COST-EFFECTIVE TREATMENT AND DISPOSAL OF MIXED LOW-LEVEL WASTE RETRIEVED FROM THE 218-W-4C BURIAL GROUND

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ABSTRACT

Bechtel Hanford, Inc., under contract with the U.S. Department of Energy (DOE), has committed to identify technologies and methods to be used as part of environmental remediation activities that would lead to cost-effective treatment and disposal of waste while still providing protection to workers and the environment.

Approximately 9,000 drums of mixed low-level waste (MLLW) from the 218-W-4C Trench are being proposed for treatment and disposal in the Environmental Restoration Disposal Facility (ERDF) at the Hanford Site. The MLLW that is being retrieved from the 218-W-4C Burial Ground is contaminated with hazardous substances and radionuclides. The vast majority of the drums are reported to be filled with "step-off pad"-type waste. Because of this, the drums are considered to have significant void space potential that could adversely impact the integrity of the future ERDF cap if not addressed.

To resolve the above-mentioned problem, potential optional methods were evaluated in order to select a method by which ERDF can receive, treat, and dispose of this waste stream with the least possible life-cycle cost (LCC). The evaluation used a value engineering process and considered a limited set of treat-and-dispose options against criteria established during subsequent meetings.

The value engineering study was performed in two distinct phases: Phase I for developing and weighting criteria for evaluation and selection of treatment and disposal ideas, identifying the "base case" of operations, and pre-screening and selecting other "options" as potential candidates for treatment and disposal of MLLW; and Phase II for preparing LCCs for the base case and selected options, and recommending the best solution.

Under the Phase I study, the base case and five other options were selected for further detailed study for the treatment and disposal of MLLW. Subsequently, DOE selected an additional option for further study.

Through the Phase II study, the base case and the six selected options were evaluated using value methodology techniques. The team determined and compiled rankings based on LCCs and advantages and disadvantages, and arrived at composite final rankings for the base case and the six selected options.

In the final analysis, the value study team determined that the option described below, with the least LCC and best final ranking, provided the best solution for treatment and disposal of MLLW retrieved from the 218-W-4C Burial Ground.

Recommended Option: ***Send MLLW debris in drums from the Central Waste Complex directly to ERDF for disposal and macro-encapsulation within Environmental Restoration Contractor-designed and -constructed structural concrete vaults at ERDF.***

The recommended option will comply with ERDF waste acceptance criteria, will not jeopardize the integrity of the future ERDF cap, and provides substantial protection to workers and the environment. It also identifies potential savings of approximately $3 million (30% of base cost) compared to the cost of the base case. The project accepted the team's recommendation and commenced implementation of the same.

INTRODUCTION

Bechtel Hanford, Inc. (BHI) has been the Environmental Restoration Contractor for the Hanford Site since 1994. Under contract to the U. S Department of Energy (DOE), BHI has characterized and remediated contaminated sites, structures, and burial grounds. This paper provides the process used to arrive at cost-effective treatment and disposal of mixed low-level waste (MLLW) retrieved from the 218-W-4C Burial Ground.

SITE BACKGROUND INFORMATION

The Hanford Site is located in the southeastern part of Washington State, U.S.A. It consists of 1,450 km^2 (560 mi^2) of sand and sagebrush. It is the world's largest environmental cleanup project, sponsored by the U.S. Department of Energy (DOE).

The Environmental Restoration Disposal Facility (ERDF), constructed by Bechtel Hanford, Inc. (BHI) on the Hanford Site, consists of a current capacity of approximately 3,670,000 m^3 (4,800,000 yd^3) for disposal of mixed low-level waste (MLLW).

WASTE BACKGROUND INFORMATION

In the 1970s, the U.S. Atomic Energy Commission (AEC) defined transuranic (TRU) waste as a separate waste category that would contain greater than 10 nCi/g of TRU radionuclides. It was also declared that TRU waste should be retrievable. In 1984, the AEC redefined TRU waste as containing greater than 100 nCi/g of TRU radionuclides. Therefore, some of the suspect TRU waste initially placed in storage is now defined as low-level waste (LLW).

Since 1970, approximately 37,400 suspect-TRU waste containers have been placed in retrievable storage at the Hanford Site. The waste container contents include failed process equipment such as pumps, resin columns, and tanks; laboratory and room trash, including paper, plastics, glassware, cloth, and solidified liquids; and decontamination and decommissioning rubble, including concrete, piping, and soils.

The MLLW and LLW that are being retrieved from the 218-W-4C Burial Ground are contaminated with hazardous substances and radionuclides. The 218-W-4C Burial Ground contains approximately 18,000 drums (55-gal) and 400 other containers of suspect-TRU waste.

The portion of the waste proposed for disposal at ERDF consists of approximately 9,000 drums containing TRU-contaminated miscellaneous solid wastes with contamination rates ranging between 10 and 100 nCi/g. Hazardous substances are present, which requires macro-encapsulation of the waste.

PROBLEM STATEMENT

The vast majority of the drums are reported to be filled with "step-off pad"-type waste. Therefore, the drums are considered to have a significant void space potential that could adversely impact the integrity of the future ERDF cap if not addressed. The requirement to macro-encapsulate the waste must also be incorporated into the solution. The initially identified method for remediation of this waste (referred to as "base case") was viewed as very expensive.

NEED AND MISSION

To resolve the problem described above, an evaluation of the base case along with other optional methods was required to select a method by which ERDF can receive, treat, and dispose of this waste stream with the least possible life-cycle cost (LCC). BHI's project group ascertained that, by adopting value methodology's phased and disciplined approach in evaluating the base case and potential options, the project could secure the best solution at the least possible LCC.

ORGANIZATION OF THE VALUE STUDY

A team of subject matter experts from BHI's Environmental Restoration Project and Fluor Hanford's (FH) Waste Treatment and Disposal Project were identified to perform a value engineering (VE) study to arrive at a cost-effective and reliable method for treatment and disposal of MLLW from the 218-W-4C Burial Ground. The VE study was facilitated by a certified value specialist and was performed in two phases:

- ***Phase I***: For developing and weighting criteria for evaluation and selection of treatment and disposal ideas, identifying the base case of operations, and pre-screening and selecting other options as potential candidates for treatment and disposal of MLLW.
- ***Phase II***: For preparing LCCs for the base case and selected options, and recommending the best solution.

PHASE I: REQUIREMENTS OF THE VALUE METHODOLOGY PRE-STUDY STAGE

Scope of the Phase I Study

The scope of Phase I of the study included the following:

Step 1: Verify if the data currently available for MLLW are accurate for this study (e.g., number of drums, size and condition of drums).

Step 2: Identify the current practice of operations (base case) for MLLW.

Step 3: Develop and weight criteria using a "paired comparison" technique for evaluation.

Step 4: Brainstorm and identify for consideration the options that may lead to waste minimization and provide effective and safe disposal of the waste to ERDF.

Step 5: Evaluate each option against the criteria developed in Step 3, and score each option.

Step 6: Select the top-scoring and most viable options as potential candidates for further detailed evaluation and cost estimation.

Criteria for Evaluation of Options for Treatment and Disposal of Mixed Low-Level Waste

Team members brainstormed and developed a set of criteria for evaluation of potential options as follows:

1. **Probability of success**
   What would be the probability of feasibility for this option for treating and disposing MLLW?
2. **Potential for meeting Fluor Hanford's initial shipment date**
   Can the process of this option be up and running in time to meet the probable initial shipment date of June 1, 2004, for MLLW from FH?
3. **Safety**
   What would be the extent of difficulty in achieving ergonomic, as low as reasonably achievable (ALARA), and Radiological Controls (RadCon) requirements in implementing this option?
4. **Compatibility with Authorization Basis**
   How will this option fall within the Authorization Basis of the ERDF?
5. **Landfill space requirements**
   How much floor space in the landfill cell will be required for the treat/disposal method specified in this option?
6. **Long-term stability**
   How well does this option provide for long-term stability of the ERDF cap?

7. **Regulatory compliance**
   How well does this option satisfy requirements of applicable laws and regulations?
8. **Infrastructure**
   How well can this option utilize the existing infrastructure?

Value Methodology Paired Comparison Technique for Criteria Weighting

While there are many different approaches that can be used to determine the weighting factor, the "paired comparison method" is one of the most effective. This method is based on the assumption that the simplest and least emotional decision considers only two criteria at a time and determines which is more important. In essence, it only requires an answer to, "Is criterion A more important than criterion B?" rather than a judgmental, "How much more important is criterion A than B?" By comparing each criterion against the other in this fashion, the relative importance of each criterion is easily established. The paired comparison matrix is an effective way to record and tally the decisions.

With the paired comparison matrix, criterion A is compared against criteria B, C, D, E, F, G, and H, and the letter relating to which criterion is more important is recorded in the box that intersects row A and the column B, C, D, E, F, G, or H. Once A has been compared against the other criteria, the process is repeated for criterion B. Since criterion B has already been compared to A, it only needs to be compared against C, D, E, F, G, and H. This process continues until each criterion has been compared against the other.

Using the above-mentioned method, the criteria were weighted for relative importance. Note that the team preferred to split and assign relative importance factors to both criteria being compared, as tabulated in Table I.

Table I. Weighting criteria for options for mixed low-level waste retrieval, treatment, and disposal

	B	C	D	E	F	G	H	EVALUATION CRITERIA	Score	Percent
A	A3 B2	A2 C3	A1 D3	A3 E2	A2 F3	A2 G3	A3 H1	Probability of Success	16	13.7
B		B1 C3	B1 D3	B2 E1	B1 F3	B1 G3	B1 H1	Potential for Meeting FH Initial Shipment Dates	9	7.7
C			C2 D3	C3 E1	C3 F2	C3 G3	C3 H1	Safety	20	17.1
D				D3 E1	D3 F2	D3 G2	D3 H1	Compatibility with Authorization Basis	21	18.0
E					E1 F2	E1 G2	E1 H1	Landfill Space Requirements	8	6.8
F						F2 G3	F3 H1	Long-Term Stability	17	14.5
G							G3 H1	Regulatory Compliance	19	16.2
H								Use of Existing Infrastructure	7	6.0
								TOTALS	**117**	**100**

How Important
1. Minor Preference
2. Medium Preference
3. Major Preference

MLLW Quantities for Treatment and Disposal to ERDF

Approximately 9,000 drums of MLLW are expected to be retrieved from the 218-W-4C Burial Ground, located west of the Plutonium Finishing Plant in the Hanford Site's 200 West Area. As a recommendation from the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (reference 1) Interagency Management Integration Team subcommittee dealing with Hanford's waste disposal options, the disposal path forward for this MLLW is the ERDF. FH's MLLW Treatment and Disposal Program has been assigned the project of dispositioning this waste.

To establish a base set of physical inputs for the LCC analysis, the following project-level information regarding the waste was considered:

- Of the 9,000 drums of MLLW, approximately 90% (about 8,100 drums) are anticipated to meet the *Resource Conservation and Recovery Act of 1976* (RCRA) (reference 3) definition of "debris." The remaining quantity (about 900 drums) is anticipated to be MLLW not meeting the definition of "hazardous debris" and will have to be stored in the Central Waste Complex (CWC) until treatment capability becomes available.

- The debris waste is currently the only waste being evaluated at this time, as it comprises the majority of the waste. Disposal options for non-debris MLLW need to be analyzed in greater detail at a later date.

- The majority (>98%) of the drummed debris waste is 55 gal in size (nominally 0.208 m^3 or 7.34 ft^3 per drum). Some 85-gal (nominally 0.322 m^3 or 11.37 ft^3 per drum) drums are also expected to be removed from the 218-W-4C Burial Ground. For the purpose of this cost analysis, all drums are assumed to be 55 gal in size.

- Waste retrieval from the 218-W-4C Burial Ground began in November 2003 and is anticipated to continue through FY06.

- Based on retrieval rates and project funding guidance, the following number of MLLW debris waste packages are anticipated to be dispositioned each FY:
  - FY04: 1,600 drums (approximately 333 m^3)
  - FY05: 3,250 drums (approximately 676 m^3)
  - FY06: 3,250 drums (approximately 676 m^3).
- The average gross weight for the 55-gal debris waste packages is anticipated to be between 150 to 200 lb. For the purpose of this LCC, 200 lb is used as the average gross weight.
- The debris is composed mainly of soft compactable debris (e.g., paper, cloth, rubber, and personal protective equipment), as well as various types and amounts of metal.
- The anticipated number of waste packages per shipment for the various types of waste forms is as follows:
  - For 55-gal waste packages shipped from FH to ERDF and/or Pacific EcoSolutions (PEcoS): 80 drums per load based on size limiting (assumes 44-ft trailer).
  - For 85-gal overpacks containing 55-gal waste packages shipped from FH to PEcoS: 40 drums per load based on size limiting (assumes 44-ft trailer).
  - For 85-gal overpacks containing super-compacted 55-gal waste packages shipped from PEcoS to ERDF: 30 drums per load based on weight limiting (1,000 to 1,400 lb each, using 1,200 lb as the average).
  - For 110-gal macro-encapsulated waste packages shipped from PEcoS to ERDF: 20 drums per load based on weight limiting (1,600 to 2,000 lb each, using 1,800 lb as the average).
- The estimated cost for an 85-gal overpack container is $125.00 each.
- Current FY04 dollars are to be used (i.e., no cost exculpation).
- The resulting cost estimate shall be in total project cost as incurred by FH (e.g., General and Administrative [G&A] overheads for the BHI, ERDF, and PEcoS subcontracts need to be applied) for the duration of the project (i.e., through FY06).

List of Identified Options

Option 1: Send MLLW debris in drums from CWC directly to ERDF, then grout-inject drums at ERDF using negative pressure before disposal and macro-encapsulation in ERDF.

Option 2: Send MLLW debris in drums from CWC directly to ERDF, then void-fill drums using grout fill/glovebag at ERDF before disposal and macro-encapsulation in ERDF.

Option 3: Send MLLW debris in drums/overpacks from CWC to PEcoS for super-compaction before sending to ERDF for disposal and macro-encapsulation in ERDF.

Option 4: Send MLLW debris in drums from CWC directly to a new super-compactor near ERDF for super-compaction, then disposal and macro-encapsulation in ERDF.

Option 5: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within procured high-integrity containers (HICs) placed in ERDF.

Option 6: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC designed and constructed structural vault in ERDF.

Option 7: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within Environmental Restoration Contractor (ERC)-designed and procured structural horizontal pipes placed in ERDF.

Option 8: Send MLLW debris in drums from CWC directly to ERDF, then void-fill drums with grout injection to meet macro-encapsulation before disposal in ERDF. (This assumes that injected drums require no further macro-encapsulation.)

Option 9: Send MLLW debris in drums from CWC to PEcoS for super-compaction and macro-encapsulation before sending to ERDF for disposal.

Evaluation and Ranking of Options

Table II. Evaluation and Ranking of Options (2 pages)

CATEGORY: MLLW Retrieval, Treatment, and Disposal		**MATRIX ANALYSIS**										
List the best ideas from the suitability evaluation. Determine which one ranks best against desired criteria. Work down, not across. *Rate from 10 = Excellent to 1 = Poor*		(1) Objectives or Criteria										
		Probability of Success	Potential For Meeting FH Initial Ship Dates	Safety	Compatibility with Authorization Basis	Landfill Space Requirements	Long Term Stability	Regulatory Compliance	Use of Existing Infrastructure			
(2) Option ↓	(3) Weight ►	13.7%	7.7%	17.1%	18.0%	6.8%	14.5%	16.2%	6.0%	(4) Sum	(5) Rank	(6) Comments
Option 1: Send MLLW debris in drums from CWC directly to ERDF, then grout-inject drums at ERDF using negative pressure before disposal and macro-encapsulation in ERDF.		8.00[a]	7.00	3.00	7.00	7.00	8.00	8.00	7.00		7	Requested for detailed study by RL on 04/29/04[c]
		1.09[b]	0.54	0.51	1.26	0.48	1.16	1.30	0.42	6.76		
Option 2: Send MLLW debris in drums from CWC directly to ERDF, then void-fill drums using grout fill/glovebag at ERDF before disposal and macro-encapsulation in ERDF.		4.00	4.00	2.00	6.00	7.00	8.00	7.00	6.00		9	
		0.55	0.31	0.34	1.08	0.48	1.16	1.14	0.36	5.41		
Option 3: Send MLLW debris in drums/overpacks from CWC to PEcoS for super-compaction before sending to ERDF for disposal and macro-encapsulation in ERDF.		9.00	8.00	8.00	9.00	10.00	10.00	7.00	8.00		2	Recommended for detailed study
		1.23	0.62	1.37	1.62	0.68	1.45	1.14	0.48	8.58		

Table II. Evaluation and Ranking of Options (2 pages)

CATEGORY: MLLW Retrieval, Treatment, and Disposal		MATRIX ANALYSIS										
List the best ideas from the suitability evaluation. Determine which one ranks best against desired criteria. Work down, not across. *Rate from 10 = Excellent to 1 = Poor*		(1) Objectives or Criteria Probability of Success	Potential For Meeting FH Initial Ship Dates	Safety	Compatibility with Authorization Basis	Landfill Space Requirements	Long Term Stability	Regulatory Compliance	Use of Existing Infrastructure			
(2) Option ↓	(3) Weight →	13.7%	7.7%	17.1%	18.0%	6.8%	14.5%	16.2%	6.0%	(4) Sum	(5) Rank	(6) Comments
Option 4: Send MLLW debris in drums from CWC directly to a new super-compactor near ERDF for super-compaction, then disposal and macro-encapsulation in ERDF.		9.00	1.00	6.00	6.00	10.00	10.00	7.00	3.00		6	
		1.23	0.08	1.03	1.08	0.68	1.45	1.14	0.18	6.86		
Option 5: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within procured high-integrity containers placed in ERDF.		10.00	4.00	9.00	8.00	6.00	6.00	9.00	9.00		3	Recommended for detailed study
		1.37	0.31	1.54	1.44	0.41	0.87	1.46	0.54	7.93		
Option 6: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC-designed and constructed structural vault in ERDF.		9.00	3.00	8.00	8.00	5.00	7.00	9.00	6.00		5	Recommended for detailed study
		1.23	0.23	1.37	1.44	0.34	1.02	1.46	0.36	7.45		
Option 7: Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC designed and procured structural horizontal pipes placed in ERDF.		8.00	7.00	8.00	8.00	6.00	6.00	9.00	8.00		4	Recommended for detailed study
		1.09	0.54	1.37	1.44	0.41	0.87	1.46	0.48	7.66		

Table II. Evaluation and Ranking of Options (2 pages)

CATEGORY: MLLW Retrieval, Treatment, and Disposal		**MATRIX ANALYSIS**										
List the best ideas from the suitability evaluation. Determine which one ranks best against desired criteria. Work down, not across. *Rate from 10 = Excellent to 1 = Poor*		(1) Objectives or Criteria: Probability of Success	Potential For Meeting FH Initial Ship Dates	Safety	Compatibility with Authorization Basis	Landfill Space Requirements	Long Term Stability	Regulatory Compliance	Use of Existing Infrastructure			
(2) Option ↓	(3) Weight ►	13.7%	7.7%	17.1%	18.0%	6.8%	14.5%	16.2%	6.0%	(4) Sum	(5) Rank	(6) Comments
Option 8: Send MLLW debris in drums from CWC directly to ERDF, then void-fill drums with grout injection to meet macro-encapsulation before disposal in ERDF. (This assumes that injected drums require no further macro-encapsulation.)		8.00	7.00	3.00	7.00	7.00	7.00	6.00	7.00		8	
		1.09	0.54	0.51	1.26	0.48	1.02	0.97	0.42	6.29		
Option 9: Send MLLW debris in drums from CWC to PEcoS for super-compaction and macro-encapsulation before sending to ERDF for disposal.		10.00	8.00	8.00	10.00	9.00	10.00	8.00	8.00		1	Recommended for detailed study
		1.37	0.62	1.37	1.79	0.62	1.45	1.30	0.48	8.99		

[a] This importance factor is derived by rating the option on a 1-to-10 scale, based on how well the option satisfies this specific criteria.
[b] This number is a multiplication of the percentage criteria weight by the importance factor.
[c] RL = U.S. Department of Energy, Richland Operations Office

List and Description of Base Case and Selected Option(s) for Further Development

In addition to the base case defined by FH, the VE study team ranked nine different options against eight criteria to derive a short list of five options for LCC. The short list of selected options is detailed below, beginning with the highest ranked and proceeding to the lowest ranked:

- ***Base Case –*** Super-compact drums and macro-encapsulate them prior to delivery to the mixed waste disposal unit for disposal. FH overpacks 55-gal drums and ships them to PEcoS under U.S. Department of Transportation (DOT) requirements. The drums would be super-compacted, placed into 110-gal overpacks, and grouted for macro-encapsulation with an assumed overall volume reduction factor (VRF) of 1.5:1. The completed packages would be shipped to the mixed waste disposal unit located in the 200 West Area of the Hanford Site, where the drums would be disposed by place-and-cover methods. Mixed waste disposal costs are based on the actual costs associated with disposal of other treated MLLW under the MLLW Treatment and Disposal Project. Weight per package is estimated at 1,600 to 2,000 lb each.

- ***Option 9*** – Super-compact and macro-encapsulate drums prior to delivery to the ERDF. FH overpacks 55-gal drums and ships them to PEcoS under DOT requirements. The drums would be super-compacted, placed into 110-gal overpacks, and grouted for macro-encapsulation with an assumed VRF of 2.5:1 overall. The completed packages would be shipped to the ERDF where they would be disposed by place and cover methods. The ERDF costs would include standard disposal cost/ton of waste for the entire package received at the ERDF. Weight per package is estimated at 1,600 to 2,000 lb each.
- ***Option 3*** – Super-compact drums before macro-encapsulation at the ERDF: FH overpacks 55-gal drums and ships them to PEcoS under DOT requirements. The drums would be super-compacted, placed inside 85-gal overpacks, and void-filled with sand. The overall VRF would be 3:1 (5 pucks/OP). The completed packages would be shipped to the ERDF, where they would be placed on a mega-macro pad and macro-encapsulated using standard ERDF methods. A total of 157 packages would be grouted on each pad.
- ***Option 5*** – Macro-encapsulate within structural vaults using a HIC: The 55-gal drums would be placed into HICs at the ERDF. The drums would be grouted for macro-encapsulation, and a structural lid would be placed on the HIC. Volume utilization of the HIC is estimated by FH to be approximately 50%. Drums could be double- or triple-stacked inside the HIC. At ERDF cranes would be required to handle the HICs, the drums, and their lids. The voids within the HIC would be filled with the low-strength floatable grout that ERDF uses for macro-encapsulation.
- ***Option 7*** – Macro-encapsulate within structural vaults using horizontal pipes: Horizontal pipes would be laid on the floor of the active cell (or on the 35-ft level). Drums (55 gal) would be placed inside the pipes and partially grouted to "pin" them in place. A second grout campaign would completely fill the pipes. The size and type of the pipes would be determined by structural analysis. The benefit of this method is that it takes advantage of the culvert effect of diverting overlying load around the horizontal drums. The key difficulty to overcome would be loading the drums into the pipes.
- ***Option 6*** – Macro-encapsulate within a structural vault using grout with a structural design: Slip-formed walls would be poured around a pad holding the 55-gal drums. Drums would be stacked two levels high. Voids would be filled with grout and a designed, reinforced, structural lid would be poured over the top of the filled unit.

PHASE II: REVIEW ASSUMPTIONS AND PRELIMINARY COST ESTIMATES OF BASE CASE AND SELECTED OPTIONS

Scope of the Phase II Study

The scope of Phase II of the study included the following:

Step 1: Assign a cost estimator to prepare LCCs for the base case and each of the selected option(s).

Step 2: Obtain cost data and other pertinent information from FH for preparing the LCC for the base case.

Step 3: Verify if data currently available for selected options are accurate and validated.

Step 4: Prepare LCCs for selected options.

Step 5: Generate advantages and disadvantages of the selected options and base case.

Step 6: Review the LCCs for the base case and the selected option(s).

Step 7: Select and recommend the method of remediation of MLLW.

For ease of reviewing, coordinating, and processing collected data, the Phase II study was carried out in three subphases: IIA, IIB, and IIC.

Phase IIA Study Summary

Initially, the base case and Options 3, 5, 6, 7, and 9 were selected for further detailed development. It was determined, however, that Option 7 would require a substantial amount of time to perform structural analysis of the pipes and would not meet FH's shipment date; hence, Option 7 was excluded from further development.

Additionally, it was determined that Option 4 for super-compaction at ERDF should be carried further for detailed development to investigate its potential.

Participants reviewed initial rough estimates and corresponding assumptions for the base case and selected Options 3, 4, 5, 6, and 9.

Comments were given to the cost estimator for further refinement of the assumptions and the LCCs.

PHASE IIB: REVIEW PROGRESS OF VALUE ENGINEERING STUDY AND SELECTED OPTIONS

Phase IIB Study

A comprehensive overview of the progress of the VE study was provided to the U.S. Department of Energy, Richland Operations Office (RL). A list of options and a set of criteria for evaluating options were reviewed, and the method used for ranking all options was explained. Upon review of the selected options for further development, RL suggested that Option 1 also be considered for further development and LCC. RL was assuming that all drums would have nuclear filter (NucFil)-type, high-efficiency particulate air (HEPA) filters installed, and that the filters installed would have sufficient air-flow capacity to pass the air that would be displaced by grout injection. RL also suggested a slight alteration to Option 1, placing a vacuum hose over the NucFil, which would have mitigated much of the RadCon concern regarding the option. As such, Option 1 was added to the list of options to be developed in more detail.

LIFE-CYCLE COST SUMMARY

The following represents a summary of LCCs of the base case and selected options (obtained from references 4, 5, and 6).

Base Case: $10.3 million
Cost estimate for sending drums from CWC to PEcoS for compaction and macro-encapsulation, and then dispose at the mixed waste disposal unit.

Option 3: $9.1 million
Cost estimate for sending the MLLW debris in drums/overpacks from CWC to PEcoS for super-compaction before sending to ERDF for disposal and macro-encapsulation.

Option 4: $8.1 million
Cost estimate for sending the MLLW debris in drums from CWC directly to a new super-compactor near ERDF for super-compaction, then disposal and macro-encapsulation in ERDF.

Option 5: $13.7 million
Cost estimate for sending the MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within procured HICs placed in ERDF.

Option 6: $7.3 million
Cost estimate for sending the MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC-designed and constructed structural vaults in ERDF.

Option 9: $9.9 million
Cost estimate for sending the MLLW debris in drums from CWC to PEcoS for super-compaction and macro-encapsulation before sending to ERDF for disposal.

Option 1: $8.7 million
Cost estimate for sending the MLLW debris in drums from CWC directly to ERDF, then grout-inject drums at ERDF using negative pressure before disposal and macro-encapsulation in ERDF.

PHASE IIC: ADVANTAGES AND DISADVANTAGES OF BASE CASE AND OPTIONS

Advantages/Disadvantages

The team members discussed the advantages and disadvantages of each potential option and the base case and arrived at the points presented in Table III.

Final Ranking

The team members compared the rankings based on LCCs and advantages/disadvantages and arrived at the final composite ranking shown in Table IV.

Table III. Advantages/Disadvantages of Each Potential Option(s) and the Base Case (3 pages)

Item	Option Description	Advantages	Points*	Disadvantages	Points*
Base Case	Send drums from CWC to PEcoS for compaction and macro-encapsulation, then dispose at the mixed waste trench.	No CERCLA action would be required (managed completely under RCRA authority) Treatment and disposal could start immediately since this work is already being performed under the Mixed Waste Treatment and Disposal Project Fewer RadCon and safety concerns because drums would not be opened outside of a ventilated controlled facility No permit/license modification required	**+1** **+1** **+1** **+2**	Difficulty in meeting DOT shipping requirements for offsite shipments Product is handled multiple times Does not meet the objectives set forth by the C3T committee on waste disposal at the Hanford Site Would take up significant disposal space in the relatively small mixed waste disposal units, which could be better utilized for other onsite RCRA waste as well as for offsite MLLW Waste is shipped off the Hanford Site and may be perceived as being more dangerous to Stakeholders and the public	**-2** **-1** **-3** **-2** **-1**
	Totals for Base Case		**+5**		**-9**
Option 1	Send MLLW debris in drums from CWC directly to ERDF, then grout inject drums at ERDF using negative pressure before disposal and macro-encapsulation in ERDF.	Less structural stability risk for the ERDF Current ERDF mega-macro-encapsulation techniques would be used Relatively small capital costs required to start No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public	**+1** **+2** **+2** **+2** **+1**	Contamination levels inside drums will drive up protective requirements to workers and environment Use of NucFils will be required for all drums, not just those without vent clips Higher capacity NucFils may be needed, requiring replacement of those currently installed A two-stage grouting process would be required ERDF not equipped to handle this at this time, which could impact completion schedule Air permit needs to be modified Auditable safety analysis needs to be modified	**-2** **-2** **-2** **-2** **-1** **-1** **-1**
	Totals for Option 1		**+8**		**-11**
Option 2	Send MLLW debris in drums from CWC directly to ERDF, then void fill drums using grout fill/glove bag at ERDF before disposal and macro-encapsulation in ERDF.	Less structural stability risk for the ERDF Current ERDF mega-macro-encapsulation techniques would be used Relatively small capital costs required to start No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public	**+1** **+2** **+2** **+2** **+1**	Contamination levels inside drums will drive up protective requirements to workers and environment Use of NucFils will be required for all drums, not just those without vent clips Higher capacity NucFils may be needed, requiring replacement of those currently installed A two-stage grouting process would be required ERDF not equipped to handle this at this time, which could impact completion schedule Air permit needs to be modified Auditable safety analysis needs to be modified RadCon and safety controls would be more difficult for this option	**-2** **-2** **-2** **-2** **-1** **-1** **-1** **-1**
	Totals for Option 2		**+8**		**-12**

Table III. Advantages/Disadvantages of Each Potential Option(s) and the Base Case (3 pages)

Item	Option Description	Advantages	Points*	Disadvantages	Points*
Option 3	Send MLLW debris in drums/ overpacks from CWC to PEcoS for super-compaction before sending to ERDF for disposal and macro-encapsulation in ERDF.	Fewer RadCon and safety concerns because drums would not be opened at the ERDF Current ERDF mega-macro-encapsulation techniques would be used Less structural stability risk for the ERDF No modifications to auditable safety analysis	**+1** **+2** **+1** **+1**	Difficulty in meeting DOT shipping requirements for offsite shipments Multiple handling of containers is required Waste is shipped off the Hanford Site and may be perceived as being more dangerous to stakeholders and the public	**-2** **-1** **-1**
	Totals for Option 3		**+5**		**-4**
Option 4	Send MLLW debris in drums from CWC directly to a new super-compactor near ERDF for super-compaction, then disposal and macro-encapsulation in ERDF.	Current ERDF mega-macro techniques would be used No offsite transportation required Sets up a process and infrastructure that can be used for other waste stream types Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to Stakeholders and the public	**+2** **+2** **+1** **+1**	ERDF is not set up for this work at this time Will impact schedule completion date Could make ERDF a Category 3 facility if not set up as a separate facility Major auditable safety analysis modification required Would require significant procedural groundwork to develop a new facility Need to buy compactor, set up building, get permitting, etc.	**-1** **-2** **-3** **-2** **-3** **-2**
	Totals for Option 4		**+6**		**-13**
Option 5	Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within procured high-integrity containers placed in ERDF.	Technology is easily adaptable to the ERDF Drum entry at the ERDF is not required No air permit modification required No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public	**+2** **+1** **+1** **+2** **+1**	Poorest utilization of landfill space More labor intensive Vaults would need to be recertified to ERDF burial depth and longevity requirements Auditable safety analysis needs to be modified	**-1** **-3** **-1** **-1**
	Totals for Option 5		**+7**		**-6**
Option 6	Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within designed and constructed structural vault in ERDF.	Better space allocation than using pre-formed HICs Technology is easily adaptable to the ERDF Drum entry at the ERDF is not required No air permit modification required No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public	**+1** **+2** **+1** **+1** **+2** **+1**	Vaults would need to be recertified to ERDF burial depth and longevity requirements Auditable safety analysis needs to be modified	**-1** **-1**
	Totals for Option 6		**+8**		**-2**

Table III. Advantages/Disadvantages of Each Potential Option(s) and the Base Case (3 pages)

Item	Option Description	Advantages	Points*	Disadvantages	Points*
Option 7	Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC designed and procured structural horizontal pipes placed in ERDF.	Technology is easily adaptable to the ERDF Drum entry at the ERDF is not required No air permit modification required No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public	**+2** **+1** **+1** **+2** **+1**	ERDF not set up to perform this at this time, which could impact scheduled completion date Structural design is needed in order to evaluate this option Drum handling may be difficult Auditable safety analysis needs to be modified	**-1** **-1** **-2** **-1**
	Totals for Option 7		**+7**		**-5**
Option 8	Send MLLW debris in drums from CWC directly to ERDF, then void fill drums with grout injection to meet macro-encapsulation before disposal in ERDF. (This assumes that injected drums require no further macro-encapsulation.)	Less structural stability risk for the ERDF Current ERDF mega-macro-encapsulation techniques would be used Relatively small capital costs required to start No outside transportation required Waste is not shipped off the Hanford Site and may be perceived as being less dangerous to stakeholders and the public The additional step of macro-encapsulating drums would not be needed	**+1** **+2** **+2** **+2** **+1** **+1**	Contamination levels inside drums will drive up protective requirements to workers and environment Use of NucFils will be required for all drums, not just those without vent clips Higher capacity NucFils may be needed, requiring replacement of those currently installed A two-stage grouting process would be required ERDF not equipped to handle this at this time, which could impact completion schedule Air permit needs to be modified Regulatory validity of this method would need to be determined Auditable safety analysis needs to be modified	**-2** **-2** **-2** **-2** **-1** **-1** **-2** **-1**
	Totals for Option 8		**+9**		**-13**
Option 9	Send MLLW debris in drums from CWC to PEcoS for super-compaction and macro-encapsulation before sending to ERDF for disposal.	Disposal at ERDF is immediately available with this option Fewer RadCon and safety concerns because drums would not be opened at the ERDF No air permit modification required No modifications to auditable safety analysis	**+3** **+1** **+1** **+1**	Difficulty in meeting DOT shipping requirements for offsite shipments Product is handled multiple times Waste is shipped off the Hanford Site and may be perceived as being more dangerous to stakeholders and the public	**-2** **-1** **-1**
	Totals for Option 9		**+6**		**-4**

*Points:

Levels Advantage Total:		Levels Disadvantage Total:	
	+1 = Low		-1 = Low
	+2 = Medium		-2 = Medium
	+3 = High		-3 = High

Table IV. Summary of Final Ranking Comparisons

Item	Description	Ranking Based on LCC Estimates	Ranking Based on Advantages/ Disadvantages	Composite Final Ranking
Base Case	Send drums from CWC to PecoS for compaction and macro-encapsulation, then dispose at the mixed waste trench	6	6	7
Option 1	Send MLLW debris in drums from CWC directly to ERDF, then grout inject drums at ERDF using negative pressure before disposal and macro-encapsulation in ERDF	3	5	4
Option 3	Send MLLW debris in drums/overpacks from CWC to PEcoS for super-compaction before sending to ERDF for disposal and macro-encapsulation in ERDF	4	3	2
Option 4	Send MLLW debris in drums from CWC directly to a new super-compactor near ERDF for super-compaction, then disposal and macro-encapsulation in ERDF	2	7	5
Option 5	Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within procured high-integrity containers placed in ERDF	7	4	6
Option 6	Send MLLW debris in drums from CWC directly to ERDF for disposal and macro-encapsulation within ERC-designed and constructed structural vault in ERDF	1	1	1
Option 9	Send MLLW debris in drums from CWC to PEcoS for super-compaction and macro-encapsulation before sending to ERDF for disposal	5	2	3

CONCLUSION

To capture the impact of other attributes that were used in this VE study, the team members determined and compiled rankings based on LCCs and advantages and disadvantages, and arrived at composite final rankings (shown in Table IV) for the base case and the selected options. The composite final rankings shown in Table IV provided a tool in addition to the cost when making a final recommendation.

The base case and all selected options were carefully reviewed from the perspective of least potential LCC and best composite final ranking.

In the final analysis, the team members unanimously concluded that Option 6, with the least LCC of $7,346,000 and best final ranking of No. 1, provided the best solution for treatment and disposal of MLLW retrieved from the 218-W-4C Burial Ground (see Figure 1 below).

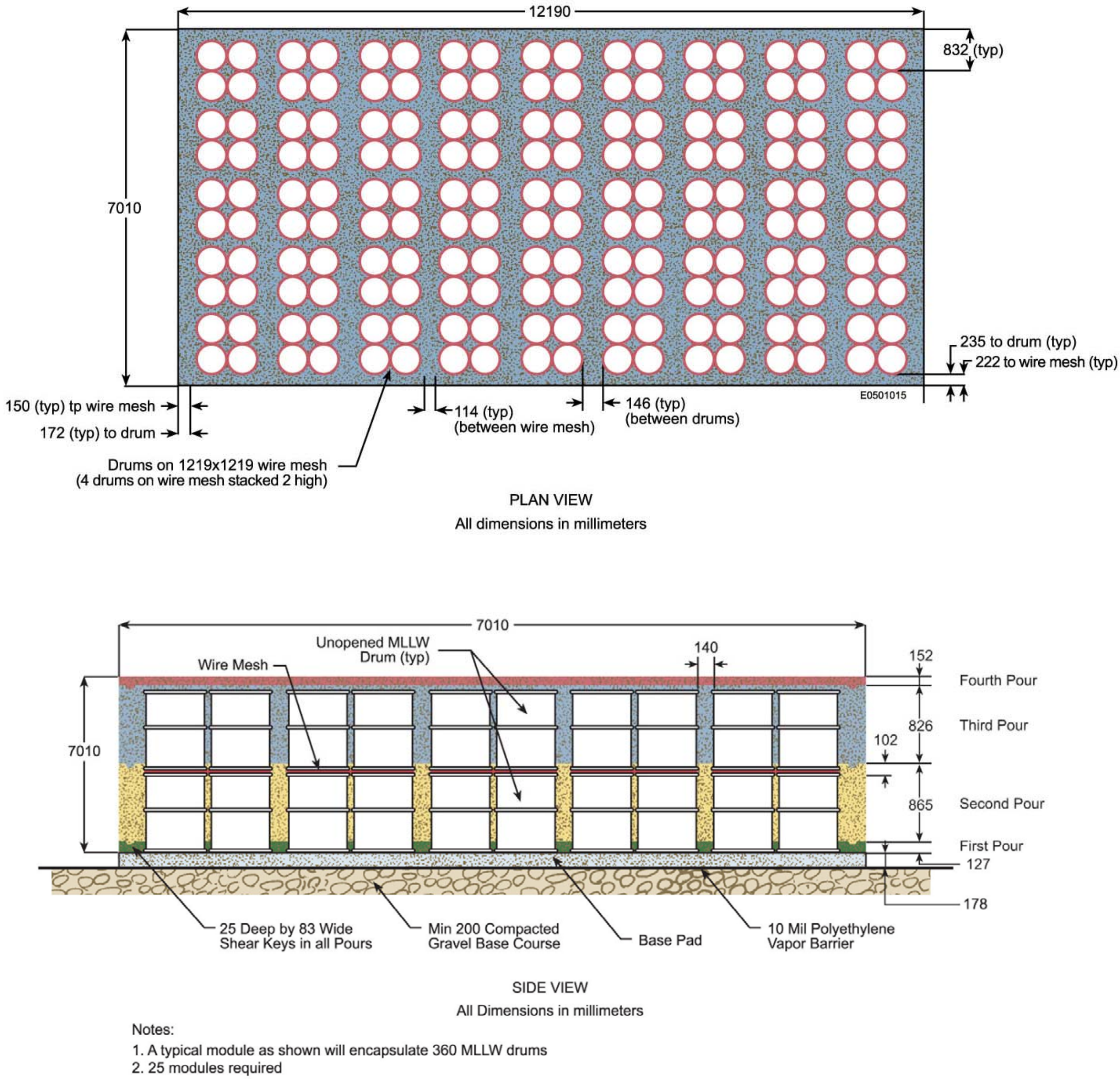

Fig. 1. Macro-encapsulation of MLLW drums in structural vault in ERDF.

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