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1	/	Cog.Eng. C. R. Eiholzer	C.R. Eiholzer	5/4/95	H0-36						
1	1	Cog. Mgr. J. S. Garfield	J S Garfield	5/12/95	H5-49						
		QA									
		Safety									
		Env.									
1	1	G. F. Williamson	[signature]	5-15-95	G6-13						
1	/	F. M. Mann	Frederick M. Mann	5/4/95	H0-36						

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Name: C. R. Eiholzer

Cheryl R Eiholzer 5/4/95

Signature

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7. Abstract

The purpose of this report is to identify and provide information on the waste package and disposal facility concepts to be used for the low-level waste tank interim performance assessment. Current concepts for the low-level waste form, canister, and the disposal facility will be used for the interim performance assessment. The concept for the waste form consists of vitrified glass cullet in a sulfur polymer cement matrix material. The waste form will be contained in a 2 x 2 x 8 meter carbon steel container.

Two disposal facility concepts will be used for the interim performance assessment. These facility concepts are based on a preliminary disposal facility concept developed for estimating costs for a disposal options configuration study. These disposal concepts are based on vault type structures.

None of the concepts given in this report have been approved by a Tank Waste Remediation Systems (TWRS) decision board. These concepts will only be used in the interim performance assessment. Future performance assessments will be based on approved designs.

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DISPOSAL FACILITY DATA FOR THE INTERIM PERFORMANCE ASSESSMENT

1.0 SUMMARY

Current concepts for the low-level waste form, canister, and the disposal facility will be used for the interim performance assessment. The concept for the waste form consists of vitrified glass cullet in a sulfur polymer cement matrix material. The waste form will be contained in a 2 x 2 x 8 meter carbon steel container.

Two disposal facility concepts will be used for the interim performance assessment. These facility concepts are based on a preliminary disposal facility concept developed for estimating costs for a disposal options configuration study (Mitchell 1995a). These disposal concepts are based on vault type structures.

None of the concepts given in this report have been approved by a Tank Waste Remediation Systems (TWRS) decision board. These concepts will only be used in the interim performance assessment. Future performance assessments will be based on approved designs.

2.0 INTRODUCTION

Following the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement)(Ecology 1994), the U.S. Department of Energy (DOE) and Westinghouse Hanford Company (WHC) are proceeding with engineering work supporting the eventual disposal of nuclear waste presently stored in large underground tanks. The Tri-Party Agreement states that the low-level waste component of the stored waste shall be vitrified. Current plans are to dispose the low-level vitrified waste in a near-surface low-level waste disposal facility on the Hanford Site.

DOE Order 5820.2A (DOE 1988) gives the requirements for the disposal of radioactive waste on a DOE site. One requirement is to develop and maintain a site-specific performance assessment of the disposal facility. The performance assessment needs to provide reasonable assurance that public health and environmental resources will be protected consistent with local, state, and federal environmental regulations.

The development of the Hanford low-level tank waste disposal facility performance assessment has three phases. First is the interim performance assessment which is not part of the DOE performance assessment process as outlined in DOE 1988. The purpose of the interim performance assessment is to show before any facility construction that there will be a high likelihood that the final performance assessment will be approved. The interim performance assessment will show the approaches that will be taken on the next phases of the Hanford low-level tank waste performance assessment. All data preliminary performance assessment that is required by the DOE order. The draft revision of the DOE order (DOE 1994) requires that the local DOE field office approves the preliminary performance assessment before construction starts on the disposal facility. The third phase is the final performance assessment which must be approved by DOE Headquarters before the disposal facility operates.

The purpose of this report is to identify and provide information on the waste package and disposal facility concepts to be used for the low-level waste tank interim performance assessment. This report contains the waste package and disposal facility data to be used for the low-level tank waste interim performance assessment. These data are based on the leading concepts for the waste package and the disposal facility as chosen by the TWRS Process Design group in Disposal Engineering. There are data for two disposal facility concepts, one of which is a variation of the leading disposal facility concept. The variation was suggested by members of the performance assessment team with concurrence from the TWRS Process Design group. The waste package and each facility concept will be briefly described.

These concepts will be changing as more becomes known about the disposal system and as decision boards choose a preferred waste package and disposal facility. There is a program planning activity in place for using a decision analysis process for defining the reference disposal system. A decision is planned to be made by September 30, 1995. Thus, this report will be updated, as necessary.

3.0 LOW-LEVEL WASTE PACKAGE

This section discusses the leading concept for the low-level waste (LLW) package. The TWRS decision board for the low-level waste program has not selected a reference waste package yet. Within TWRS Engineering, the various shapes of the glass component of the waste package are being discussed. The two most notable shapes are cullet and monolith. However, until decisions are made on a LLW package, the interim performance assessment will use the leading waste package concept as identified by the TWRS Process Design group.

The waste package consists of the waste form and the waste canister. Currently, the suggested waste form is glass cullet in sulfur polymer cement. The suggested canister is a 2 x 2 x 8 meter carbon steel canister. The following subsections give the known details on the waste form components and waste canister. Most of the data in the following subsections are from (Mitchell 1995a).

3.1 WASTE FORM

The leading candidate for the waste form is glass cullet surrounded by sulfur polymer cement. The glass cullet is the vitrified LLW component of the tank farm waste. Molten glass, made from the LLW and glass formers, is introduced to a stream of chilled water that quickly fractures and quenches the glass into pieces of vitrified glass cullet (Mitchell 1995a). The glass cullet will have fractured surfaces and there will be a size distribution. The cullet will be dried before packaging. (Mitchell 1995a) gives more details on making cullet and why it is recommended for the vitrified waste form.

The size of the glass cullet must be assumed for the interim performance assessment. The actual cullet size and size distribution will be determined after a reference melter is selected. For the interim performance assessment, the cullet will be considered spherical with a 0.5 cm radius (Eiholzer 1995). There will not be a size distribution.

Sulfur polymer cement (SPC) was chosen as part of the waste form (matrix material) due to the good physical properties and the possibility that SPC could be a good chemical barrier. SPC is a mixture of ~95 wt% sulfur with 5 wt% chemical modifiers (Sullivan 1986). Good quality SPC has good compressive strength and extremely low water conductivity. The sulfur in the SPC will probably chemically react with technetium released from the glass corrosion process. Thus, SPC would be a chemical barrier.

For the interim performance assessment, SPC will be part of the waste form. The amount of SPC in each canister is discussed in the next section. The SPC will be considered highly fractured. This assumption is based on a private conversation with Fluor Daniel representatives who stated that the canister filling process is conducive to SPC fracturing.

3.2 LLW CANISTER

The leading LLW canister for a glass cullet/SPC waste form is a large carbon steel canister. Figure 1 shows a drawing of the canister. The overall dimensions of the canister are 2 x 2 x 8 meters. The carbon steel sheets are 8 mm thick except the bottom sheet that is 15 mm thick. Sixteen horizontal and four vertical hollow tubes are part of the internal structure. These tubes are welded to the box to provide structural support and to increase the total surface area of the canister for cooling operations. The outside diameters of the smaller horizontal tubes and the larger vertical tubes are 50 mm and 200 mm, respectively. The internal diameters are not given. The canister has two lids--an internal lid to seal the container and an external lid to bear the external load.

Filling the canister is a multi-step process that is summarized here. First the glass, SPC, and canister are preheated to 160 °C, 140 °C, and 135 °C, respectively. The glass and the SPC are stored in bins, two for each material. After the canister is prepared for filling, one bin of SPC is emptied into the canister. Then the cullet from the two bins is put in the canister. A pneumatic blow out device is used to flatten the cone of cullet that develops during filling. Then the second bin of SPC is emptied into the container. During filling, an air removal system coupled to the filling head removes the displaced air from the canister. After the canister is filled, the lids are sealed and the canister is moved to a cooling pond. After cooling in the pond, the canister is allowed to dry before being taken to the disposal area. (Mitchell 1995a) gives a complete description of the canister filling, cooling, and transporting processes.

The canister is filled to 95% of capacity. There is a 5% void at the top of the canister due to the filling process and the canister design (Mitchell 1995a). The filled portion of the canister consists of a sulfur polymer concrete that is 70% glass cullet and 30% SPC by volume.

For the interim performance assessment, the number of canisters is assumed to be 6,804. The exact number of canisters that will be made is not known now and will be determined after several decisions about the LLW production process are made. The assumed number is based on the number of canisters that the disposal facility described in Section 4.1 can hold (Mitchell 1995a). Each disposal facility concept discussed in this report will hold 6,804 canisters.

Table 1 summarizes the data on the waste form and canister to be used for the interim performance assessment.

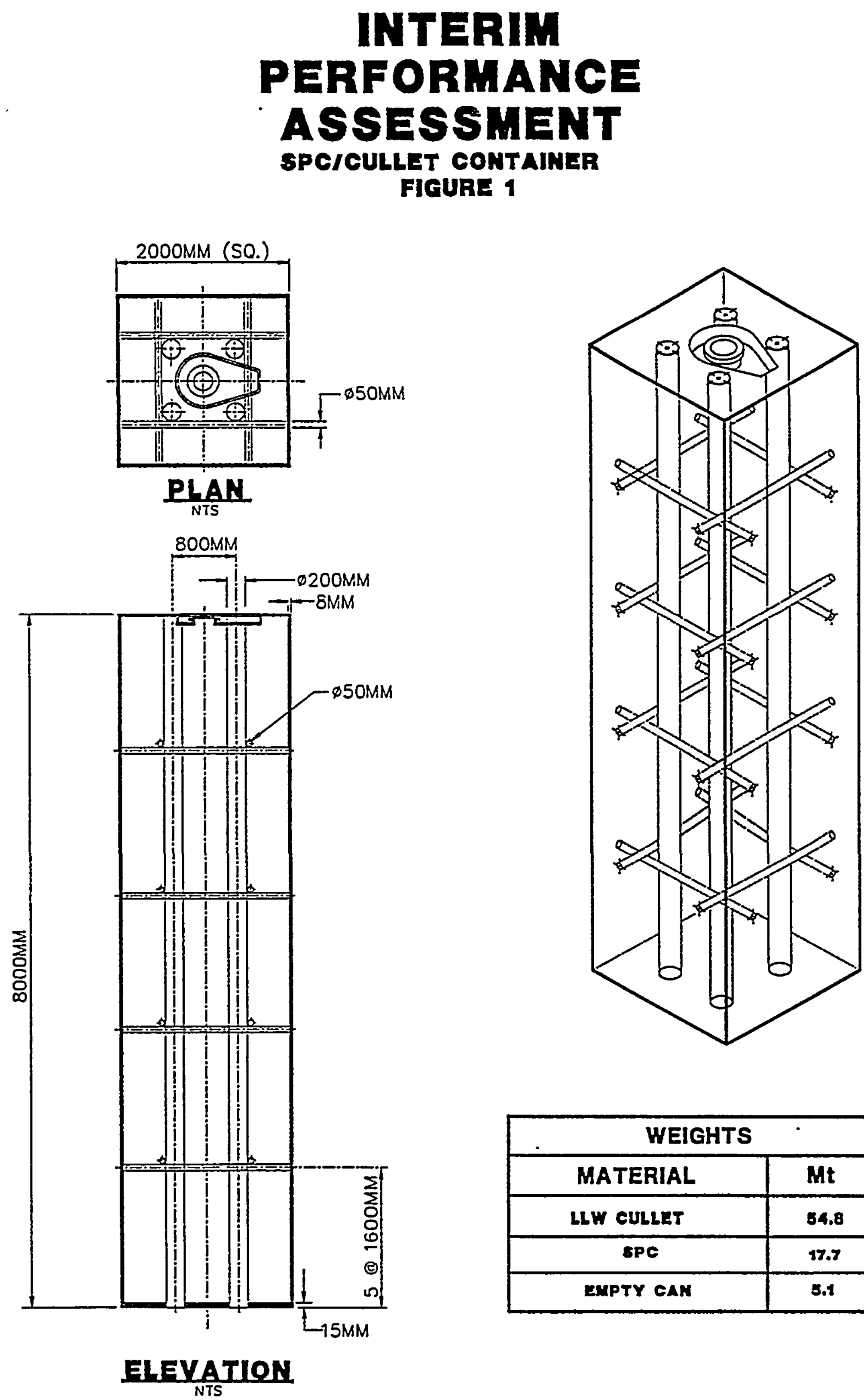
4.0 DISPOSAL FACILITY CONCEPTS

Two disposal facility concepts have been developed for the interim performance assessment. The first disposal facility concept is based on the vault concept developed by Fluor Daniel for a waste package containing glass cullet in SPC (Mitchell 1995a). This vault concept is the leading disposal concept for the TWRS Process Design group (Mitchell 1995b). The other disposal facility concept is a variation of the first concept. The variation was suggested by performance assessment members and with concurrence from the TWRS Process Design group. Both facility concepts include a surface barrier and a moisture diverter to help minimize the amount of moisture that enters the vault. The facility concepts contain a water conditioning layer to add silica to the water. The added silica may help decrease the corrosion process. Each concept also includes soil for long-term structural support to prevent subsidence of the facility. The soil also wicks water away from the waste packages. The following subsections discuss the disposal concepts, the surface barrier, the moisture diverter, the water conditioning layer, and the soil.

4.1 DISPOSAL FACILITY CONCEPT 1

The first disposal concept consists of a concrete vault containing 42 bays for filled waste canisters, a surface barrier, a moisture diverter,

Figure 1. Reference Container Concept for SPC/Cullet Waste Form.



WEIGHTS	
MATERIAL	Mt
LLW CULLET	54.8
SPC	17.7
EMPTY CAN	5.1

D0240101

Table 1. Waste Form and Canister Data for the Interim Performance Assessment.

Waste Form: Glass Cullet/Sulfur Polymer Cement

Glass Cullet Data:
size: 1 cm diameter spheres (radius = 0.5 cm)
size distribution: assume all are spheres.
glass type: to be determined by technology development.
glass corrosion rate: to be determined by glass testing and modeling.

Sulfur Polymer Cement (SPC) Data:
water conductivity: assume SPC will be highly fractured.
chemical barrier performance: to be determined, experiments in progress.

Canister data:
material: carbon steel
shape: rectangular prism
over all size: 2 x 2 x 8 meters.
top and side plate thickness: 8 mm
bottom plate thickness: 15 mm
structure/cooling tubes: 16 - about 2 meters x 50 mm OD (see Figure 1).
4 - about 8 meters x 200 mm OD (see Figure 1).
number of canisters: 6,804

Canister fill data:
Void space: Top 5%
Filled space contents: 70% glass cullet, 30% SPC by volume.

a water conditioning layer, and filler soil. Figure 2 shows the the vault concept. Figure 3 shows a cross-section of the disposal facility. The remainder of this section will focus on the vault. Sections 4.3.1, 4.3.2, 4.3.3, and 4.3.4 discuss the surface barrier, the moisture diverter, the water conditioning layer, and the filler soil, respectively.

The vault is made from reinforced Portland concrete. The amount and type of reinforcement (rebar or welded-wire fabric) have not been determined as yet[1]. The bottom pad is 146.5 x 246 x 0.76 meters. The pad is not sloped. The top of the vault has the same dimensions as the bottom pad. The outer walls are 2 meters thick and 9 meters tall. The interior walls, which define the bays, are 1 meter thick and 9 meters tall. The interior walls, which define the bays, are 1 meter thick and 9 meters tall. The inside length and width of each bay are 38 and 19.5 meters, respectively. There is a 3 meter opening into each bay.

The canisters are brought into the vault and moved within the vault remotely. A cart on a track brings a canister into the vault from the process facility. The vault crane is used to remove the canister from the cart and place the canister in the bay. The width of the cart area is 8 meters and runs through the center of the vault. The rails and crane system will remain in the facility after it closes. The rails and the crane system are probably made from carbon steel. The amount of carbon steel has not been determined.

The canisters are placed in an array within each bay. The canisters are placed approximately 10 cm apart from each other, 35 cm from the 38-meter wall, and 15 cm from the 19.5-meter wall. Figure 4 shows a plan view of canisters packed in a corner of an interior bay. Each bay is packed the same and holds 162 canisters. The spacing was based on the packing given in (Mitchell 1995a) for another vault concept for canisters containing the glass cullet/SPC waste form. The spaces between the canisters and the void area above the canisters will be filled with soil. Table 2 summarizes the data for disposal facility Concept 1.

4.2 DISPOSAL FACILITY CONCEPT 2

The second waste disposal concept is based on the first concept described in Section 4.1. Concept 2 is different from Concept 1 in three ways.

First, the distance between the canisters and the canisters and the walls was increased to incorporate more soil. The additional soil was added to provide a larger wicking medium to wick moisture away from the waste packages and to provide stronger soil columns to prevent subsidence. Approximately, 35 cm of soil is between the canisters, 53 cm of soil separates the canisters from the 38 meter wall, and 35 cm of soil separates the canisters from the 19.5 meter wall. Figure 4 shows a plan view of some canisters packed in a corner of an interior bay. Each bay is packed the same and holds

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[1]Details of the waste form (cullet distribution) and of the facility concepts have not been determined since designs are in the preconceptual phase. As designs progress, more details will be provided. However, these details will probably not be available for the interim performance assessment.

128 canisters. The additional distance increases the facility size. The new facility size is discussed in a following paragraph.

The second difference between Concept 1 and Concept 2 is that every other row in Concept 2 is filled with soil (Figure 5). This change was done to reduce the width of the moisture diverter. Very wide moisture diverters may not be possible or may have a limited life as compared to smaller moisture diverters. The continuous moisture diverter in Concept 1 will be replaced with small moisture diverters in Concept 2. Each row containing canisters will have a moisture diverter that will drain into the middle of the adjacent row containing soil or to the side of the facility (Figure 6). The moisture diverters will have about a 5° angle with the horizon. A water conditioning layer will be only under each moisture diverter.

The additional rows of soil and distance between canisters will produce a few changes to the disposal facility. The general size of the facility is increased by 10 rows (Figure 5) to dispose 6,804 canisters. All the walls that define the rows will be 2 meters thick since these walls will support soil on one side. The rows with soil do not have bays. Only the rows with canisters have the concrete top.

The third difference between Concepts 1 and 2 is the bottom pad. For Concept 2, the bottom pad is multi-sloped for the length of the facility. The bottom pad will peak in the center of each row containing canisters and will slope 2% to the center of the adjacent row that contains soil or to the outer parameter wall (Figure 6). The reason for the multi-sloped bottom pad was to provide drainage to the vault and to drain to the nearest section of soil. Soil is place on the pad to provide a flat surface for the canisters.

The rest of the structural components and the surface barrier will be the same as the first waste disposal concept. Table 3 summarizes the data for disposal facility Concept 2.

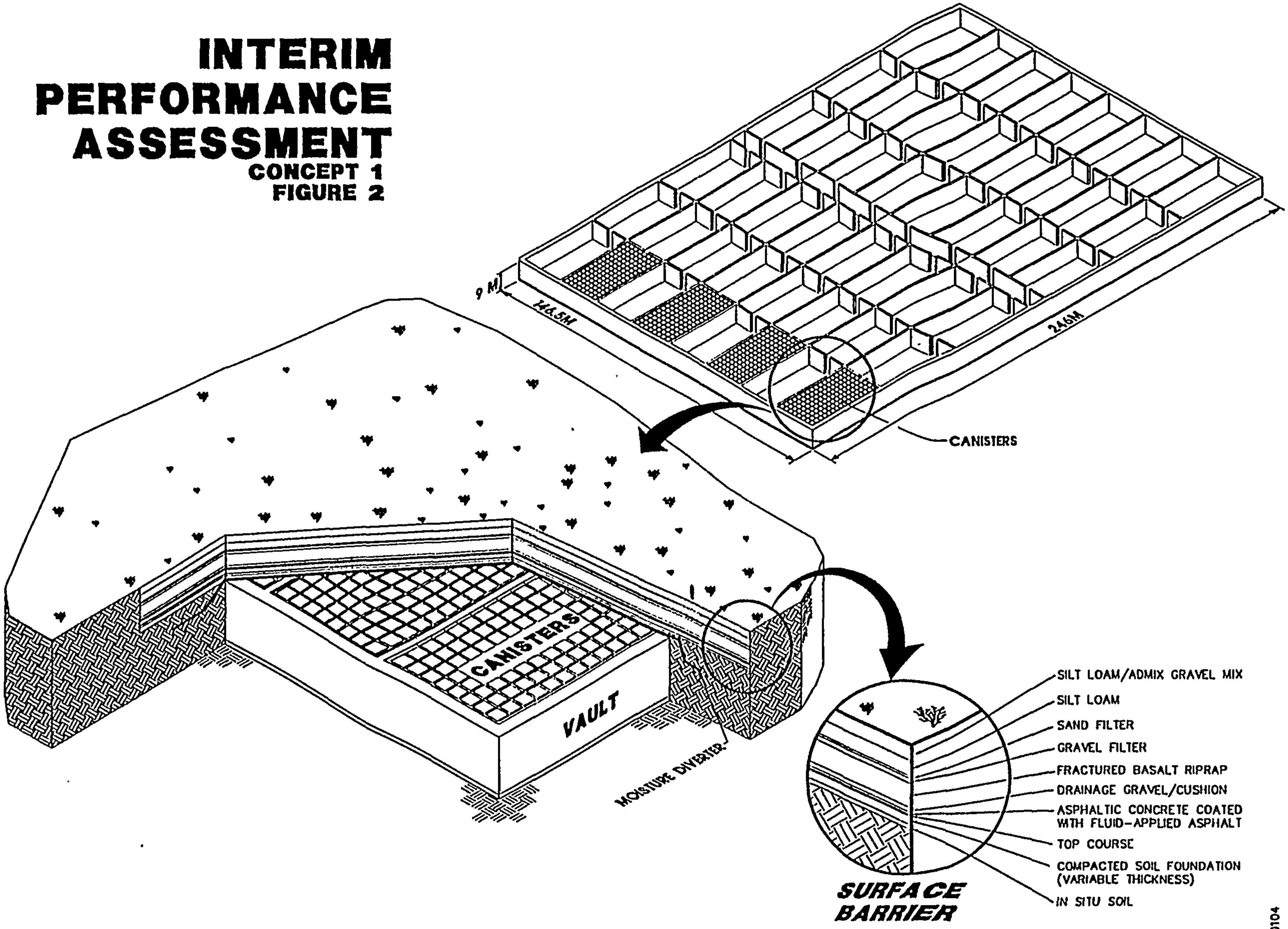

Figure 2. Interim Performance Assessment Disposal Concept 1.

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Figure 3. Interim Performance Assessment Disposal Concept 1 - Cross Sectional View of Width of Disposal Facility.

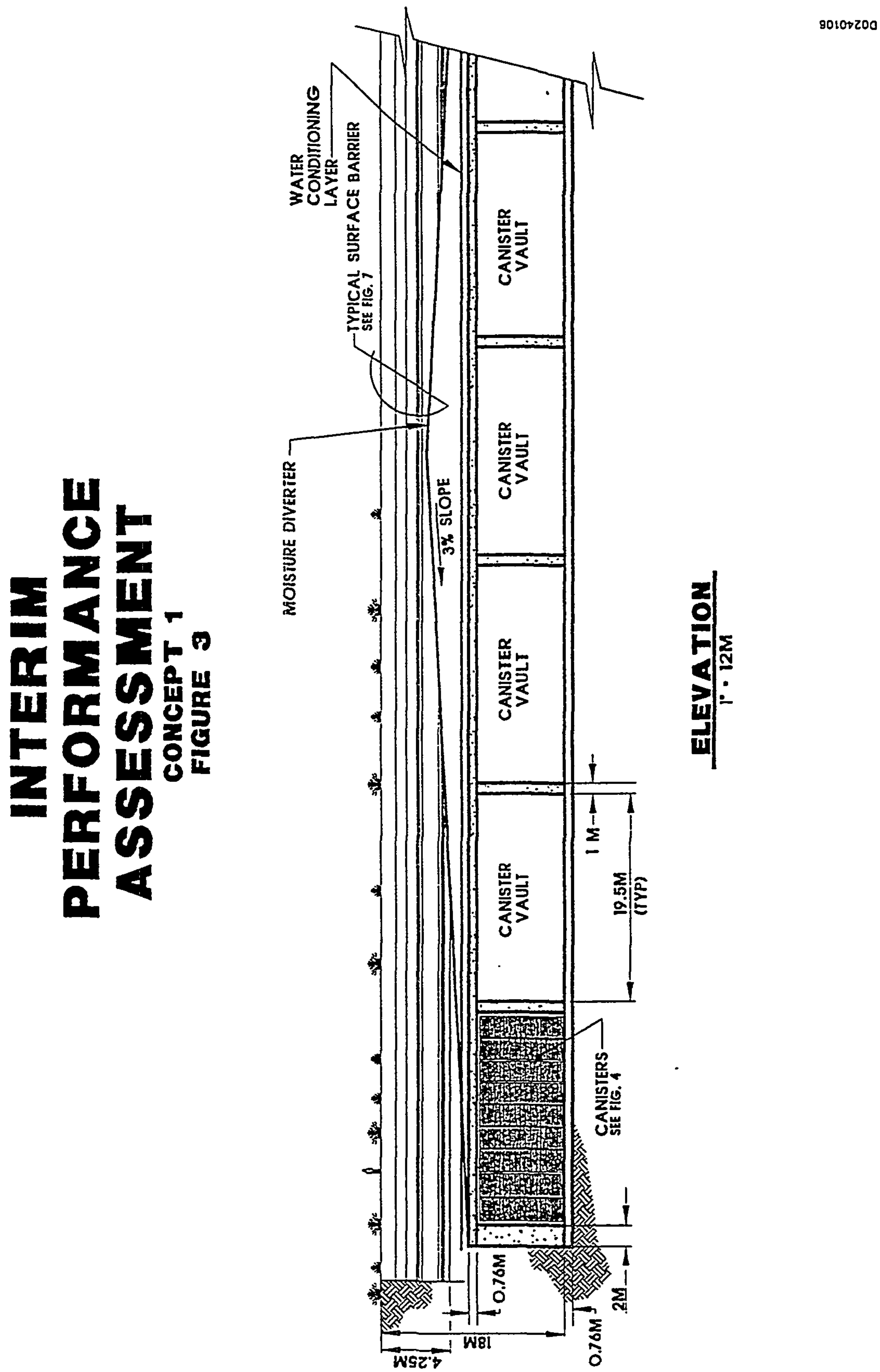


Figure 4. Interim Performance Assessment Disposal Concepts 1 and 2 - Canister Packing in a Bay.

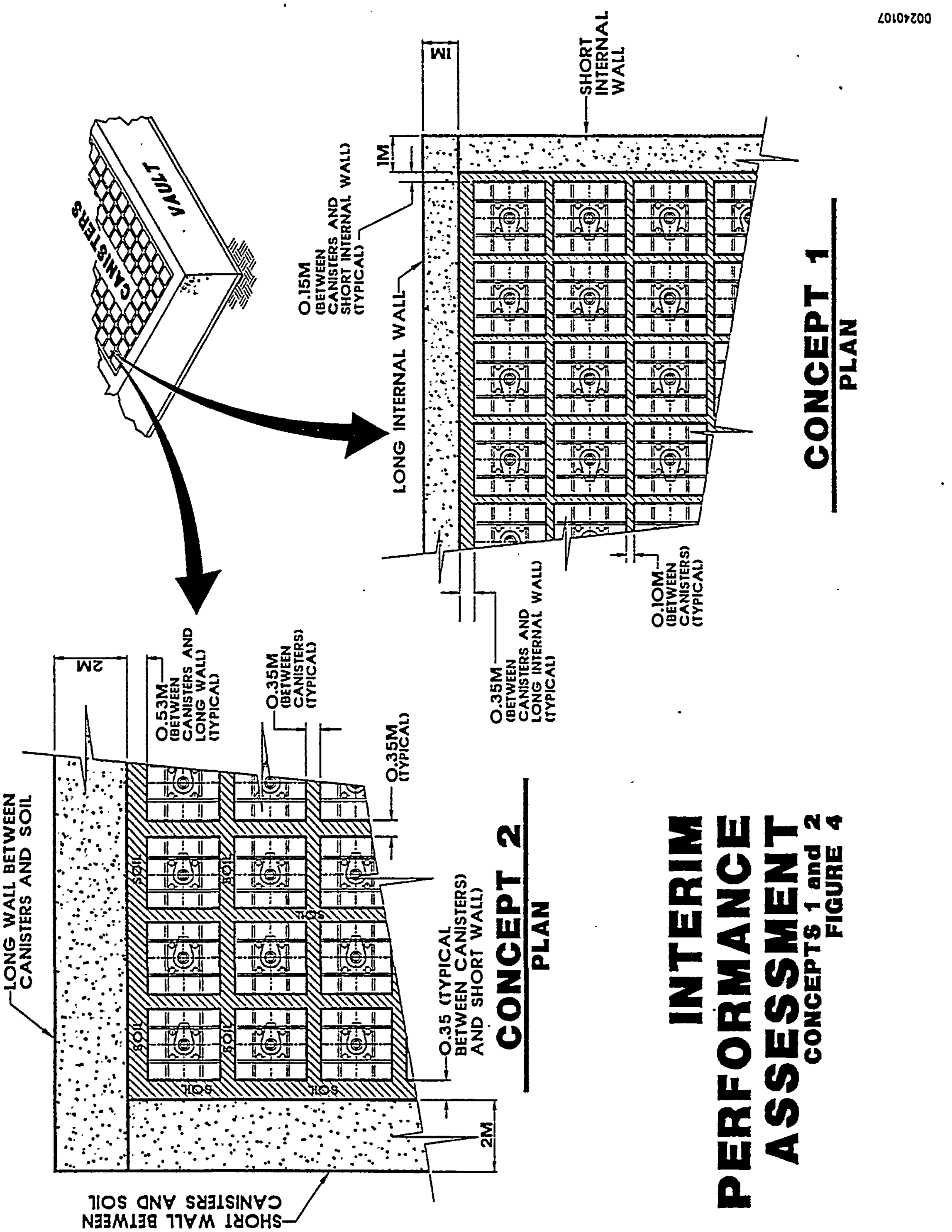


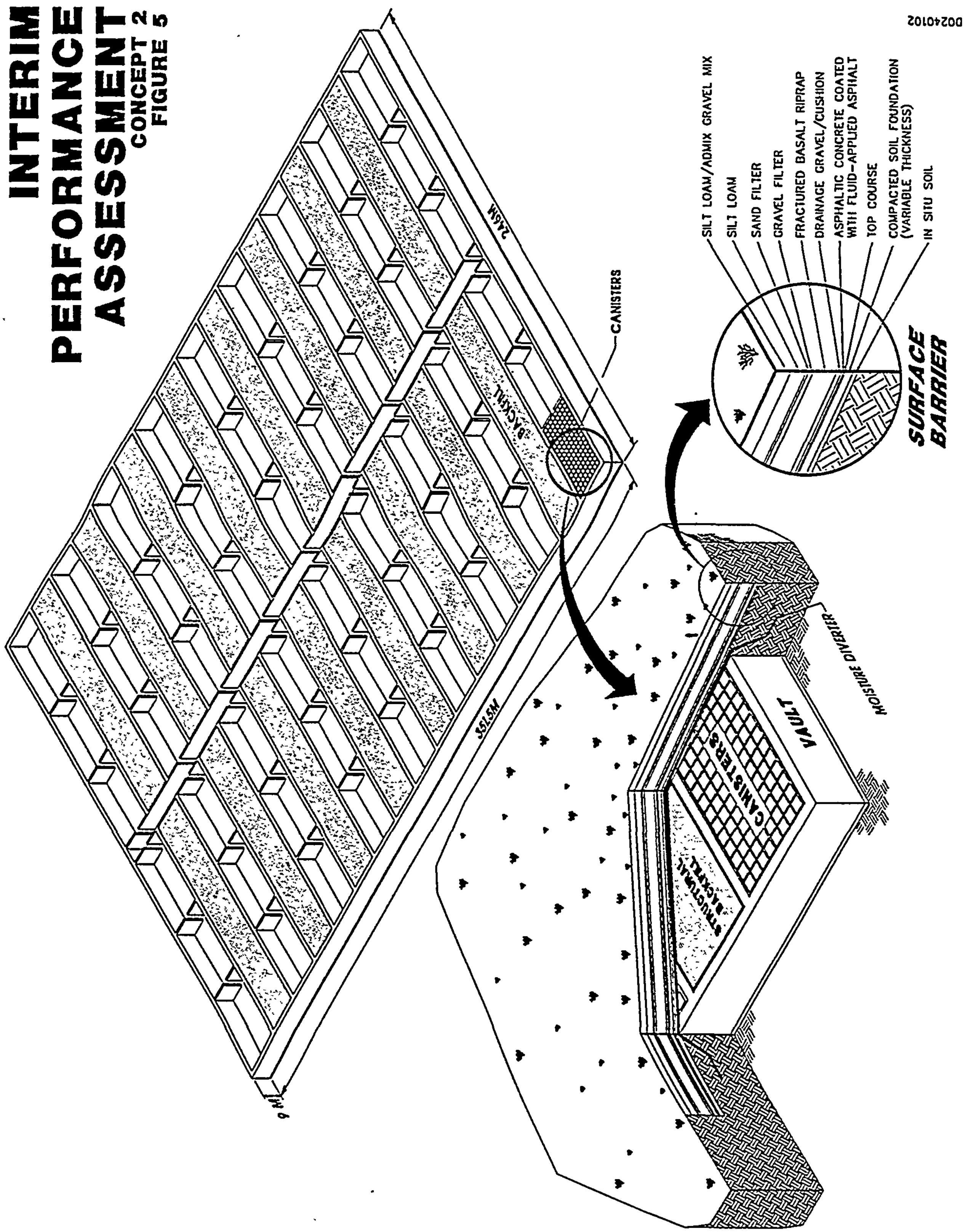
Table 2. Data Summary for Interim Performance Assessment Disposal Facility Concept 1.

Concrete Structures
- Concrete:
  - Reinforced portland concrete. Reinforcement type and size to be determine during detail design development.
- Bottom Pad:
  - 146.5 x 246 x 0.76 meters, no slope. Top of pad 18 meter from top of grade.
- Vault Top:
  - 146.5 x 246 x 0.76 meters, no slope.
- Outer walls: 9 meters tall x 2 meters thick.
- Internal walls: 9 meters tall x 1 meter thick.
- Reference figures: Figures 2 and 3.

Disposal Bays
- Number of bays: 42
- Bay matrix: 7 row x 6 columns (see Figure 2).
- Bay interior floor size: 38 x 19.5 meters.
- Number of canisters per bay: 162
- Spacing between canisters: 10 cm.
- Spacing between canisters and long (38 meter) wall: 35 cm.
- Spacing between canisters and short (19.5 meter) wall: 15 cm.
- Spacing filler: Soil (All void spaces in vault will be filled before closure.)
- Spacing reference figure: Figure 4

Barriers
- Surface barrier:
  - Hanford type. Minimum depth is 4.25 meters. Extends to moisture diverter.
- Moisture diverter:
  - Over entire facility. 3% slope. Peak over and parallel to center row of bays.
- Water conditioning layer: Between moisture diverter and concrete top. Covers entire facility. Thickness to be determined.
- Reference figure: Figure 3

Figure 5. Interim Performance Assessment Disposal Concept 2.



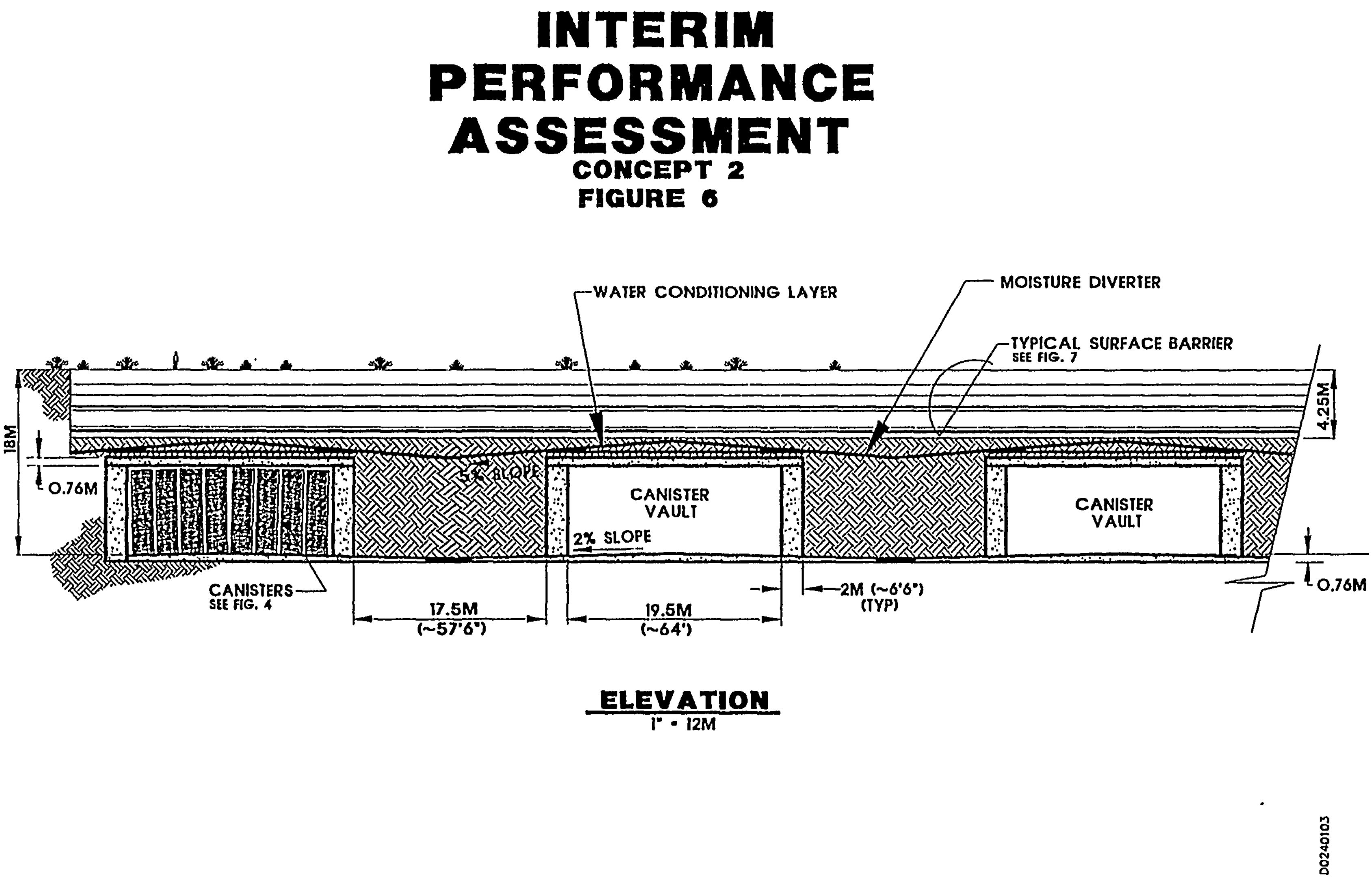


Figure 6. Interim Performance Assessment Disposal Concept 2 - Cross Sectional View of Width of Disposal Facility.

Table 3. Data Summary for Interim Performance Assessment Disposal Facility Concept 2.

Concrete Structures
- Concrete:
  - Reinforced Portland concrete. Reinforcement type and size to be determined by detailed design process.
- Bottom Pad:
  Overall pad width and length: 246 x 351.5 meters. For each row with canisters there is a bottom pad. Sloped 2% from center of the row to the center of the row with soil or to the outside wall. Soil is placed on top of pad to give even bottom pad for canisters. The distance from the top of the thickest part (0.76 m) of pad to the top of grade is 18 meters.
- Vault Top:
  - Only the rows with canisters have a top. These tops are 38 x 246 x 0.76 meters, no slope.
- Outer walls: Walls that separate canisters from soil. About 9 meter tall x 2 meter thick. Height is adjusted for sloping bottom pad. Minimum height is 9 meter at maximum thickness of bottom pad.
- Internal walls: About 9 meter tall and 1 meter thick. Height is adjusted for sloping bottom pad. Minimum height is 9 meter at maximum thickness of bottom pad.
- Reference figures: Figures 5 and 6.

Disposal Bays
- Number of bays: 54 which are used for canisters.
- Bay matrix: 179 rows x 6 columns with a row of soil between each row containing canisters. (Figure 7).
- Bay interior floor size: Canister bays are 38 x 19.5 meters. Rows of soil are 246 x 17.5 meters.
- Number of canisters per useable bay: 128.
- Spacing between canisters: 35 cm.
- Spacing between canisters and long (38 meter) wall: 53 cm.
- Spacing between canisters and short (19.5 meter) wall: 35 cm.
- Spacing filler: soil. (All void spces in the vault will befilled before closure.)
- Spacing reference figure: Figure 4.

Barriers
- Surface barrier:
  - Hanford type. Minimum depth is 4.25 meters. Extends to moisture diverter and over entire facility.
- Moisture diverter: 9 moisture diverters, each over a row containing canisters. Each diverter centers over the row. Each diverter has a 5% slope from the peak to the top center of the soil bay.
- Water conditioning layer: Between moisture diverter and concrete top. Thickness to be determined.
- Reference figure: Figure 6

4.3 ENGINEERED BARRIERS AND SOIL

The surface barrier, moisture diverter, water conditioning layer, and backfill soil act on moisture going to or in the vault. Moisture is required for the glass corrosion process which will release radioactive components from the glass and for transporting the corrosion products to the ground water. Reducing the amount of moisture that reaches the waste form will reduce the release from the vault.

The two disposal concepts incorporate mechanisms to prevent or control water approaching the waste form. The two concepts include a surface barrier and a moisture diverter to prevent moisture from entering the vault. Each concept includes a water conditioning layer to modify the water chemistry of the water entering the vault. The concepts also use soil to fill void space to prevent subsidence that could break barriers and allow more moisture to enter the vault. Soil is also used as a medium to wick water away from the waste forms. The following subsections discuss each method of moisture control.

4.3.1 Surface Barrier

The intent of a surface barrier is to use evaporation and plant transpiration to minimize the effect of precipitation on the disposal system. The surface barrier envision for the interim performance assessment disposal facility concepts is based on the Hanford barrier (Myers and Duranceau 1994). Figure 7 shows an example Hanford barrier. For the interim performance assessment disposal facility concepts, a Hanford type barrier will be in the area from the grade level to the moisture diverter.

4.3.2 Moisture Diverter

The moisture diverter is another defense for minimizing the amount of moisture that enters the vault. The materials of the moisture diverter are selected for diverting any moisture coming through the surface barrier to the outside of the concrete outer walls (Concept 1) or to the rows of soil (Concept 2). The diverter consists of a sand on top and a gravel capillary break on bottom. The center of the diverter is peaked. The slope and position of the diverter for each concept are given in the appropriate disposal concept section.

4.3.3 Water Conditioning Layer

The purpose of the water conditioning layer is to increase the silica content of the moisture that penetrates through the surface barrier and moisture diverter. Moisture entering the vault will be the mechanism for glass corrosion. During the glass corrosion process for a silica glass, silica from the glass goes in to the water until the water is saturated with silica. The more glass silica that transports to the water, the more the glass structure is broken down. Then there is a higher potential for releasing radioactive products. Less silica from the glass should go into water conditioned with silica. Then the corrosion process would be slowed.

For the interim performance assessment, a water conditioning layer will be underneath the gravel section of the moisture diverter and above the vault. The water conditioning layer will consist of silica (sand). The depth of the layer has not been determined.

4.3.4 Fill Soil

The primary purpose of the soil is for structural support after components of the system (e.g. waste package and concrete structures) degrade. Performance assessment analyses evaluate the disposal system for thousands of years. During that period, the components of the system will fail or become non-existent. (The Nuclear Regulatory Commission only allows performance assessments to take credit for concrete structures for 500 years.) If the vault design has void space, then the failing components like the top of the vault will fall in to the voids. This would cause the soil and fabricated features above the failed component to subside. Subsidence will cause fabricated features, such as the moisture diverter, to break and fail prematurely. More moisture will reach the waste form. The soil in the vault designs prevents such subsidence.

Another important purpose of soil is to wick moisture away from the canisters thus away from the waste form. The soil should have the ability to conduct moisture through the vault.

The soil also provides radiation shielding. The rows of soil in Concept 2 can reduce exposure for constructions workers who are working in the next row of bays for the canisters. The current plan for constructing a LLW disposal facility is to build sections at a time and not the full facility at once. The workers will benefit from the extra shielding if only a few rows at a time are built.

For the interim performance assessment, it is assumed that the soil between the canisters is sieved for large rocks and that the soil is packed. The fill soil used for the rows in Concept 2 does not have a rock size restriction. However, the soil used for both concepts must wick well.

5.0 DISPOSAL FACILITY LOCATION

A tentative site for the TWRS Site Complex, which contains the low-level tank waste (LLTW) disposal facility, is in the 200 East Area. The site is north of Route 4 South and between Baltimore Avenue and the PUREX Plant (WHC 1995). Figure 8 shows the location of the TWRS Site Complex. The area labeled "LLW Vaults" is the proposed location for the LLTW disposal facility. If later analyses show that the disposal facility should be larger than shown, then the area south of the proposed disposal site can be used (Leach 1995).

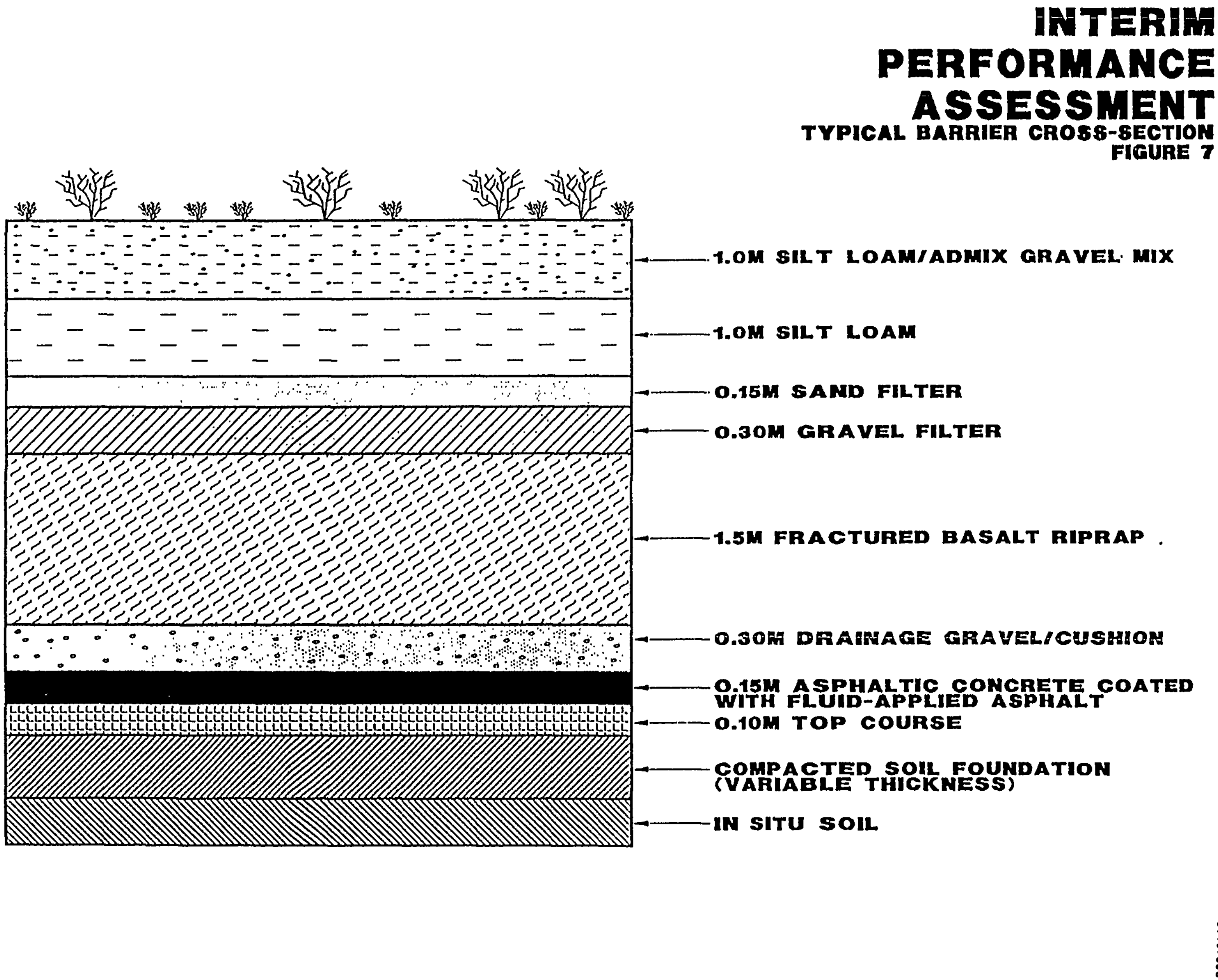
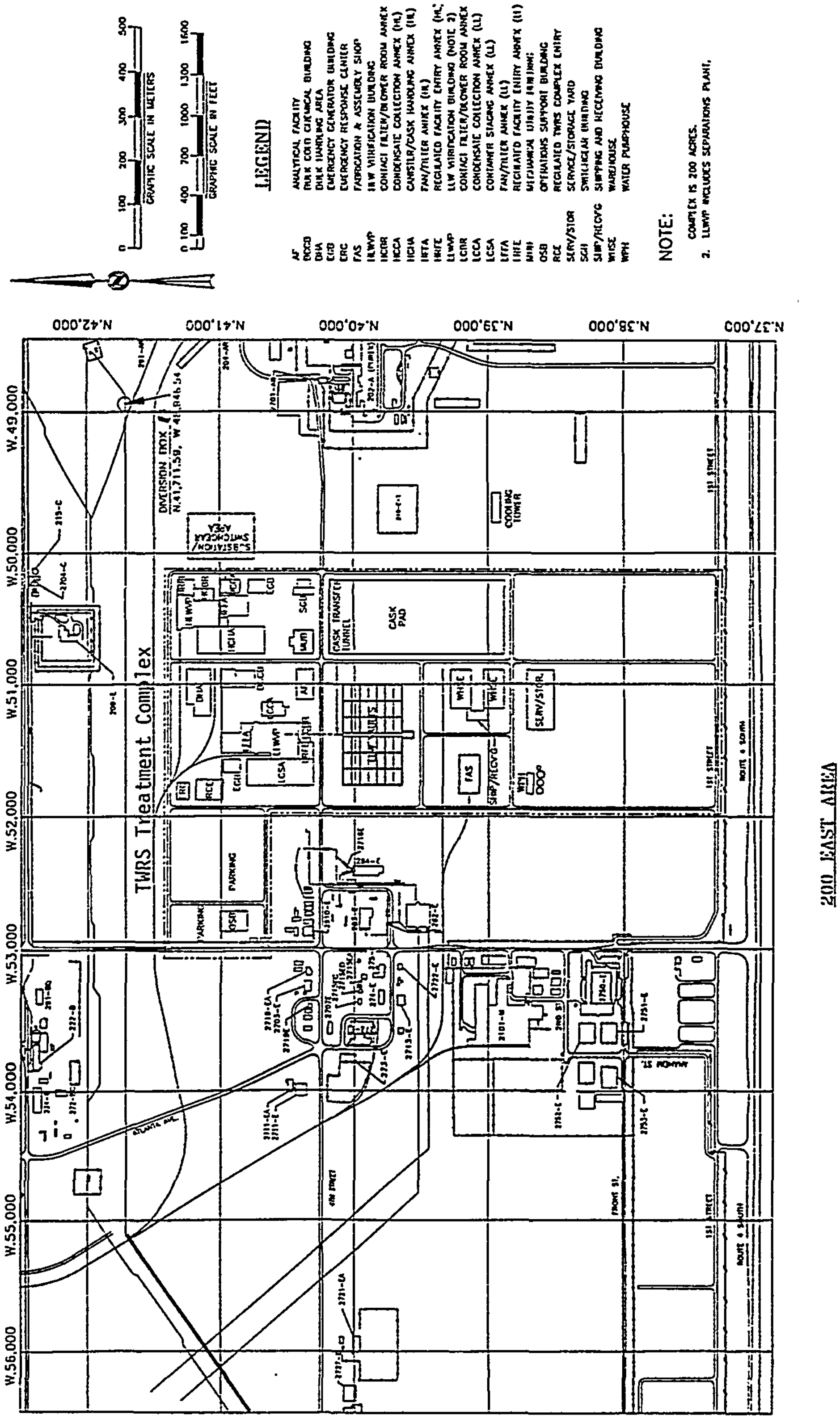


Figure 7. Example Hanford Barrier.

Figure 8. Location of the TWRS Treatment Complex.



For the interim performance assessment, both disposal facility concepts will be at the LLW Vault location shown in Figure 8. Figure 8 already shows disposal facility Concept 1. The additional rows needed for Concept 2 will be added to the south end of the facility.

6.0 REFERENCES

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DOE, 1988, *Radioactive Waste Management*, DOE Order 5820.2A, U.S. Department of Energy, Washington, D.C.

Ecology, EPA, and DOE 1994, *Hanford Federal Facility Agreement and Consent Order*, Tri-Party Agreement, WLN90-299779, Washington State Department of Ecology, U.S. Environmental Protection Agency, and U.S. Department of Energy, Olympia, Washington.

Eiholzer, C. R., 1995, *Monthly Status - Important Parameters in Performance Assessment* (internal letter OM621-95-CRE-005 to J. S. Garfield, March 1), Westinghouse Hanford Company, Richland, Washington.

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Mitchell, D. E., 1995a, *Immobilized Low-Level Waste Disposal Options Configuration Study*, WHC-SD-WM-TI-686, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

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Myers, D. R., and D. A. Duranceau, 1994, *Prototype Hanford Surface Barrier: Design Bases Document*, BHI-0007, Bechtel Hanford Company, Richland, Washington.

Sullivan, T. A., 1986, *Corrosion-Resistant Sulfur Concrete*, The Sulfur Institute.

WHC, 1995, *Facility Design Philosophy: TWRS Process Support and Infrastructure Definition*, WHC-SD-W378-ES-002, Rev 00), Westinghouse Hanford Company, Richland, Washington.

APPENDIX A. INTERNAL MEMOS AND NOTES.

Westinghouse Hanford Company **Internal Memo**

From: Risk Assessment and Environmental Modeling 0M621-95-CRE-005
Phone: 373-9659 H0-36
Date: March 1, 1995
Subject: MONTHLY STATUS - IMPORTANT PARAMETERS IN PERFORMANCE ASSESSMENT

To: J. S. Garfield H5-49

cc: F. M. Mann H0-36
J. A. Swenson H5-49
G. F. Williamson G6-13
CRE File/LB

Reference: J. A. Rawlins et. al., "Impacts of Disposal System Design Options on Low-Level Glass Waste Disposal System Performance," Staff Working Draft.

The attached table summarizes the important parameters for the low-level waste disposal performance assessment (PA). The table contains two parts -- design dependent parameters and design independent parameters--which were updated at the February 3, 1995, meeting. This table can aid in deciding what design features should be incorporated in the low-level waste disposal facility in order to meet the required drinking water scenario (reference).

Based on the calculations in the referenced document, a 1 ppm/year release rate from the near-field would give the drinking water dose limit of 4 mrem/year. The release rate, as currently estimated, from the waste glass alone would exceed the drinking water dose limit. However, there is a high probability that the near-field will have the target release rate of 1 ppm/year or less if the design includes a combination of design features. The most promising features are discussed below.

Moisture diverter (design dependent parameter 2c). By incorporating a gravel moisture diverter, the drinking water dose could decrease by a factor ranging from 2 to 100 (reference). The second white paper, due August 30, 1995, will contain calculations on the effectiveness of moisture diverters.

Chemical barriers (design dependent parameter 2d). Two chemical barriers have been discussed. A water conditioner barrier above the waste could linearly decrease glass corrosion. There is a potential to reduce the glass corrosion rate by an order of magnitude (reference).

Another chemical barrier could be a matrix material that chemically reacts with released constituents (e.g., Tc) to make the constituents more insoluble. Sulfur polymer cement is a candidate matrix material. The sulfur in the cement may chemically react with Tc released from the glass corrosion process. If all the Tc that is released from the glass chemically combines with the sulfur in the cement, then the drinking water dose peak is a little over 4 mrem/yr for fractured sulfur polymer cement (reference). Iodine 129 then becomes the leading chemical contributor. If a larger piece of cullet was used in the calculation, the drinking water peak dose value could be at or under the target 4 mrem/yr. (Note that the referenced calculations are at equilibrium between the water, matrix and glass system. Kinetics will be incorporated later.) If the sulfur polymer cement reacts with the Tc, we expect to be able to take credit for the reaction in the PA.

Wicking water through the disposal cell (design dependent parameter 2b). A filler material that could wick the water away from the waste and down to the vadose zone should decrease the water for glass corrosion. Soil has been suggested for the wicking material. At this time, the second white paper will contain calculations on the effectiveness of the soil wicking action.

Glass cullet size (design dependent parameter 2f). As a result of the February 3 meeting, the base radius for the cullet size was increased to 0.5 cm from 0.25 cm. The larger radius decreased the drinking water dose by about a factor of 2 (reference, figure 4). The dose rates were based on fixed corrosion and infiltration rates.

Matrix material hydraulic conductivity (design dependent parameter 2g). The current base matrix material is sulfur polymer cement. A well formed, not fractured piece of sulfur polymer cement could delay water from reaching the glass. However, only 500 years of credit for this physical barrier may be allowed. Probably no credit for hydraulic conductivity would be taken for highly fractured sulfur polymer cement.

Facility length perpendicular to ground water flow (design dependent parameter 3). The referenced paper suggested that if the length of the facility is perpendicular to the ground water flow, then the dose decreases by 20% compared to a facility that is parallel to the ground water flow.

The discussion above is based on what the PA team knows now. The attached table summarizes the work that needs to be done in order to have a more defensible case. We will keep you inform on the related results of the tests and calculations. If you have any questions, please call me at 373-9659.

Cheryl R. Eiholzer

C. R. Eiholzer
Risk Assessment and Environmental Modeling

bab

Attachment

Important Parameters in Performance Assessment. (Rev. 1. 2/13/95)

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
Design Dependent Parameter[1]				
1. Canister height	8 meters	Intruder dose by way of drilling scenario is proportional to height.	System definition selection (4/1/95 Process Design)	
2. Disposal system release rate[2]	1 ppm/year. Value is at the exit of the near field (the man-made system).	Drinking water dose is proportional to release rate.	• System definition selection (4/1/95) •Material properties (on going) •Material interactions with radionuclides •Interim performance assessment (PA) (9/30/96)	Based on the assumptions made in white paper[3], the given base value leads to a 4 mrem/year value for drinking water scenario.
2a. Contaminant solubility	To be determined (TBD)	Drinking water dose is proportional to solubility.	•Experimental tests on SPC (in progress) •Interim PA (9/30/96)	

[1] Based on long-release, one-dimensional, homogeneous, low-recharge model calculating drinking water and intruder doses.

[2] Parameters 2a - 2f are components of the disposal system and contribute to the total system release rates.

[3] Rawlins et al, "Impacts of Disposal System Design Options On Low-Level Glass Waste Disposal System Performance", WHC-EP-0810, September 2, 1994, Westinghouse Hanford Company, Richland, WA.

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
2b. Effectiveness of soil wicking in disposal cell	TBD	Affects available moisture for attacking glass. Soil has a wicking action, pulls water away from canisters.	•Calculations in white paper 2. (8/30/95)	•Soil is a suggested material, could be changed.
2c. Moisture diverter effectiveness (capillary break above vault roof)	TBD	•Affects amount of moisture entering disposal facility. •Affects amount of moisture available for attaching the glass.	• Reviewing experimental evidence •calculations in white paper 2 (8/30/95)	
2d. Chemical barriers (in-coming water conditioner, sulfur polymer cement for Tc-99)	TBD	A in-coming water conditioning layer has the potential to reduce glass mass loss rates.	•Calculations in white paper 2 for water conditioning (8/30/95) •Experiments planned for sulfur polymer cement (SPC)-Tc-99 interaction (9/30/95) •Information in the interim PA (9/30/96)	Calculations for the white paper took credit for the SPC - Tc-99 chemical interaction.
2e. Glass corrosion rate	TBD	Drinking water dose likely proportional to corrosion rate.	•System definition selection (4/1/95) •Determine glass composition •Evaluate chemical environment •Developed data base •First calculations in interim PA (9/30/96)	Various rates used in white paper. 1×10^{-3} $g/m^2/d$ based on conversations with experts.

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
2f. Glass cullet size	1 cm diameter marble	Drinking water dose is likely to be inversely proportional to cullet size.	• System definition section (4/1/95) •Melter selection	The glass geometry used in the white paper was a 0.25 cm radius marble.
2g. Sulfur polymer cement hydraulic conductivity as a function of time	White paper values: 3. x 10^{-4} cm/s for highly fractured matrix. 3 x 10^{-31} cm/s for impermeable matrix.	Affects amount of moisture available for attacking glass. Cracks and fractures will allow moisture to reach the glass.	•Experiments in progress •Information in the interim PA (9/30/96)	•May not be able to take significant credit for delaying glass corrosion based on NRC staff's position on life time of physical barriers
3. Facility length perpendicular to ground water flow	TBD	Drinking water dose is inversely proportional.	•System definition selection (4/1/95)	
4.Inventory concentration of key radionuclides (Sr, secondarily Cs)	Curies in LLW glass. ^{90}Sr:6.0E+6 ^{137}Cs: 1.0E+6	Intruder dose is proportional to most key radionuclides.	•System definition selection (4/1/95) •Determining inventory (5/31/95)	Assumed inventory values from Al Boldt.[4]

[4] A. L. Boldt, "Source Terms," DSI to K. D. Boomer, Westinghouse Hanford Company, Richland, Washington, February 9, 1994.

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
5. Total inventory of key radionuclides (Tc, secondarily I)	Curies in LLW glass. ^{99}Tc: 2.4E+4 ^{129}I: 5.1E+0	Drinking water dose is proportional to key radionuclides.	•Determining inventory (5/31/95)	•Assumed inventory values from Al Boldt[5] and used in white paper. •^{129}I may not exist •Tc may not be important pending SPC or sulfur effectiveness.
6. Useable vadose zone depth	70 meters	•Drinking water dose inversely proportional to useable depth. •Travel time of water and radionuclides is proportional to usable depth.	•System definition selection (4/1/95)	•Total depth of Vadose zone is well known -- 85 meters. •Peak dose is likely to occur after 10,000 years.

[5] A. L. Boldt, "Source Terms," DSI to K. D. Boomer, Westinghouse Hanford Company, Richland, Washington, February 9, 1994.

Important Parameters in Performance Assessment. (Rev. 1. 2/13/95)

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
7. Materials interaction	magnitude TBD	•Affects glass corrosion.	• Determine if carbon steel or stainless steel should be used near the glass. •System definition selection (4/1/95).	•Large amount of iron inside glass/matrix form could increase glass corrosion. •Portland Concrete should not have much affect on glass corrosion.
Design Independent Parameters[6]				
1. Dose conversion factors	TBD	doses are proportional	•Document well established parameters (6/30/95)	
2. Ground water hydraulic velocity	TBD	Drinking water dose is inversely proportional	•Part of characterization program (1997)	Per Grout PA
3. Intruder scenario parameters	TBD	Affects intruder dose	•Document well established (by case law) parameters (6/30/95)	

[6]Based on long-release, one-dimensional, homogeneous, low-recharge model calculating drinking water and intruder doses.

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
4. Long-term infiltration rate (recharge)	0.1 cm^3/yr	Affects disposal system release rate and moisture in vadose zone.	•Experiments in progress •Recharge workshop schedule for May 1995 •Rate determination (1997)	
5. Vadose zone hydraulic dispersion	TBD	Drinking water dose decrease as dispersion increases.	•Reanalyzing old experiments (current) •new experiments are being planned. (1996-1997)	
6. Vadose zone moisture	estimated values used: 5% vol/vol	Used in calculating retardation factor, travel time.	•Measure geohydraulic parameters (1996) •Determine recharge •Calculation (1997)	
7. Vadose zone retardation parameters	TBD	drinking water dose is inversely proportional to retardation.	•Kd values being measured •Interim PA (9/30/96)	•Parameters dependent on calculated moisture in soil, Kd and soil density. • Parameters may be in white paper 2. (8/30/95) •Parameters are unlikely to be a large effect for key radionuclides. (factor about 2)

Important Parameters in Performance Assessment. (Rev. 1. 2/13/95)

Parameter	Current Base Value	Influence on Design	Work to Refine Value (Due Date)	Comments
8. Well opening height	EPA Region 10 has set value.	Drinking water dose is inversely proportional	•Document established regional practice (6/30/95)	
9. Well pumping rate	infinitesimal	Can decrease all pathways dose for some scenarios.	based on scenario selection (done)	Well 100 meters down gradient from disposal area.

(Note: page numbers (e.g p 8-29) referred to in the following CC:Mail are pages in reference 1 in the reference section of this report.)

Author: Dolores E Mitchell at ~WHC208
Date: 3/28/95 10:08 AM
Priority: Normal
TO: Cheryl R Eiholzer at ~WHC71
CC: Dolores E Mitchell
Subject: Vaults, etc.
------------------------------- Message Contents

I talked with Rich Lowery of Fluor about the drawings we discussed yesterday. The one on p 8-29 is different from 8-26.

P 8-29 takes into account the different way of handling the self supported canisters in case 12 as opposed to the thin-walled canisters in case 11. For now use the simpler vault in case 11 shown on page 8-26 for your basis.

Also I talked to Rich about condensation/collection of water in the cooling pipes that run through the containers in case 12. According to Rich the pipes are pitched for drainage and the containers are then sent to a drying area. At any rate this is something that can be handled with appropriate design he said.

Hope this helps. Dolores

Author: Carole E Leach at ~WHC16
Date: 3/9/95 10:20 AM
Priority: Normal
TO: Cheryl R Eiholzer at ~WHC71
TO: Ann M Tallman at ~WHC53
TO: Stephen P Reidel at ~WHC304
TO: Frederick M Mann at -MailLink
CC: Carole E Leach
CC: John D Galbraith at ~WHC208
CC: John S Garfield
CC: George F Williamson at ~WHC181
CC: Albert L (Al) Shord at ~WHC116
CC: Kayle D Boomer at ~WHC165
CC: Dolores E Mitchell at ~WHC208
CC: Jeffry A Voogd at ~WHC347
Subject: LLW Storage Vaults
-------------------------------- Message Contents

A number of you astute people out there have noticed that there is a considerable difference between the areas allotted for the Low Level Waste glass storage vaults as depicted in the following two references:

(1) TWRS Master Site Plan Report, Final Design Review, dated February 27, 1995. WHC PO TVW-SV-370252.

(2) WHC-SD-W378-ES-002, "TWRS Process Support and Infrastructure Definition, " dated February 1995, draft.

First of all, and perhaps most important, the difference between these two references has nothing to do with waste volume projections and everything to do with physical arrangement assumptions. The assumptions used in the first reference are superseded by those used in the 2nd reference. Hence, the arrangement depicted in the 2nd reference should be the basis for any work you are doing related to the LLW storage vaults.

For background, the 1st reference assumed over 50 feet of spacing between each of the vaults. 25% additional area was assumed on top of this for "circulation". Finally, 100% contingency was assumed. The result was an area allotment on the order of 88 acres. The reference 2 effort which supersedes reference 1 assumes that adjacent vaults share walls, hence there is no spacing between vaults. The total resulting area is on the order of 16 acres. If, for your purposes it is particularly prudent to assume a contingency, you can assume an additional adjacent 16 acres directly south of the vault location indicated in Reference 2.

CEL