a reorganization or liquidation of the company under the bankruptcy code.