INTEGRATED DISPOSAL FACILITY
CHAPTER 4.0 ADDENDUM C
PROCESS INFORMATION
CHANGE CONTROL LOG

Change Control Logs ensure that changes to this unit are performed in a methodical, controlled, coordinated, and transparent manner. Each unit addendum will have its own change control log with a modification history table. The “Modification Number” represents Ecology’s method for tracking the different versions of the permit. This log will serve as an up to date record of modifications and version history of the unit.

Modification History Table

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INTEGRATED DISPOSAL FACILITY

CHAPTER 4.0 ADDENDUM C

PROCESS INFORMATION
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## TERMS

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<th>Description</th>
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<tr>
<td>AEA</td>
<td>Atomic Energy Act of 1954</td>
</tr>
<tr>
<td>ALR</td>
<td>Action leakage rate</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing and Materials International</td>
</tr>
<tr>
<td>CDN</td>
<td>Composite drainage net</td>
</tr>
<tr>
<td>DOE</td>
<td>U.S. Department of Energy</td>
</tr>
<tr>
<td>DOT</td>
<td>U.S. Department of Transportation</td>
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<td>DWMU</td>
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<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<td>GCL</td>
<td>Geosynthetic clay liner</td>
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<tr>
<td>HDPE</td>
<td>High-density polyethylene</td>
</tr>
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<td>IDF</td>
<td>Integrated Disposal Facility</td>
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<td>ILAW</td>
<td>Immobilized low-activity waste</td>
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<tr>
<td>LCRS</td>
<td>Leachate collection and removal system</td>
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<tr>
<td>LDR</td>
<td>Land disposal restrictions</td>
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<tr>
<td>LDS</td>
<td>Leak detection system</td>
</tr>
<tr>
<td>LLW</td>
<td>Low-level waste</td>
</tr>
<tr>
<td>MLLW</td>
<td>Mixed low-level waste</td>
</tr>
<tr>
<td>PE</td>
<td>Polyethylene</td>
</tr>
<tr>
<td>PVC</td>
<td>Polyvinyl chloride</td>
</tr>
<tr>
<td>RAP</td>
<td>Response action plan</td>
</tr>
<tr>
<td>RCRA</td>
<td>Resource Conservation and Recovery Act of 1976</td>
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<tr>
<td>SLDS</td>
<td>Secondary leak detection system</td>
</tr>
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<td>USACE</td>
<td>U.S. Army Corp of Engineers</td>
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<td>WAP</td>
<td>Waste Analysis Plan</td>
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<td>Waste Treatment and Immobilization Plant</td>
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4.0 C.1 PROCESS INFORMATION


The IDF Operating Unit Group is used for disposal of immobilized low-activity waste (ILAW) from the Waste Treatment and Immobilization Plant (WTP) and mixed low-level waste (MLLW) from Hanford Site operations. IDF also manages non-dangerous, radioactive low-level waste (LLW) from Hanford Site operations in accordance with the Atomic Energy Act of 1954 (AEA). Management of radioactive waste is not within the scope of RCRA or WAC 173-303. Any information provided in this document for radioactive waste is for informational purposes only. The IDF consists of four dangerous waste management units (DWMUs): a storage pad permitted for container storage, a treatment pad permitted for container storage and treatment, and two disposal cells permitted for landfill disposal.

Waste containers disposed at the IDF consist primarily of WTP ILAW glass containers. In addition to ILAW glass containers, a diverse range of LLW and MLLW containers can be disposed in IDF, including but not limited to boxes, drums, and long-length contaminated equipment. Addendum A, “Part A Form,” lists the wastes disposed at IDF. Some of these Hanford Site wastes will be sent off-site for treatment and returned to IDF for disposal.

Critical systems for the IDF are identified in Appendix C2, “Critical Systems Table,” with cross-references to applicable sections in Appendix C6, “Construction Specifications,” and Appendix C9, “Infrastructure Construction Specifications.”

the processes that will be used to dispose waste in the Integrated Disposal Facility (IDF) and includes a discussion of the design and function of the following:

- Container.
- Disposal landfill.
- Leak Detection System (LDS).
- Leachate Collection and Removal System (LCRS).
- Secondary Leak Detection System (SLDS).

Note that the SLDS is not a design requirement of Washington Administrative Code (WAC) 173-303-665, however U.S. Department of Energy (DOE) is adding the design feature pursuant to its authority under the Atomic Energy Act of 1954 (AEA) and not for the purposes of compliance with the dangerous waste regulations. Therefore, information regarding the design, construction, and operation of the secondary LDS is provided in this application as information only. Pursuant to AEA, DOE has sole and exclusive responsibility and authority to regulate the source, special nuclear and by-product material component of radioactive mixed waste at DOE owned nuclear facilities. Source, special nuclear and by-product materials, as defined by AEA, are not subject to regulation under Resource Conservation and Recovery Act (RCRA) or the Hazardous Waste Management Act, by the State of Washington and are not be subject to State dangerous waste permit, orders, or any other enforceable instrument issued there under. DOE recognizes that radionuclide data may be useful in the development and confirmation of geohydrologic conceptual models. Radionuclide data contained herein is therefore provided as a matter of comity so the information may be used for such purposes.
Waste stream compatibility (i.e., compatibility between individual waste streams and compatibility between waste streams and landfill design and construction parameters) will be assessed on a case-by-case basis. Criteria for assessing and determining compatibility is identified in the Waste Acceptance Criteria, Waste Analysis Plan, or other protocol or procedure as appropriate (Chapter 3.0, for further discussion of waste stream compatibility).

Process Code S01 (container storage) has been included within this permit, in the event that storage is required before final disposal (e.g., to support the confirmation process of the waste or cooling of vitrified waste if required). Waste failing the confirmation process (Chapter 3.0) will be identified as off-specification and may require storage prior to disposal. Only off-specification waste or vitrified waste requiring cooling (due to process heat) may be stored in the lined portion of the IDF pending disposition.

To maintain operational flexibility, off-specification containers and vitrified waste requiring cooling could be left on the transport vehicles at the IDF until disposal can occur but may be off-loaded into the lined portion of the IDF pending final disposal provided the temperature administrative control limit is not exceeded. Off-specification waste and vitrified waste requiring cooling will be separated from other waste via tape, ropes, chains, or other cordon mechanism.

C.1.1 Dangerous Waste Management Unit Descriptions

The IDF is located on 82 hectares (202 acres) of land within the southcentral portion of the 200 East Area of the Hanford Site. The IDF consists of four DWMUs, as detailed in Table C-1 and depicted in Addendum A. The DWMUs provide storage, treatment, and disposal of LLW and MLLW from the WTP and other Hanford on-site generators. Table C-1 shows the waste management activities that are conducted at the IDF DWMUs.

<table>
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<td>Disposal Cell 1</td>
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<td>Disposal Cell 2</td>
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C.1.1.1 Storage and Treatment Pads

The Storage and Treatment Pad DWMUs are located at ground surface to the west of the IDF landfill. The storage pad provides container storage for ILAW from the WTP as well as containerized LLW and MLLW from Hanford on-site generators prior to placement in the disposal cells. The Storage and Treatment Pad DWMUs are uncovered/unenclosed concrete pads located outside that do not have engineered secondary containment systems (Appendix C3, “Design Drawings”). Section C.2.3 contains additional information about the storage and treatment pads.

The storage capacity for each pad was calculated based on the storage requirements in WAC 173-303-630, Use and management of containers, and then used to determine the total DWMU maximum permitted storage capacity. Permitted storage capacities are listed in Table C-2. Containers that do not meet WAC 173-303-630(7)(c) criteria (e.g., waste packages that contain free liquids or exhibit characteristics of ignitability or reactivity) are not accepted at the Storage and Treatment Pads.
Table C-2 Storage and Treatment Pads Design and Storage Capacities

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</table>

DWMU = Dangerous waste management unit

Treatment of containerized MLLW debris is conducted to meet the disposal requirements of WAC 173-303-140, Land disposal restrictions, and consists of immobilization technologies conducted in accordance with 40 Code of Federal Regulations (CFR) 268.45, Land Disposal Restrictions, Treatment standards for hazardous debris (Table 1, “Alternative Treatment Standards for Hazardous Debris”). Treatment activities are discussed in Section C.3.

The process design capacity for waste treatment on the treatment pad is 136 metric tons (150 tons) per day. To determine the maximum permitted treatment capacity, a calculation was performed using the volume of containers expected to be treated at the DWMU in a day, based on a container size of roughly 6.1 x 2.4 x 1.5 m (20 x 8 x 5 ft):

5 containers/day x 30 tons/container = 150 tons/day = 136 metric tons/day

The Storage and Treatment Pad DWMUs manage LLW and MLLW. The MLLW dangerous waste constituents include listed hazardous waste, characteristic hazardous waste, and/or state-only dangerous waste. Refer to the Part A (Addendum A) for the estimated annual quantity of waste managed at IDF in the DWMUs and the associated dangerous waste numbers.

C.1.1.2 Disposal Cells

The landfill is a large rectangular excavation made up of two cells (divided lengthwise) with a side slope ratio of 3:1 (horizontal/vertical). Table C-3 lists the dimensions and capacities of the cells at their size.

Table C-3 Disposal Cells Design and Capacities

<table>
<thead>
<tr>
<th>Stage of Disposal Cells</th>
<th>Dimensions</th>
<th>Available Waste Disposal Area</th>
<th>Disposal Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m</td>
<td>ft</td>
<td>m²</td>
</tr>
<tr>
<td>Initial construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width</td>
<td>m</td>
<td>ft</td>
<td>m²</td>
</tr>
<tr>
<td>Initial construction</td>
<td>m</td>
<td>ft</td>
<td>m²</td>
</tr>
<tr>
<td>size</td>
<td>410</td>
<td>1,345</td>
<td>89,592</td>
</tr>
<tr>
<td>Length</td>
<td>m</td>
<td>ft</td>
<td></td>
</tr>
<tr>
<td>Initial construction</td>
<td>m</td>
<td>ft</td>
<td></td>
</tr>
<tr>
<td>size</td>
<td>219</td>
<td>717</td>
<td></td>
</tr>
<tr>
<td>Depth</td>
<td>m</td>
<td>ft</td>
<td></td>
</tr>
<tr>
<td>Initial construction</td>
<td>m</td>
<td>ft</td>
<td></td>
</tr>
<tr>
<td>size</td>
<td>12.8</td>
<td>42</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
- Dimensions given are at the ground surface and the combined value for both cells. Width is the measured east/west and length is measured north/south.
- The maximum permitted disposal capacity reported on the “Part A Form” (Addendum A) is the capacity at full size.
- The width of each cell is 205 m (672.5 ft).
The disposal cells are permitted for disposal of mixed waste from on-site Hanford generators in accordance with WAC 173-303-140 requirements. Detailed information on design and construction activities are provided in Section C.4 and in Appendix C4, “Construction Quality Assurance Plans.”

The IDF landfill consists of a leachate collection and removal system (LCRS), a leak detection system (LDS), and a secondary leak detection system (SLDS). Note that the SLDS is not a design requirement of WAC 173-303-665, Landfills; however, the U.S. Department of Energy (DOE) added the design feature pursuant to its authority under the AEA. Therefore, information regarding the design, construction, and operation of the SLDS is provided in this application as information only.

The IDF landfill is permitted for disposal of land disposal restrictions (LDR)-compliant waste. A tracking system documents all LDR-compliant waste disposed within the disposal cells as described in Section C.2.1.4. Refer to the Part A (Addendum A) for the estimated annual quantity of waste managed at IDF in the DWMUs and the associated dangerous waste numbers.

C.2 WASTE MANAGEMENT

The information in this section relates to management of waste at the IDF Operating Unit Group. Newly generated waste and containers accepted for storage and treatment are subject to WAC 173-303-630 requirements. Treatment technologies are addressed in Section C.3.

4.1 Containers

All mixed waste accepted for disposal at the IDF will be packaged in standard containers (U.S. Department of Transportation [DOT] and/or DOE), unless alternate packages are dictated by the size, shape, or form of waste (49 Code of Federal Regulations [CFR] 173) (e.g., metal boxes), and self-contained bulk waste.

4.1.1 C.2.1 Description of Containers

The majority of the waste accepted at IDF is ILAW glass stored in cylindrical steel containers. The ILAW glass containers have outer dimensions of 2.3 m (7.5 ft) high with a 1.22 m (4.0 ft) diameter. The most common containers for the remainder of waste accepted at IDF include, but are not limited to:

- Waste boxes in various sizes:
  - Type A boxes (e.g., 0.6 × 0.6 × 1.8 m [2 × 2 × 6 ft], 1.5 × 1.5 × 2.7 m [5 × 5 × 9 ft]).
  - High integrity containers (1.8 × 1.8 × 1.8 m [6 × 6 × 6 ft]).
  - Custom boxes for long-length equipment.
  - 208 L (55 gal) painted carbon steel or galvanized drums.
  - Steel boxes measuring approximately 1.2 × 1.2 × 2.4 m (4 × 4 × 8 ft).

Waste will be packaged in U.S. Department of Transportation (DOT) or DOE-approved containers, including alternate packages required due to the size, shape, or form of the waste (e.g., metal boxes and flexible containers). Containers are compatible with the waste and maintain containment during handling and storage before disposal (WAC 173-303-630). If required, using an appropriate combination of protective coatings and liners prevents loss of container integrity. Containers must meet one of the following criteria:

- Constructed of metal, concrete, or masonry.
- Constructed of rigid plastic that has a maximum flame spread rating as defined by the most current version of the American Society for Testing and Material (ASTM) International E-84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- Other authorized containers approved by the IDF waste acceptance team.
Mixed waste disposed at the IDF is limited to vitrified low-activity waste (LAW) from the River Protection Project (RPP)-WTP and Demonstration Bulk Vitrification System (DBVS). Additionally, mixed waste generated by IDF operations will be disposed of in IDF.

The RPP-WTP and DBVS containers are designed specifically for the vitrified LAW form. Nominal RPP-WTP container dimensions will be 122 centimeters base outside dimension, 107 centimeters top by 230 centimeters in length, with a wall thickness of 0.357 centimeter with a container volume of 2.55 cubic meters. The DBVS container dimensions are approximately 2.4 meters wide by 3.1 meters tall and 7.3 meters long and a container volume of 54 cubic meters. The vitrified LAW will be compatible with the containers, stainless steel for RPP-WTP and carbon steel for DBVS. Before receipt at the IDF, containers will be closed by the generator.

Due to the radioactivity and remote handling of the RPP-WTP immobilized waste containers, conventional labeling of the vitrified immobilized waste containers will not be feasible and an alternative to the standard labeling requirements will be used. This alternative labeling approach will use a unique alphanumeric identifier that will be welded onto each immobilized glass waste container. The welded “identifier” will ensure that the number is always legible, will not be removed or damaged during container decontamination, will not be damaged by heat or radiation, and will not degrade over time.

The identifier will be welded onto the shoulder and sidewall of each immobilized glass container at two locations 180 degrees apart. Characters will be approximately 2 in. high by 1.5 in. wide. The identifier will be formed by welding on stainless steel filler material at the time of container construction. This identifier will be used to track the container from receipt at the RPP-WTP, throughout its subsequent path of shipment and disposal at the IDF.

Each identifier will be composed of unique coded alphanumeric characters. This unique alphanumeric identification will be maintained within the plant information network, and will list data pertaining to the waste container including waste numbers, and the major risk(s) associated with the waste.

Mixed waste generated through waste operations at IDF will be packaged based on the size of the waste, with the most common container being galvanized or aluminized 208-liter containers.

The container packaging and handling for the IDF are designed to maintain containment of the waste, limit storage intrusion, and limit human exposure to mixed waste. Unusual sized containers such as vitrified LAW packages will be handled by using cranes or other appropriate equipment.

Operations personnel will inspect each container to confirm appropriate documentation and compliance with the waste acceptance criteria before the container is placed in the IDF (refer to Chapter 3).

If containerized mixed waste must be opened (i.e., for confirmation sampling, repackaging, etc.), the container typically would be removed to an onsite treatment and/or storage unit or other approved location before being opened. The container would be sealed before being returned to the IDF.

## C.2.1.1 Condition

Containers that are accepted at IDF shall be in good condition (as defined in WAC 173-303) or in overpacks. If a container is not in good condition (as defined in WAC 173-303), and returning it to the generator for repackaging is not possible, the container may be segregated from other waste and managed in accordance with waste receipt discrepancies. Receipt discrepancies are discussed in Addendum B, “Waste Analysis Plan” (WAP).
**C.2.1.2 Identification and Labeling**

Containers sent to and received at the IDF will be labeled for identification and to communicate information needed for proper waste management (i.e., container identification number, “Hazardous Waste” label, and Washington State hazard label). Hazard labeling requirements are listed in Table C-4. The labeling and marking will be durable, legible, visible, and meet applicable regulations (DOT, WAC 173-303-630). Labels will be legible from a distance of 25 ft or the lettering size will be a minimum of one-half inch in height [WAC 173-303-630(3)(a)].

**Table C-4 Washington State Hazard Labeling**

<table>
<thead>
<tr>
<th>Hazard or Risk</th>
<th>Acceptable Labels and Markings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dangerous Waste Characteristics – D004 – D043 [WAC 173-303-090(8)]</td>
<td>TOXIC</td>
</tr>
<tr>
<td>Washington State Dangerous Waste Criteria – WT01, WT02 (WAC 173-303-100)</td>
<td>TOXIC</td>
</tr>
<tr>
<td>Washington State Dangerous Waste Criteria – WP01, WP02, WP03 (WAC 173-303-100)</td>
<td>TOXIC</td>
</tr>
</tbody>
</table>
| Discarded Chemical Products – (U, P codes) (WAC 173-303-9903) | a. If a listed dangerous waste no longer exhibits a characteristic hazard, then label TOXIC.  
  b. Otherwise, label with TOXIC labels. |
| Dangerous Waste Sources – (F codes) (WAC 173-303-9904) | a. If a listed dangerous waste no longer exhibits a characteristic hazard, then label TOXIC.  
  b. Otherwise, label with TOXIC labels. |

References: WAC 173-303, Dangerous Waste Regulations  
-090, Dangerous waste characteristics  
-100, Dangerous waste criteria  
-9903, Discarded chemical products list  
-9904, Dangerous waste sources list

Except for the ILAW glass containers, each waste container placed in storage will be affixed with a hazard label indicating the hazards associated with the waste contents (i.e., ignitable, corrosive, reactive, or toxic). Labels will be supplied by the generator and managed to facilitate compliance with the requirements outlined in Addendum I, “Inspection Plan.” If waste management activities (e.g., treatment processes or overpacking) obscure the label, a new label will be affixed. During management of empty containers, old labels will be destroyed by removing them from the containers, or the labels will be made nonlegible.

Due to the radioactivity and temperature-driven remote handling of the RPP-WTP immobilized waste ILAW glass containers, conventional labeling of the vitrified immobilized waste containers will not be feasible and an alternative to the standard labeling requirements will be used by the generator. This alternative labeling approach will use a unique alphanumeric identifier that will be welded onto each immobilized glass waste container. The welded “identifier” must be sufficiently robust to ensure that the alphanumeric characters are always legible, will not be removed or damaged.
during container decontamination, will not be damaged by heat or radiation, and will not degrade over time. This identifier will be used to track the container from receipt at the WTP throughout its subsequent path of shipment and disposal at the IDF. In addition, the ILAW pallet sign holders will contain the marks/labels to support DOT and RCRA storage compliance.

C.2.1.3 Waste Compatibility
Waste will be packaged in containers that are compatible and nonreactive with the waste to be stored. Waste containers are made of or lined with compatible or nonreactive materials (e.g., chemical resistant epoxy). Labpacks will have at least two layers of containment (outer container and inner container).

Waste disposed in IDF must be compatible with the IDF liner system, and each waste stream will be evaluated by the IDF for liner compatibility. Waste stream compatibility (i.e., compatibility between individual waste streams and compatibility between waste streams and landfill design and construction parameters) will be assessed on a case-by-case basis. Criteria for assessing and determining compatibility are identified in the WAP (Addendum B) and other protocols and procedures.

C.2.1.4 Waste Tracking
Waste management information is maintained to provide tracking of activities for each waste container. A unique identification number is assigned to each waste container managed at IDF to support waste identification and disposition. The waste tracking system is used to provide a complete inventory of the waste containers held within each DWMU. This system provides information such as: a general description of the waste composition and packaging, quantity of waste, shipment/transfer details, and container location. Records are maintained in the Hanford Facility Operating Record, IDF portion, as described in Section C.12.

C.2.2 Managing Containers
Prior to shipment and receipt of containers, generators must complete the IDF pre-acceptance process detailed in the WAP (Addendum B).

Containers used to store waste will be handled, managed, stored, and/or treated in a manner that maintains containment and limits personnel contact with the waste. Waste containers are managed based on the following criteria.

- Waste contents must be compatible with the layers used for containment (e.g., container and lining).
- Waste contents must be authorized in accordance with the Part A (Addendum A) and WAP (Addendum B).
- Each container must be labelled according to Section C.2.1.2.

If waste discrepancies, such as improper container labeling, improper packaging, or manifest discrepancies, are discovered during the container receipt inspection, the nonconforming containers or shipment will not be accepted until the discrepancies have been resolved. Discrepancy resolutions are detailed in the WAP (Addendum B).

The entire landfill will be able to accept all waste codes identified in the IDF “Part A Form” (Addendum A). The IDF will not accept incompatible waste.

C.2.2.1 Procedure for Handling
Waste packages received at the IDF will be configured for safe handling and management prior to and upon disposal. Unusually sized containers will be handled by cranes or other appropriate equipment. Packages that must be unloaded are equipped with a lifting system designed to lift the fully loaded package safely. For packages that have special unloading requirements (e.g., ILAW glass containers), information must be provided concerning methods for unloading before the shipment is scheduled.
Waste container handling practices are conducted by trained and qualified personnel. Containers shall always be closed, except at the following times:

- While adding or removing waste.
- While conducting waste treatment activities.
- When sampling activities are required.
- When the container meets the definition of empty as defined in WAC 173-303-160(2)(a).

Containers (i.e., a nonregulated dangerous waste container).

If it is determined upon examination that a container that needs to be opened should not be opened, the container will be shipped to and managed at an appropriate Hanford on-site or off-site facility.

C.2.2.2 Container Handling Equipment

Containers may be handled individually or grouped on pallets (e.g., four 208 L [55 gal] drums). The primary types of container handling equipment are described briefly in the following subsections. This list is not all-inclusive, but it provides examples of equipment utilized while moving containers. In accordance with WAC 173-303-630(5)(b), containers holding mixed waste will not be opened, handled, or stored in a manner which may rupture the container or cause it to leak. The processes and equipment used to transport waste containers and items into the disposal cells will be added by a permit modification prior to the acceptance of waste at IDF.

C.2.2.2.1 Forklifts

Forklifts are used to unload waste containers from vehicles, move waste containers within and between the IDF DWMUs, stack waste containers, and load containers onto vehicles. Drum lifting attachments, commonly called drum grabs, are used to remove single drums. Drum grabs are sized for the waste drums to be moved. The drum grabs can pick up drums without the need for banding, strapping, or anchoring. Waste received on pallets or in waste boxes is unloaded using the forklift tines. Pallets of drums are secured, as necessary, with banding or load straps to prevent toppling. Forklifts will be used to unload ILAW pallets from the ILAW transports. The ILAW pallets may require temporary staging for cooling on the storage pad as needed prior to disposal.

C.2.2.2.2 Cranes

Various cranes may be used to lift heavy containers or when remote handling is needed. The types of cranes used include mobile cranes, temporary A-frame type cranes, and other lifting devices.

C.2.2.3 Aisle Spacing

Aisle spacing requirements in WAC 173-303-630(5)(c) mandate a minimum of 76 cm (30 in.) between rows of containers located on the storage and treatment pads. In accordance with WAC 173-303-340(3), Preparedness and prevention, aisle space will be maintained to allow for the unobstructed movement of personnel and equipment during emergency situations and inspection of storage containers. Rows of containers will be placed no more than two containers wide. Pallets with multiple containers will not be placed against another row of pallets. Aisle spacing requirements described in this subsection do not apply to the IDF disposal cells.

C.2.2.4 Inspections

Inspections of active storage areas and containers are conducted by qualified personnel trained in accordance with Addendum G, “Personnel Training,” to detect signs of malfunction, deterioration, discharges, or other anomalies. Type and frequency of inspections are described in Addendum I.
C.2.3 Storage and Treatment Pad Design

This section identifies storage and treatment pads design features associated with containment and controlling run-on and runoff.

C.2.3.1 Containment

There is no secondary containment at the storage and treatment pads because the pads will not accept free liquids, containers holding wastes designated as F020, F021, F022, F023, F026, and F027, or wastes exhibiting the characteristic of ignitability or reactivity. Containers accepted for storage and treatment operations are designated as LLW or MLLW that may contain listed dangerous waste, characteristic dangerous waste, and state-only dangerous waste. Containers designated for acceptance may be stored without a containment system under either of the following conditions:

- Storage area is sloped to drain and remove liquids resulting from a known source (e.g., precipitation), or
- Containers are elevated or otherwise protected from accumulating liquids (e.g., pallets).

Each pad provides a location for transfer of containerized waste from delivery trucks to other equipment (e.g., forklifts) that either place the containers in storage or dispose of the containers in the landfill. The bases of the pads are concrete with thickened edges. Portable pallets may be used to elevate containers during storage.

C.2.3.2 Controlling Run-On and Runoff

Storage areas are constructed and operated with positive drainage control to prevent accumulation and facilitate prompt removal of uncontaminated precipitation. The foundation is graded with slope angles of approximately 0.5 to 1 percent.

Run-on into and runoff away from the pads are prevented by one or more of the following characteristics:

- Engineering controls such as perimeter curbs prevent run-on.
- Elevated or otherwise graded foundation slopes away from the system, preventing and/or diverting run-on from adjacent areas.
- Positive drainage control design that precludes runoff.

In addition, storage areas may utilize equipment (e.g., pallet) to elevate containers.

C.2.4 Requirements for Ignitable, Reactive, and Incompatible Wastes

Containers with ignitable, reactive, and/or incompatible wastes will not be accepted for storage or treatment at the Storage and Treatment Pad DWMUs. Special requirements for disposal of ignitable and/or reactive waste are described in Section C.6. Special requirements for disposal of incompatible waste are described in Section C.7.

C.3 TREATMENT ON THE TREATMENT PAD

The information in this section relates exclusively to treatment technologies conducted on the Treatment Pad DWMU. IDF treatment capabilities are identified in the WAP (Addendum B).

Treatment is conducted to meet the requirements in 40 CFR 268, Subpart D, Treatment Standards, and WAC 173-303-140 for waste subject to LDR requirements. In accordance with 40 CFR 268.45 (Table 1), compliance with LDR is achieved through the following immobilization technologies:

- Macroencapsulation.
- Microencapsulation.
- Sealing.
The following sections provide details about the treatment processes to be utilized at IDF. Macroencapsulation is the preferred treatment process for debris waste streams. Microencapsulation or sealing will be used when macroencapsulation is impractical (e.g., results in excessive final unit weight) or not achievable (e.g., cannot maintain minimum foundation, annulus, or head space requirements). This treatment determination will be made on a case-by-case basis. See Figure C-1 for the decision tree that provides guidance for conducting treatment.

![Treatment Decision Tree](image)

**Figure C-1  Treatment Decision Tree**

### C.3.1 Macroencapsulation

Macroencapsulation is an immobilization technology that is dependent on the ability of the surface coating material (e.g., grout reagent) to create a barrier around the waste, thereby reducing exposure to potential leaching media. The encapsulating barrier does not need to be chemically bound to the waste or constituent.

#### C.3.1.1 Applicability

Macroencapsulation per 40 CFR 268.45 is applicable to waste codes listed in the IDF Part A (Addendum A). With the exception of radioactive lead solids, waste to be macroencapsulated must meet the definition of hazardous debris in accordance with 40 CFR 268.2(h), *Definitions applicable in this part*. Because macroencapsulation is dependent on the properties of the coating rather than the properties of the waste, and because there are no contaminant restrictions specified in Table 1 of 40 CFR 268.45, macroencapsulation can effectively treat all debris types.
Macroencapsulation (MACRO) per 40 CFR 268.42, Treatment standards expressed as specified technologies, is applicable to radioactive lead solids including, but not limited to, all forms of lead shielding and other elemental forms of lead (nonwastewaters only). These lead solids do not include treatment residuals, such as hydroxide sludges, other wastewater treatment residuals, or incinerator ashes, that can undergo conventional pozzolanic stabilization, nor do they include organo-lead materials that can be incinerated and stabilized as ash. Macroencapsulation per 40 CFR 268.42 specifically does not include any material that would be classified as a tank or container as defined in 40 CFR 260.10, Hazardous Waste Management System: General, Definitions.

C.3.1.2 Process Description

The primary objective of this section is to ensure that waste(s) will be encapsulated using surface coating materials resistant to degradation by the waste and its contaminants, and any substances it may come into contact with after final placement (i.e., leachate and microbes).

While reagents, mixing, and handling requirements are tailored to each specific waste or waste type, the process described below provides an example of containerized waste treatment:

- Approximately 5 to 8 cm (2 to 3 in.) of the following surface coating material (grout reagent) is poured into the macroencapsulation container to create a grout foundation: Portland cement or lime/pozzolans (e.g., fly ash and cement kiln dust).
- Approximately 72 hours before placement of containerized waste, the preformed grout foundation is provided to allow for initial cure. Additional reagents (e.g., iron salts, silicates, carbon, or clays) may be utilized to enhance the set/cure time and working properties of the grout.
- Containerized waste is placed inside the prepared macroencapsulation container, ensuring that a minimum 5 cm (2 in.) annulus and head space will be maintained.
- If needed, to mitigate floating of containerized waste during deployment of reagent, a restriction tool is placed across the inside of the macroencapsulation container to ensure that containerized waste remains stationary.
- Volume or mass of grout reagent required to complete macroencapsulation is deployed into the macroencapsulation container to ensure complete covering of the containerized waste.
- Initial curing is performed in the same manner described above.
- The LDR-compliant macroencapsulation container is placed into the landfill.

C.3.1.3 The Limitations

Control measures and limitations include the following.

- For alternative treatment standards (40 CFR 268.45), waste must meet the definition of debris in accordance with 40 CFR 268.2(g), with the exception of radioactive lead solids. This is determined through review of waste profiles, in accordance with the WAP (Addendum B), which includes generator-provided information showing that the waste meets debris standards.
- With the exception of radioactive lead solids, no other wastes with specific treatment standards may be macroencapsulated unless requirements under 40 CFR 268.42 are met.
- Radioactive lead solids (e.g., lead shielding, elemental lead, and radioactive lead-acid batteries) will be treated via macroencapsulation (MACRO), as required by 40 CFR 268.40, Applicability of treatment standards, and defined in 40 CFR 268.42. Macroencapsulation specifically does not include any material that would be classified as a tank or container according to 40 CFR 260.10.

C.3.2 Microencapsulation

Microencapsulation is an immobilization technology that encapsulates waste with low-permeability materials and restricts contaminant migration by decreasing the surface area exposed to leaching.
C.3.2.1 Applicability
Microencapsulation is applicable to waste codes listed in the IDF Part A (Addendum A) to achieve applicable LDR treatment standards. As microencapsulation has no contaminant restrictions specified in Table 1 of 40 CFR 268.45, it can be used to effectively treat all debris types.

C.3.2.2 Process Description
Where containerized waste is irregularly shaped, microencapsulation will be used to meet LDR treatment standards. The following details provide a general explanation of treatment.

- Waste in the containers will be accessed through the top via drilled holes, grout ports, or removing the cover.
- Microencapsulating reagent (e.g., flowable grout) is added directly into the waste container, filling in void/interstitial areas in the debris waste.
- Microencapsulating reagent is in direct contact with the waste where it chemically and physically stabilizes the waste contaminants, reducing their leachability.
- Microencapsulating reagent is provided approximately 72 hours to initially cure. Additional reagents (e.g., iron salts, silicates, carbon, or clays) may be utilized to enhance the set/cure time or reduce the leachability of debris constituents.
- The LDR-compliant microencapsulated container is placed into the landfill.

C.3.2.3 Limitations
Control measures and limitations include the following.

- Waste must meet the definition of debris in accordance with 40 CFR 268.2(g).
- Debris is not conducive to microencapsulation where surfaces are not exposed such that it is not reasonable to expect appropriate coating to occur, such as the following:
  - Internally contaminated surfaces (e.g., piping).
  - Complex shapes (e.g., pumps).
- Containers must not be leaking and must have sufficient integrity to contain the material being added into the container.
- Treatment by microencapsulation may not be performed on process residuals or waste with other specific treatment standards.

C.3.3 Sealing
Sealing is an immobilization technology and is the application of materials (e.g., epoxy, silicone, and urethane compounds) that adhere tightly to the debris surface to avoid exposure of the surface to potential leaching media. When necessary for effective sealing, the debris surface is pretreated to remove foreign matter and/or to clean and roughen the surface.

C.3.3.1 Applicability
Sealing is applicable to waste that meets the definition of debris in accordance with 40 CFR 268.2(g) and has waste codes listed in the IDF Part A (Addendum A) to achieve applicable LDR treatment standards. Sealing has no contaminant restrictions specified in Table 1 of 40 CFR 268.45.

C.3.3.2 Process Description
The primary objective of this section is to ensure that sealing materials adhere tightly to the waste item and avoid exposure of the surface to potential leaking media.
Polyurea, or other similar materials, may be used for treatment. The following process provides a general explanation of waste debris treatment utilizing polyurea:

- Polyurea material is applied to the waste item utilizing an applicator (e.g., polyurea spray gun).
- The sealed waste item is initially cured per manufacturer direction and recommendation.
- The LDR-compliant sealed waste item is placed into the landfill.

C.3.3.3 Limitations

Control measures and limitations include the following.

- Waste must meet the definition of debris in accordance with 40 CFR 268.2(g).
- Sealing may not be performed on process residuals or waste with other specific treatment standards.

4.2 Leachate Collection Tanks

The aboveground leachate collection tanks support the lined IDF landfill. The leachate collection tanks will be operated in accordance with the generator provisions of WAC 173-303-200 and WAC 173-303-610 as referenced by WAC 173-303-200.

For informational purposes, the following is provided for an understanding of the operation of the leachate collection tanks. Procedures will be written to manage the leachate in accordance with WAC 173-303-200. The presence of leachate in the tanks will be detected with instrumentation within two stilling wells in each tank. The level instrument within the first stilling well monitors the depth of leachate in the tank. A second stilling well will have instrumentation for high-high and low-low alarm set-point trips. The leachate will be removed from the tanks using a transfer pump.

The leachate collection tanks have fabricated dome covers. Piping connecting the leachate transfer buildings allows leachate to be pumped from each cell into either tank. Designs for the fabricated dome covers and leachate tank transfer pipeline are discussed in Appendices 4A and C9.

4.3 C.4 LANDFILLS

The following addresses the IDF lined landfill. This section provides information about the IDF landfill. Dimensions and capacities for the IDF landfill are given in Table C-3. The IDF landfill operates in accordance with WAC 173-303-140 and WAC 173-303-665 for disposal of LDR-compliant waste from the WTP and other on-site generators. Hanford Site waste may be sent off-site for treatment and returned for disposal at IDF. Detailed information about the IDF landfill is provided in Appendix C4 and Appendix C1, “Phase I Critical Systems Design Report.”

4.3.1 List of Wastes

IDF will receive mixed and/or dangerous waste.

Waste will be accepted in containers (e.g., drums, boxes, larger containers).

Waste streams acceptable at the IDF facility fall within the range of dangerous waste numbers identified in Chapter 1.0, “Part A Form.”

4.3.2 Liner System Exemption Requests

This permit documentation does not seek an exemption to liner system requirements.
C.4.1 Liner System – Overview

The IDF landfill consists of two adjacent DWMU cells that are double-lined and constructed to RCRA Subtitle C standards. The following subsections provide a general description of the liner systems for the IDF Disposal Cell DWMUs. The liner system is made up of the following layers, as shown in Table C-5, Figure C-2 and Figure C-3. Sections C.4.1.1 through C.4.1.5 provide summary information about each layer.

Table C-5 Integrated Disposal Facility Liner System Description

<table>
<thead>
<tr>
<th>Layer (Top-to-Bottom)</th>
<th>Components (Landfill Base)</th>
<th>Components (Landfill Slopes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations Layer</td>
<td>Native Soil</td>
<td>Native Soil</td>
</tr>
<tr>
<td>Leachate Collection and</td>
<td>Separation Geotextile</td>
<td>LCRS CDN</td>
</tr>
<tr>
<td>Removal System</td>
<td>Drainage Gravel</td>
<td>Primary Geomembrane</td>
</tr>
<tr>
<td></td>
<td>Cushion Geotextile</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Primary Geomembrane</td>
<td></td>
</tr>
<tr>
<td>LDS</td>
<td>LDS CDN</td>
<td>LDS CDN</td>
</tr>
<tr>
<td>LDS Sump</td>
<td>LDS CDN</td>
<td>Secondary Geomembrane</td>
</tr>
<tr>
<td></td>
<td>Secondary Geomembrane</td>
<td></td>
</tr>
<tr>
<td>SLDS Sump</td>
<td>Operations layer material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LDS CDN</td>
<td></td>
</tr>
<tr>
<td>Admix Layer</td>
<td>0.9 m (3 ft) thick</td>
<td>0.9 m (3 ft) thick</td>
</tr>
</tbody>
</table>

CDN = Composite drainage net
GCL = Geosynthetic clay liner
LCRS = Leachate collection and removal system
LDS = Leak detection system
SLDS = Secondary leak detection system
Figure C-2. Integrated Disposal Facility Liner System Schematic – Base and Side Slopes
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Figure C-3. Integrated Disposal Facility Liner System Schematic – Sumps
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4.3.3—Liner System, General Items

This section provides a general description of the liner system to be used for the IDF lined landfill. The liner system was designed to prevent migration of leachate out of the lined landfill during the active life of the landfill. The Active Life will consist of the operational period and the closure/postclosure period. The liner system was designed to meet U.S. Environmental Protection Agency (EPA) requirements, as identified in RCRA Subtitle C requirements for hazardous waste disposal facilities (40 CFR 264), technical guidance documents (e.g., EPA 1985), and WAC 173-303-665. In addition, the liner system incorporates the following general functional requirements:

- Range of Operating Conditions—year-round operation, withstand construction, and long-term stresses.
- Degree of Reliability—function safely and effectively throughout operating and closure/postclosure period with minimum maintenance.
- Intended Life—operational phase plus closure/postclosure monitoring phase.

4.3.3.1—Liner System Description

The landfill liner system will comply with WAC 173-303-665 requirements for dangerous waste landfills. Figure 4-2 shows a typical design and includes the following components (from top to bottom).

- Operations layer: Minimum 0.9-meter thick of native soil. This layer provides a working surface for equipment, protect the liner from mechanical damage, and prevent freezing of the underlying low hydraulic conductivity soil layer. (Hydraulic conductivity is a measure of how rapidly a material can transmit water and is based on specific American Society for Testing Materials [ASTM] testing requirements.)
- LCRS contains a minimum 0.3-meter thick drainage gravel layer with a hydraulic conductivity of at least $1 \times 10^{-2}$ centimeter per second (sometimes including perforated drainage pipes). A nonwoven separation geotextile is located between the operations layer and the drainage gravel layer to minimize sediment (fine soil) migration into the LCRS. A nonwoven cushion geotextile is located between the drainage gravel and the primary geomembrane to protect the primary geomembrane.

The LCRS liners collect and convey leachate to the LCRS sump for removal and include the following components:

- Primary geomembrane liner: This liner consists of high-density polyethylene (HDPE) because of its excellent resistance to expected chemicals (Chapter 1.0), nominal 60-mil thickness (54 mil minimum), which is textured (to improve stability against sliding). The geomembrane acts as a moisture barrier. Located immediately above the primary geomembrane the LCRS includes a perforated pipe that helps collect and guide water into the leachate collection sump. The perforated pipe is located along the centerline of the cell and provides high-flow path water to the primary collection sump.
- Primary geosynthetic clay liner (GCL): The GCL consisting of a high-swelling sodium synthetic mat containing bentonite with a hydraulic conductivity of $1 \times 10^{-8}$ centimeter per second or less. This layer acts as an additional primary moisture barrier directly under the primary geomembrane.

The LDS is similar to the LCRS except the composite drainage net (CDN) replaces the primary gravel layer, the GCL is placed directly under the secondary geomembrane liner only under the LDS sump and the perforated pipes are not be needed because very high flow capacities are not be required.
The purpose of this system is to collect any leachate that leaks through the primary liner system and convey the leachate to the LDS sump for removal. The LDS also serves as a secondary LCRS. The LDS liners will collect and convey leakage to the LDS sump and include the following components:

- **Secondary geomembrane liner**: Same as primary geomembrane liner.
- **Secondary geosynthetic clay liner**: Same as primary geosynthetic clay liner.
- **Admix liner**: A minimum 0.9-meter-thick layer of compacted soil/bentonite admixture with a hydraulic conductivity of 1 x 10^{-5} centimeter per second or less. The bentonite is high-swelling sodium bentonite. This layer acts as an additional moisture barrier directly under the secondary geosynthetic clay liner in the LDS sump area and the secondary geomembrane outside the LDS sump area.
- **The SLDS consists of operations layer type fill for a foundation of the LDS admix layer, drainage gravel with a hydraulic conductivity of at least 1 x 10^{-5} centimeter per second adjacent to a perforated pipe, a CDN and tertiary geomembrane. A nonwoven separation geotextile is located between the operations layer type material and the drainage gravel to minimize sediment (fine-soil) migration into the SLDS piping. The purpose of this system is to provide access to the area immediately below the LDS sump area. The SLDS collects liquids resulting from construction water and potentially, liquid from other sources. The SLDS liners will convey collected liquids to the SLDS piping for monitoring and/or removal.**

4.3.3.1.4 Operations Layer

The purpose of the operations layer is to protect the underlying liner components from damage by equipment during lined landfill construction and operation. This layer also protects the admix layer from freezing and desiccation cracking.

Previous research and experience has shown that desiccation cracks can occur under geomembrane liners when either the liner is not in close contact with the compacted admix or when the liner is subjected to wide temperature fluctuations (Corser and Cranston 1991). The operations layer acts as a weight to keep the geomembrane in contact with the admix, thereby reducing the potential for water vapor to form in an underlying airspace. The operations layer also acts as an insulating layer, together with the dead air space trapped in the underlying drainage layers.

The operations layer material typically consists of onsite granular soil that is reasonably well-graded. The material has a maximum particle size limit of 5.1 centimeters or less, to facilitate protection of the underlying layers. The operations layer is composed of native soil (eolian sand and/or gravel) with a minimum 0.9 m (3 ft) thickness. This layer provides a working surface for equipment, protects the liner from mechanical damage during operations, and prevents freezing of the underlying low hydraulic conductivity soil layer. The operations layer covers both the landfill floor and side slopes.
C.4.1.2 Leachate Collection and Removal System

The LCRS is located below the operations layer and is designed, constructed, operated, and maintained to collect and remove leachate from the landfill. The LCRS provides a flow path for the leachate flowing into the LCRS sump.

Between the operations layer and the underlying drainage gravel, a geotextile layer functions as a filter separation barrier. The geotextile prevents migration of fine soil and clogging of the drainage gravel. On the lined landfill floor, the drainage gravel is a minimum 0.3-meter (1 ft)-thick layer of washed, rounded stone, with a hydraulic conductivity of at least $1 \times 10^{-2}$ cm/sec (4 x $10^{-3}$ in/sec). Between the operations layer and the underlying drainage gravel, a geotextile layer functions as a filter separation barrier. The geotextile layer prevents migration of fine soil and clogging of the drainage gravel by inhibiting the migration of fine soil into the underlying gravel. In addition, a perforated high-density polyethylene (HDPE) drainage pipe placed within the drainage gravel accelerates leachate transport into the LCRS sump during high precipitation events. On the lined landfill floor, the drain gravel layer is underlain by a geotextile cushion resting on the primary HDPE geomembrane. The geotextile cushion provides additional protection for the primary geomembrane on the floor of the landfill.

On the lined landfill side slopes, the LCRS does not have drainage gravel or geotextiles. In place of drainage gravel and geotextiles, the LCRS on the slopes has a CDN layer composed of a geonet (which is a network of HDPE strands, interwoven and bonded to form a panel that provides a drainage pathway for fluids), with a layer of geotextile thermally bonded to each side. This CDN layer has a transmissivity of at least $3 \times 10^{-5}$ meters squared (3 x $10^{-4}$ ft²) per second. The CDN is used on the side slopes to avoid problems associated with placement of clean granular material on slopes, thereby minimizing the potential for damaging the underlying liner system.

4.3.3.1.3 Primary Geomembrane Liner

The primary geomembrane liner acts both as an impermeable leachate barrier and as a flow surface, routing leachate to the primary sump. HDPE was used because of its high resistance to chemical deterioration. Generally, textured (roughened) geomembrane is used to maximize shear strength along adjacent interfaces and to reduce the potential for sliding of the liner system.

4.3.3.1.4 Primary Geosynthetic Clay Liner Layer

A primary GCL consists of a mat of bentonite placed between two geotextiles. The GCL is installed immediately beneath the primary HDPE liner on the floor of the lined landfill only. The purpose of this liner is to provide extra protection in the case of deterioration (such as stress cracking) of the primary geomembrane where operations will continue for several years.

The in-place hydraulic conductivity of the GCL is $1 \times 10^{-8}$ centimeter per second or less, exceeding the WAC hydraulic conductivity requirement for the secondary soil liners. The upper surface of GCL provides a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.5 Leak Detection System

The LDS is capable of detecting, collecting, and removing leaks of dangerous constituents at the earliest practicable time through the areas of the primary liner that are likely to be exposed to leachate. The LDS provides the flow path for leachate flowing into the LDS sump. The following is a description of the system to be used in the IDF landfill.
The LDS has a CDN drainage layer on the floor, and a CDN drainage layer on the side slopes. The CDN consist of a layer of geotextile thermally bonded to each side of the geonet. These materials and their configuration is similar to the LCRS described in Section 4.3.3.1.2, except for the absence of a drainage gravel layer and a perforated drainage pipe system on the floor of the lined landfill. The LDS will channel leachate that penetrates the primary liner system through the CDN into the leak detection LDS sump.

The LDS serves as a secondary LCRS for the IDF. Leachate collected in the secondary LDS sump will be measured to determine the leakage rate through the primary liner.

4.3.3.1.6 Secondary and Tertiary Geomembrane Liner

The secondary geomembrane liner, located underneath the LDS, is placed directly against the secondary compacted soil/bentonite mixture (admix liner), along the base and side slopes, except in the LDS sump area, which includes a GCL between the secondary geomembrane liner and the secondary compacted admix liner. For information only, the tertiary geomembrane liner for the SLDS is placed directly against the primary liner layers. The secondary and tertiary geomembrane liners are identical to the primary geomembrane described in Section 4.3.3.1.3. The secondary GCL material is identical to the primary GCL described in Section 4.3.3.1.4.

C.4.1.4 Landfill Sumps

The liner system layers are intended to collect and convey leachate to the sump areas of the LCRS, LDS, and SLDS. There is a sump located in each disposal cell. The LCRS sumps are 4.6 m² (50 ft²) long troughs lying 0.15 m (0.5 ft) below the base of the LCRS. The LCRS sump liner layers are identical to the LCRS base liner system. The LDS sumps lie 0.46 m (1.5 ft) below the base of the LCRS sumps and contain an additional 0.46 m (1.5 ft) of drainage gravel, underlain by a cushion geotextile, secondary geomembrane and secondary GCL identical to the primary liner layers. The SLDS is comprised of sumps located below the LCRS and LDS sumps and the 0.9 m (3 ft) admix layer. The SLDS sump extends 0.8 m (2.5 ft) below the base of the admix layer and is composed of operations layer material underlain by an SLDS CDN and SLDS (Tertiary) Geomembrane.

4.3.3.1.7 C.4.1.5 Secondary Admix Layerliner

The IDF landfill is lined with secondary admix liner has a minimum 0.9 -meter (3 ft) -thick layer of compacted soil/bentonite admixture (admix) located immediately beneath the secondary geomembrane HDPE liner, as required by WAC 173-303-665. This layer acts as an additional moisture barrier directly under the secondary geomembrane. The secondary admix liner typically consists of silty sand from local borrow sources mixed with a nominal 12 percent sodium bentonite, by dry weight. The admix layer has an in-place hydraulic conductivity of the admix liner is no more than 1 x 10⁻⁷ centimeters/second or less, consistent in accordance with WAC 173-303-665(2)(i)(B) requirements for secondary soil liners. The upper surface of the secondary admix liner is trimmed to the design grades and tolerances. The surface was rolled with a smooth steel drum roller to remove all ridges and irregularities. The result is a smooth uniform surface on which to place the overlying geomembrane liner.

4.3.3.1.8 Subgrade/Liner System Foundation

The lined landfill in the IDF is founded in undisturbed native soils or material compacted to at least 95% of a standard proctor maximum density (determined by ASTM D698). The liner system foundation is discussed in further detail in Section 4.3.4.
4.3.3.1.9 Access Ramp

The lined landfill has an access ramp outside the lined portion of the landfill, minimizing damage to the liner system from vehicle traffic into the lined landfill. As the landfill expands the access ramp will be reconstructed to the south of each expansion in the landfill. The access ramp design could vary as the landfill expands.

4.3.3.1.10 Landfill Expansion

The initial phase of the IDF liner was complete at the north end of the landfill. As shown in Figure 4.1, construction of the initial IDF phase completed the liner system on the north sideslope and the excavated portions of the landfill floor, east sideslope, and west sideslope. The dashed line of Figure 4.1 across the south edge of the landfill floor denotes the southern extent of the landfill liner. The liner system will be installed to extend approximately 1.5 meters beyond the estimated toe of slope of the first phase waste placement. This extension will also allow waste haul vehicles to be staged or unloaded over a lined area. Termination detail for the south edge of the liner system is found in Appendix 4A, drawing H-2 830840. The south sideslope of the first phase of IDF is not lined to allow future expansion of the IDF. At the south end of the cells is a storm water berm/ditch with an infiltration area, which will capture clean runoff from the unlined south sideslope before it runs onto the lined landfill. The landfill floor slopes up 1% from north to south to allow adequate leachate collection capacity for a 25-year storm event. Each future liner construction project will connect to the south edge of the previously constructed liner and operations systems and extend the disposal area further to the south. With the expansion of the IDF in subsequent phases, access ramps for the previous phase will be destroyed and new ramps built on the south edge of the landfill.

4.3.3.2 C.4.1.6 Liner System Location Relative to High Water Table

The water table is located approximately 90 to 100 meters (295 to 328 ft) below the ground surface at the IDF. It is anticipated that the deepest point of the liner system is no greater than 20 meters (66 ft) below ground surface. Consequently, the liner systems is at least 69 meters (226 ft) above groundwater. The liner systems will not be affected by the water table because of this large elevational difference.

4.3.3.3 C.4.1.7 Loads on Liner System

The liner system experiences several types of stresses during construction, operation, and closure/postclosure periods. The following sections discuss the types of stress and analytical methods used to design the IDF liners.

4.3.3.4 C.4.1.7.1 Liner Stresses from Installation or Construction Operations

The side slope geosynthetic liner components can experience some stress particularly during installation and before placing waste in the lined landfill but also during the entire lifecycle.

The HDPE liner is temperature sensitive, expanding and contracting with changes in as liner temperatures increase and decrease. Thermally induced stresses can develop in the liner if deployment and anchoring occur just before a significant decrease in the liner temperature. The operations layer is sufficiently thick to ensure liner stress remains well below the yield strain and stress. Administrative procedures will prevent loading and backfilling of waste exceeding applicable thermal limits due to recent vitrification processes to avoid potential liner damage.

The drainage gravel has the potential to produce localized stress on the geomembrane liner during gravel placement with construction equipment. The geotextile placed at the base of the drainage gravel protects the underlying geomembrane. A puncture analysis was performed to select a sufficiently thick cushion geotextile. This analysis incorporated expected construction vehicle ground pressures and assumed drainage gravel gradation listed in the construction specifications. A safety factor of three was used when evaluating puncture stress. If required, engineering controls such as independent foundations will be installed to minimize liner stress involved with large package disposal.

Addendum C
On the landfill sideslopes, tension induced by liner component load transfer is not anticipated, because the liner interface effective shear strength angles are higher than the sideslope angles. The liner component interface strengths were determined by laboratory direct shear tests. Both static and dynamic stability analyses were performed, using standard methods, design accelerations, and factors of safety.

Stresses on the geomembrane in the anchor trench also were evaluated during detailed design. Wind uplift and thermal expansion and contraction could cause stress in the geomembrane during construction. However, these stresses are not a problem, because they are relatively low compared to the tensile strength of the liner. In addition, these stresses are minimized by using sand bags to control liner position during liner panel placement and welding, as well as keeping the anchor trench open until the liner is stabilized with overlying fill material. Placement of overlying fill material is controlled to limit stress buildup in the liner. The stress is not present after construction, because of the weight and insulating properties of the operations layer.

4.3.3.2 C.4.1.7.2 Stress Resulting from Operating Equipment

Loads on the liner system due to operating equipment are expected to be less severe than those generated by construction equipment. Operating equipment is typically lighter than construction equipment, and analyses show that the 0.9 m (3 ft) thick operations layer dissipates stresses produced by the operating equipment sufficient to protect the IDF liner system. Operations equipment provides a design load case on the IDF liner, which was analyzed as part of the IDF design (Appendix C14A). The analyses show that the 0.9-meter-thick operations layer dissipates stress produced by the operating equipment and is sufficient to protect the IDF liner system. Operating equipment does not pose a risk of puncture or other damage to the primary liner, or damage to berms. Only equipment that can be adequately supported by the operations layer, considering the geotechnical properties of the operating layer soil and the design and configuration of such equipment, will be used within the lined portion of the IDF.

The maximum allowable ground pressure weight limit of 63,770 kg/m² (13,060 lb/ft²) is controlled by performing a ground pressure evaluation of vehicles/equipment that could potentially be used on the cell floors. This evaluation is by simple review for equivalency or by informal or formal calculation. A list of vehicles/equipment approved for use on the IDF cell floors will be maintained in the IDF portion of the Hanford Facility Operating Record. Approval for entry of vehicles/equipment onto the cell floors is granted after verifying the vehicle/equipment is covered by the list of approved vehicles/equipment in the operating record. Vehicle or equipment traffic is not allowed on the disposal cell side slopes or shine berm unless specifically authorized by the IDF Facility Manager.

4.3.3.3 C.4.1.7.3 Stress from Maximum Quantity of Waste, Cover, and Proposed Closure/Post-Closure Land Use

When the lined landfill is full and the cover system is in place, the liner system will experience a static load from the overlying waste, backfill, and cover materials when the lined landfill is full and the final cover is in place. No significant increase in stresses on the liner system is anticipated from closure/postclosure land use. The maximum design load of material overlying the liner system includes an allowance for the cover system. Analyses include puncture resistance protection of the geomembranes by the cushion geotextile, and decrease in transmissivity of CDNeocomposite drainage layers. Materials were specified based on their ability of the materials to perform adequately under closure/postclosure loading conditions. The maximum quantity of waste, fill material, and the closure cover will not exceed 63,770 kg/m² (13,060 lb/ft²).
Dynamic stresses on the liner system will result primarily from ground accelerations during seismic events. Both static and dynamic analyses were performed on the subgrade and liner components based on the finished configuration of the empty landfill. Under closure/postclosure conditions, the waste, backfill, and cover materials will tend to buttress the liner system, under closure/post-closure conditions, resulting in greater stability relative to the operational phase. All of the analyses verified adequate stability for the IDF.

Administrative procedures will prevent loading and backfilling of waste exceeding applicable thermal limits due to recent vitrification processes to avoid potential liner damage. Waste packages with elevated temperatures shall be evaluated and managed in a manner to maintain the primary liner below the design basis temperature for the liner (71°C [160°F]). Waste packages with elevated temperatures shall be evaluated and managed in a manner to maintain the primary liner below the design basis temperature for the liner. If required, engineering controls such as independent foundations will be installed to minimize liner stress involved with package disposal.

### 4.3.3.3.4 Stresses Resulting from Settlement, Subsidence, or Uplift

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, non-cohesive, and drained nature of the soil. The subgrade rebounded during the excavation phase of construction and will settle as the landfill is filled. The compacted admix liner will consolidate under waste loads. The total settlement will be a combination of the subgrade elastic and the admix consolidation settlements.

These settlements were analyzed with standard methods during detailed design of the lined landfill. In general, differential settlements will be expected to occur primarily across the lined landfill sideslopes as the thickness of waste decreases from maximum to zero. The geosynthetic liner components were analyzed, the anticipated strains likely will not produce any appreciable stresses in the liner system.

The potential for subsidence-induced stress is believed to be negligible based on the following information:

- The soils underlying the IDF tend to be coarse-grained soils, sands, and gravels, in a relatively dense configuration that will not be subject to piling effects that could transport soil resulting in subsidence.
- The groundwater level is deep, at least 69.6 meters below the base of the lined landfill, and will not affect bearing soils.
- No natural voids, or man-made mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater below the lined landfill.

The potential for stresses resulting from uplift on the liner system also is expected to be negligible. The seasonal groundwater level is very deep, and higher elevation perched groundwater likely will not develop because of the absence of aquitards in the coarse-grained Hanford formation underlying the IDF. The coarse-grained nature of the Hanford formation also promotes rapid, primarily vertical, infiltration, which means it is unlikely that infiltration from outside the lined landfill boundary would be transported laterally underneath the landfill liner. Gas pressures similarly are unlikely to develop because of the absence of any organic material that could generate significant subsurface gas (from organic material decomposition) and the coarse-grained, highly permeable sands and gravels underlying the landfill.
4.3.3.5 Internal and External Pressure Gradients

Pressure gradients across the liner caused by liquids or gases will be expected to be negligible. Internal pressures due to liquids will be controlled by the LCRS. Because leachate will be removed from the flat 50 foot by 50 foot LCRS sump in a timely manner, there will be minimal liquid head on the liner (less than 30.5 centimeters according to WAC regulations). Gas generated internally is expected to be minimal because waste is inorganic and non-reactive. However, any pre-closure internally generated gas will be vented through either the waste or the leachate collection system. The closure cover design will consider gas venting.

External pressures on the liner system is expected to be minimal. Gas pressures will be negligible because the subgrade soil contains no gas producing materials and is highly permeable, readily venting any potential gas to the atmosphere. External pressure from liquids is not anticipated because of the deep groundwater table and the highly permeable foundation soils.

4.3.4 C.4.1.8 Liner System Coverage

The liner system covers all soils underlying the lined landfill and extends over the crest of the side slopes into the anchor trench (Figure 4-2, Detail 3). Liner system details are shown in Engineering Drawing H-2-830836 and H-2-830838 in Appendix C3.

4.3.5 C.4.1.9 Liner System Exposure Prevention

No geosynthetic or admix components of the liner system are exposed to the atmosphere. The minimum 0.9-meter (3 ft) thick operations layer covers the entire lined landfill surface. This layer serves both as a physical protective barrier and as thermal insulation, protecting the admix layer from desiccation and frost damage.

Excessive erosion of the operations layer, such as gullying, will be repaired by replacing the eroded soil. Dust suppression agents will be used to prevent excessive wind erosion on the landfill side slopes. The dust suppression agents will bind the surface of the operations layer and will minimize wind entrainment of soil. Section C.4.8 discusses control of wind dispersal.

4.4 C.4.2 Subgrade Liner System, Foundation

The following sections discuss the subgrade foundations beneath the IDF liner systems. The excavated subgrade surface was moisture conditioned and compacted as required to achieve the specified compaction before placing the admix layer.

4.4.1 C.4.2.1 Foundation Description

At the IDF, the Hanford formation consists mainly of sand dominated facies with lesser amounts of silt dominated and gravel dominated facies. Where sands are present, these sands are underlain by the Hanford formation. Here, the Hanford formation has been described as poorly sorted pebble to boulder gravel and fine to course grained sand, with lesser amounts of interstitial and interbedded silt and clay at the IDF.

The two geologic units pertinent to the IDF lined landfill are summarized as follows.

- Recent eolian sand: The sand is light olive gray in color and has a density that is loose at the surface but becomes compact with depth. The sand has a fine to medium grain size and includes little to some nonplastic silt-sized fines. The deposit is homogeneous except for a distinguishable layer of volcanic ash in some locations.
- Glaciofluvial flood deposit: This deposit has well graded mixtures of sands and gravels with trace to little non-plastic silt-sized particles. The gravel content can vary with depth, and the deposit can become predominantly gravel. This coarse-grained deposit is part of the Cold Creek Bar, which was formed during the Pleistocene Epoch by glacial outburst flooding.
4.3.4.2 C.4.2.2 Subsurface Exploration Data

Geological site investigations were used to support the detailed design of the landfill. The investigations consisted of a review of historical data, including well logs (Chapter 5.0), exploratory borings, and surface pit samples data. Because the foundation soils are relatively consistent over broad areas, the need for additional borings and geophysical investigations will be determined on a case-by-case basis. If boreholes are drilled, penetration test data will be collected to determine the strength of the foundation materials in situ.

4.3.4.3 C.4.2.3 Laboratory Testing Data

Laboratory testing will be performed on the surface soil samples and borings, both from the lined landfill site and from potential borrow source locations as follows. Testing will be performed to classify soils, provide input parameters to verify engineering analyses, and for preparing material and construction specifications. The following tests will be performed on the soil samples:

- Visual classification (ASTM D2487)—to classify soils.
- Natural moisture content (ASTM D2216)—for input to engineering analyses and preparing construction specifications.
- Particle size analysis (ASTM D422 or D1140/C136)—for classification and input to engineering analyses.
- Moisture-density relationships (ASTM D698 or D1557)—for preparing compaction specifications.

Laboratory testing will be performed according to the most recent versions of ASTM methods or other recognized standards. Additional tests will be performed as needed.

4.3.4.4 C.4.2.4 Engineering Analyses

The subgrade will be required to support the liner system and overlying materials (waste, fill, and cover) without excessive settlement, compression, or uplift that could damage the liner system. This section describes the design approach used to satisfy these criteria.

4.3.4.4.1 C.4.2.4.1 Settlement Potential

The subgrade settlement produced by waste loading essentially will be elastic because of the coarse-grained, non-cohesive, and drained nature of the soil. The subgrade will rebound during the excavation phase of construction and will settle as the landfill is filled. The compacted admix liner will consolidate under waste loads. The total settlement will be a combination of the subgrade elastic and admix consolidation settlements.

An elastic These settlements were analyzed using standard methods during detailed design of the lined landfill. The performed and results indicate the magnitude of the total and differential settlement is within performance limits. In general, differential settlements will be expected to occur primarily across the lined landfill side slopes as the thickness of wastes decreases from maximum to zero. Settlement-induced strain from foundation and admix soil settlement under maximum landfill content pressure will have no adverse impact on lining system function.

4.3.4.4.2 C.4.2.4.2 Bearing Capacity

The bearing capacity of the subgrade soil will need to support structures such as leachate collection tanks and support buildings. The construction specifications typically require that the upper portion of the subgrade soil and all structural fill be moisture conditioned and compacted to at least 95 percent of the maximum standard Proctor dry density (ASTM D698). Maximum allowable bearing capacities for foundations have been established using standard geotechnical methods. Bearing capacities for the types of soils expected at the IDF typically are greater than the maximum expected loads from the support structures.
4.3.4.3 C.4.2.4.3 Stability of Lined Landfill Slopes

The lined landfill was constructed in eolian sand and the underlying coarse-grained Hanford formation. In granular, cohesionless, and drained soils such as these, the stability of the slope will be related primarily to the maximum slope angle. Both veneer and global stability analyses were performed to determine both static and dynamic side slope stability. On the landfill side slopes, tension induced by liner component load transfer is not anticipated, because the liner interface effective shear strength angles are higher than the side slope angles. The liner component interface strengths were determined by laboratory direct shear tests. Results demonstrate adequate stability for the IDF throughout its design life.

9.4.3.4.4 C.4.2.4.4 Potential for Excess Hydrostatic or Gas Pressures

No external hydrostatic pressure will be expected because the seasonal high-water level is at least 69 meters (226 ft) below the base of the deepest lined landfill. No external hydrostatic pressure will be expected from this source. Because of the coarse-grained nature of the foundation soils, any infiltration of surface water around the perimeter of the lined landfill will be expected to travel primarily downward. Therefore, infiltration should not cause substantial pressure on the exterior of the liner system. Internal hydrostatic pressure from leachate will be negligible because the leachate will be removed from the lined landfill to limit head on the liner.

Gas pressure exerted externally on the liner system is expected to be negligible, because no gas-generating material (i.e., organic material) is expected in the foundation soils. If any gas were generated below the liner system, little pressure buildup would occur because of the unsaturated coarse-grained nature of the foundation soils, which would vent the gas to the atmosphere. Internal gas pressure buildup will not be anticipated, because wastes are generally inorganic and have low gas generating potential. Additionally, the leachate collection system will be vented to the atmosphere and dissipates any gas.

4.3.4.4.5 C.4.2.4.5 Seismic Conditions

Potential hazards from seismic events will include faulting, slope failure, and liquefaction. Disruption of the lined landfill by faulting is not considered a significant risk because (1) no major faults have been identified at the IDF (DOE/RW-0164, Site Characterization Plan: Reference Repository Location, Hanford Site, Washington) and (2) only one central fault at Gable Mountain on the Hanford Site shows evidence of movement within the last 13,000 years. The potential for slope failure is considered low, because granular materials typically have high strengths relative to the maximum side slope angles expected for the lined landfill. Liquefaction will occur in loose, poorly graded granular materials that are subjected to shaking from seismic events. Saturated soils will be most susceptible because of high dynamic pore pressures that temporarily lower the effective stress. During this process, the soil particles will be rearranged into a denser configuration, with a resulting decrease in volume. The foundation materials at the IDF are not considered susceptible to liquefaction because the materials are well-graded granular soils that are unsaturated and relatively dense.

The IDF support building (not sited within the Treatment, Storage, and Disposal [TSD] boundary) will be located in Zone 2B as identified in the Uniform Building Code (ICBO 1997).

4.3.4.4.6 C.4.2.4.6 Subsidence Potential

In general, subsidence of undisturbed foundation materials would be the result of dissolution, fluid extraction (water or petroleum), or mining. The potential for subsidence will be negligible at the IDF based on the following:

- The soils underlying the IDF are coarse-grained sands and gravels, in a relatively dense configuration, which are not subject to piping that can cause transport of soil and resulting subsidence.
- The groundwater level is deep, at least 69 meters (226 ft) below the base of the lined landfill, and does not affect bearing soils.
- The soil and rock types below the IDF are not soluble.
- No mining or tunneling has been noted. If the groundwater level was lowered substantially and consolidation occurred in the aquifer, local site-specific subsidence would be negligible because of the depth of the groundwater table below the lined landfill.

4.3.4.7 Sinkhole Potential

Borings in and around the IDF have not identified any soluble materials in the foundation soils or underlying sediments. Consequently, the potential for any sinkhole development is negligible.

4.3 Liner System - Liners

The following sections discuss the individual components of the IDF liner systems.

4.3.5 Synthetic Liners

As described in Section 4.3.3, the synthetic liners act as an impermeable barrier for leachate migration (Figure 4-2C-3). The synthetic liners consist of HDPE material that make the liners resistant to chemical deterioration. Section 4.3.3 describes the synthetic liner system in detail. The HDPE was deployed with the length of the roll parallel to the slope. Adjacent panels were overlapped and thermally seamed using fusion or extrusion methods. Seams were inspected continuously using air pressure tests. A vacuum box was used in areas where air pressure tests could not be used (e.g., extrusion weld areas). Destructive seam tests (ASTM D4437) (peel and adhesion) were performed on samples taken at regular intervals.

- Geomembrane Liner: The geomembrane liner consists of a chemical resistant, nominal 1.5-mm (60-mil) thickness HDPE. The geomembrane liner acts as both an impermeable leachate barrier and as a flow surface, routing leachate to the sump area for recovery. The geomembrane liner is textured to prevent sliding and maximize shear strength.
- Cushion Geotextile Liner: The cushion geotextile liner is a non-woven geotextile with nominal 407 g/m² (12 oz/yd²) weight and serves to protect the geomembrane liner.
- Geosynthetic Clay Liner: The GCL consists of a mat of bentonite placed between two geotextiles. The GCL provides extra protection in the case of deterioration (such as stress cracking) of the geomembrane liner. The in-place hydraulic conductivity of the GCL is $1 \times 10^{-8}$ cm/sec ($3.9 \times 10^{-9}$ in./sec) or less.
- Composite Drainage Net: The CDN layers are composed of a geonet bonded to a layer of geotextile on each side. The geonet is a network of HDPE strands interwoven and bonded to form a panel that provides a drainage pathway for fluids. The CDN layer has a transmissivity of at least $3 \times 10^{-5}$ m²/sec ($3.2 \times 10^{-4}$ ft²/sec).

On the landfill floor, the primary geomembrane liner underlies the drainage gravel and cushion geotextile and is in contact with the GCL. The primary geomembrane is protected from the coarser drainage gravel and admix layers by overlying geotextile cushion or CDN layers. These geotextiles were designed to provide adequate protection during construction and operation to withstand the loads discussed in Section C.4.1.7. The secondary geomembrane liner is in direct contact with the compacted admix layer.

4.3.5.2 Synthetic Liner Compatibility Data

During detailed design of the lined landfill, the composition of the expected leachate was estimated. Expected leachate composition was based on known waste composition, process information, leachate from other operating lined landfills, and similar sources of data. Leachate constituents were compared to manufacturers' chemical compatibility data for synthetic liner components. In addition, the results of previous chemical compatibility testing and studies were evaluated against leachate composition.
Information gained from this evaluation was used to select a liner that will be compatible with the expected leachate. Compatibility testing for leachate tank liner material is planned for construction. An immersion test program is included in the technical specifications for the tank liner (anticipated to be XR-5 material). The immersion testing program will require the construction general contractor to submit tank liner samples to the design engineer for immersion testing as part of the submittal and certification process for the tank. Immersion testing will follow EPA 9090A (and ASTM) test protocols.

During landfill operation, the compatibility of waste receipts with the liner will be ensured. The compatibility of the waste constituents with the liner material will be established by laboratory testing if determined to be necessary, based on waste type and concentrations. Such tests will follow EPA Method 9000A or other appropriate methods. Test results will be evaluated using statistical methods and accepted criteria (based on past projects and agency acceptance) for liner/leachate compatibility.

4.3.5.3 Synthetic Liner Strength

As discussed in Section 4.3.3.3, the liner system will experience loads from several sources. During the detailed design process for the landfill, the strength of liner system materials was evaluated against these loads. The analysis indicated an adequate factor of safety for liner system materials.

Seams in geomembranes is a critical area; however, correct installation methods make the seams stronger than the surrounding material. Detailed installation and testing requirements will be included in the Construction Quality Assurance Plan (Section 4.3.7.3) to ensure that the liner is constructed properly. In addition, methods will be established to demonstrate adequate seam strength is achieved during installation.

Seaming requirements for the geotextiles and CDN: These materials were overlapped sufficiently to provide complete area coverage, and relatively light seams were used to hold the panels in position during construction; seam strength requirements for these materials will be negligible.

4.3.5.4 Synthetic Liner Bedding

The primary geomembrane liner is in contact with the GCL and geotextile cushion underlying the drainage gravel.

The secondary geomembrane liner is in direct contact with the compacted admix layer. This type of subgrade is typical for flexible geomembrane liners.

With respect to the drainage gravel and operations layers, the geomembranes are protected by overlying geotextile cushion or CDN layers. These geotextiles were designed to provide adequate protection during construction and operation to withstand the loads discussed in Section 4.3.3.3.

4.3.5.5 Soil Liners

The IDF landfill is lined with a minimum (0.9 m (3 ft)eter thick) layer of compacted soil/bentonite mixture (admix) under the secondary geomembrane liner. This layer has an in-place hydraulic conductivity of less than $1 \times 10^{-7}$ centimeter/second ($3.9 \times 10^{-8}$ in./sec). The soil component of the admix is silty, fine sand or similar material from areas near the IDF. The soil was free of roots, woody vegetation, rocks greater than 2.5 cm (1 in.) in diameter, and other deleterious material. Approximately 12 percent bentonite by dry weight was added to the fine soil to achieve sufficiently low hydraulic conductivity; however, the percent might vary.
4.3.5.1 Material Testing Data

Laboratory testing will be performed on soil liner materials to confirm input parameters for engineering analyses and for refining material and construction specifications.

Before constructing the lined landfill, a full-scale test fill of the admix material will be conducted. The primary purpose of the test fill will be to verify that the specified soil density, moisture content, and hydraulic conductivity values will be achieved consistently using proposed compaction equipment and procedures. In-place density will be measured using both the nuclear gauge (ASTM D2922) and sand cone (ASTM D1556) methods. In-place hydraulic conductivity will be determined from a two-stage infiltration from a borehole (ASTM D6391). Admix hydraulic conductivity will be estimated from thin-wall tube samples (ASTM D1587) obtained from the test fill and tested in the laboratory (ASTM D5084). Details of the test fill are presented in the Construction Quality Assurance Plan (Appendix 4B). During construction, field density (e.g., ASTM D2922, D2167, and/or D1556) and moisture content (ASTM D2216) will be measured periodically. Thin-wall tube samples (ASTM D1587) will be taken at regular intervals and will be tested for hydraulic conductivity (ASTM D5084). Additional details of field testing during construction will be presented in the Construction Quality Assurance Plan.

The soil and bentonite were blended thoroughly and moisture conditioned so that the admix is uniform and homogeneous throughout. The admix layer was placed in loose lifts and compacted to that the compacted lift meets the requirements of the “Construction Quality Assurance Plans” (Appendix C4). Each new life of admix was kneaded into the previously placed lift. The methods for admix preparation, type of compaction equipment, number of passes, and other details of the placement process was determined by constructing a test fill section before placing admix in the lined landfill.

The admix soil testing program involved testing the permeability of various combinations of sand and bentonite to achieve a compacted admix permeability of less than or equal to $1 \times 10^{-7}$ cm/sec ($3.9 \times 10^{-8}$ in./sec). The final surface of the soil liner was rolled smooth before placing the overlying geomembrane.

Dispersion and piping in the admix are not considered likely because the hydraulic conductivity permeability, and thus the flow velocity, will be very low, making it difficult to move the soil particles or otherwise disrupt the soil fabric. In addition, the admix will be well graded, so the component particles will tend to hold each other in place. Therefore, testing for these characteristics will not be necessary.

Following the completion of placement, compaction, and trimming of the secondary soil liner, an as-built survey of the soil liner surface was performed. Preconstruction specifications required a minimum secondary soil liner thickness of 0.9 m (3 ft), measured perpendicular to the subgrade surface. Testing of the secondary soil liner was conducted in a manner similar to that of the primary soil liner.

4.3.5.2 C.4.3.3 Soil Liner Compatibility Data

As discussed in Section 4.3.5.2, expected leachate composition was determined as part of detailed landfill design. The results of previous chemical compatibility testing and studies were evaluated against leachate composition to determine the effect of leachate on soil liner composition or hydraulic conductivity. The tests followed the procedures of ASTM D5084 (flexible wall parameter) and considered the effects of radiation on the soil liner materials.

During detailed design of the lined landfill, the composition of the expected leachate was estimated. Expected leachate composition was based on known waste composition, process information, leachate from other operating lined landfills, and similar sources of data. Leachate constituents were compared to manufacturers’ chemical compatibility data for synthetic liner components. In addition, the results of previous chemical compatibility testing and studies were evaluated against leachate composition.
Information gained from this evaluation was used to select a liner that is compatible with the expected leachate.

During landfill operation, it will be ensured that the waste is compatible with the liner. The compatibility of the waste constituents with the liner material will be established by laboratory testing if determined to be necessary, based on waste type and concentrations. Such tests will follow U.S. Environmental Protection Agency (EPA) Method 9090A or other appropriate methods. Test results will be evaluated using statistical methods and accepted criteria (based on past projects and agency acceptance) for liner/leachate compatibility.

The LCRS and LDS are composed of inert geologic materials (sand and gravel), HDPE, and other geosynthetic materials such as polypropylene. To ensure that the geosynthetics used in the lined landfill are similar chemically to those evaluated, manufacturers are required to submit quality control certificates and other manufacturing information on all materials.

Before a new waste constituent that has not been previously analyzed (based on a dangerous waste code) is allowed in the lined landfill, the waste constituent will be evaluated for compatibility with the liner (e.g., identified in 9090A test results or other appropriate testing methods, etc.). Other materials could contact the leachate, such as:

- HDPE and Polyvinyl chloride (PVC) piping,
- PVC and other plastics.

Compatibility of these materials with the expected leachate was considered in the landfill liner system design. Compatibility of these materials is of lesser concern, because these materials will be located entirely within the containment area. Failure of these items would not result in a dangerous waste release, and the materials would be replaced or repaired.

### 4.3.5.3 Soil Liner Thickness

The IDF was designed to operate to minimize the leachate head over the liner systems.

Design of the primary liner system included an additional clay layer (the primary GCL layer, which was previously described in Section 4.3.3.1) underlying the primary HDPE geomembrane to further minimize liner leakage from the primary liner. Note that only a single geomembrane is required under WAC 173-303 for the primary liner.

Calculations evaluated the effectiveness of the primary soil liner as a barrier to leachate. Leakage analyses were performed for the primary liner system using EPA’s Hydrologic Evaluation of Landfill Performance (HELP) Model (Schroeder et al. 1997). Estimated leakage rates were compared to the action leakage rate (which is defined in WAC 173-303-665[8] as “the maximum design flow rate that the LDS... can remove without the fluid head on the bottom liner exceeding 1 foot”), and were determined to be much lower than the action leakage rate. This demonstrates the benefit of the GCL included in the primary bottom-lining system, which provides a composite lining system and minimizes actual leakage through the bottom primary lining system.

Overall, the IDF is designed to actively convey and collect leachate from the liner areas of the facility to minimize leachate buildup over the liners. Leachate is conveyed to the LCRS and LDS sumps for active removal from the facility. In addition, the LCRS sump area has been designed with a 6-inch deep sump trough where the LCRS pumps are positioned to minimize the area of the sump that has a permanent liquid level (below the pump intake/shutoff elevation). Both the LCRS and LDS sump pumps will be operated throughout the Active Life of the facility and into the postclosure period until leachate generation has essentially ceased. By actively removing leachate from the IDF, head buildup is minimized, which in turn minimizes leakage through both the primary and secondary liner systems.
4.3.5.4 Soil Liner Strength

The expected loads on the liner system are discussed in Section 4.3.3. Significant stresses in the soil liner that were considered include (1) stresses from the weight of the liner system, (2) stresses on the interface with the overlying materials, and (3) stresses during construction.

Stresses will be present on the sideslopes from the weight of the operations layer and soil liner itself. Using material properties determined from laboratory testing, the stability of the soil liner was evaluated under both static and dynamic loading conditions. Standard methods of slope stability analysis were used. Interface strengths were found to provide adequate veneer stability for the liner system. Interface strength is the shear strength that occurs between layers of liner materials at their interface boundary, as established by ASTM test methods.

The primary concern during construction will be bearing failure caused by the weight of overlying soil components of the liner system (e.g., drainage gravel on the floor) and the construction equipment used to spread these materials. Strength parameters developed from laboratory testing and standard analytical methods were again used to determine that adequate stability and bearing capacity exist for the IDF liner system.

4.3.5.5 Engineering Report

An engineering report was prepared for the lined landfill as part of the definitive design document package. The report describes the design of the liner system and includes supporting calculations. The critical systems: IDF Design Report is provided in Appendix 4A. The final IDF design report was prepared under the supervision of a professional engineer registered in Washington State.

4.3.6 C.4.4 Liner System - Leachate Collection and Removal System

The purpose of the LCRS is to provide sufficient hydraulic conductivity and storage volume to collect, retain, and dispose of, in a timely manner, fluids falling on or moving through the waste. The primary LCRS provides the preferential path along which the leachate flows into the primary sump. The secondary LCRS (also called the LDS) is located between the primary and secondary geomembranes. The secondary LCRS provides the preferential path along which any fluids leaking through the primary liner system flow to the secondary sump.

The collected leachate will be pumped to a leachate collection tank, screened and/or sampled, and transferred to a permitted treatment and disposal unit below the operations layer and is designed, constructed, operated, and maintained to collect and remove leachate from the landfill. The following sections provide details about the LCRS.

4.3.6.1 C.4.4.1 System Operation and Design

The lined landfill operates in a way that ensures the bottom liner is maintained as dry as possible, and the head on the top liner is maintained as dry as possible. The head on the top liner is calculated to not exceed 30.5-centimeters (1 ft) measured above the flat. In extreme conditions (i.e., in excess of a 25-year storm event), the leachate depth on the primary liner could exceed 30.5-centimeters (1 ft) for short durations. The operating methodology, described in the following paragraphs, ensures that liquids on the secondary bottom liner are removed continuously before liquids could accumulate and exceed 30.5-centimeters (1 ft) for the design storm event.

Both the LCRS and the LDS leachate collection systems operate either manually or automatically. When operated automatically, liquid level sensors will cycle the pumps on and off, in response to rising and falling leachate levels in the sumps. The leakage rate through the top primary liner will be calculated to demonstrate that the leakage rate is less than the 'action leakage rate'. Data to support the leakage rate calculations will be obtained either from the flow totalizer in the secondary leachate collection system or from the pump discharge line or from the liquid level gauges. The action leakage rate (ALR) is discussed in more detail.
4.3.6.1.4 **C.4.4.1.1 Leachate Collection and Removal System Primary System**

The base of the LCRS is defined by the primary geomembrane. On the floor of the lined landfill, the primary geomembrane is overlain by geotextile cushion, and the granular drainage layer. The granular drainage layer drains to the primary sump and a perforated pipe is located along the centerline of the cell to increase flow capacity to the primary sump. Geotextile layers at the top of the LCRS prevent migration of fine soil particles into the gravel or geonet, thus prevent clogging. On the sideslopes, a CDN layer is over the geomembrane. The CDN includes bonded geotextiles on both sides of a geonet that increase the interface shear strength. Because of construction difficulties in placing a 30.5 cm thick gravel layer on 3:1 sideslopes, no drainage gravel was placed on the sideslopes.

The LCRS is covered by the operations layer. The operations layer is a minimum 0.9 meter (3 ft) thick, and provides protection for the underlying liner and drainage materials. The operations layer covers both the landfill floor and the side slopes. The LCRS is described in more detail in Section C.4.1.2.

The LCRS was designed to accommodate the 25-year, 24-hour storm, as required by WAC regulations. However, the EPA recognizes the need to store temporarily leachate from such rare events (EPA 1985). Should a storm event occur that exceeds the 25-year, 24-hour storm event, the LCRS sump is designed to store temporarily leachate at a depth greater than 30.5 centimeters (1 ft), as opposed to the alternative of constructing an excessively large leachate collection tank.

The LCRS sump is equipped with two sump pumps. One pump is a high capacity pump capable of rapid removal of large volumes of leachate, and is suitable for the transfer of batch quantities of leachate; and can handle the larger volumes of leachate anticipated from the 25-year, 24-hour storm event. The other pump is a low-capacity submersible pump located in the base of the sump. The sump pumps are located in a sump trough.

The sump trough is designed to contain the leachate below the intake of these pumps, within the smallest possible area, to minimize the residual leachate volume after each pumping cycle. The pumps are fabricated from stainless steel or other corrosion resistant material.

4.3.6.1.2 **C.4.4.1.2 Leak Detection System**

The base of the LDS is formed by the secondary geomembrane. The LDS is similar to the LCRS, except that there is no perforated collection pipe included. The perforated pipe is not needed because high flow capacity is not required for the low leachate volumes.

The LDS drains to the LDS sump, which is located immediately below the LCRS sump. Because of the low volumes, the LDS is equipped with only one low-capacity submersible pump to meet WAC 173-303-665(8)(a).

**Addendum C.44**
4.3.6.1.3—Response Action Plan

In compliance with regulatory requirements, a response action plan (Appendix 4C) was prepared for the lined landfill. In accordance with EPA guidance, the action leakage rate was calculated as “the maximum design flow rate that the LDS can remove without the fluid head on the bottom liner exceeding 30.5 centimeters” (EPA 1992). If the action leakage rate were exceeded, DOE will do the following:

- Notify the appropriate regulatory authority in writing of the exceedance within 7 days of the determination.
- Submit a preliminary written assessment to the appropriate regulatory authority within 14 days of the determination, on the amount of liquids, likely sources of liquids, possible location, size, cause of any leaks, and short-term actions taken and planned.
- Determine to the extent practicable the location, size, and cause of any leak.
- Determine whether waste receipt should cease or be curtailed, whether any waste should be removed from the unit for inspection, repairs, or controls, and whether the unit should be closed.
- Determine any other short-term and/or long-term actions to be taken to mitigate or stop any leaks.
- Within 30 days after the notification that the action leakage rate has been exceeded, submit to the appropriate regulatory authority the results of the analyses specified in the following paragraphs, the results of actions taken, and actions planned. Monthly thereafter, as long as the flow rate in the LDS exceeds the action leakage rate, DOE will submit to the appropriate regulatory authority, a report summarizing the results of any remedial actions taken and actions planned.

The leachate will be analyzed for RCRA constituents as appropriate. A procedure will be in place to address details of analysis (i.e., analyses, constituents, test methods, etc.). If the analytical results on leakage fluids indicate that these constituents are present, and if the constituents can be traced to a particular type of waste placed in a known area of the lined landfill, it might be possible to estimate the location of the leak. In addition, waste packages might not undergo enough deterioration during the active life of the landfill to permit escape of the contents; the leachate might be clean or the composition too general to show a specific source location.

If the source location cannot be identified, large-scale removal of the waste and operations layer to find and repair the leaking area of the liner would be one option for remediation. However, this risks damaging the liner. In addition, waste would have to be handled, stored, and replaced in the landfill. Backfill would need to be removed from around any waste packages to accomplish this. If the waste packages were damaged during this process, the risk of accidental release might be high. For these reasons, large-scale removal of waste and liner system materials will not be a desirable option and will not be implemented except as a last resort.

The preferred alternative will depend on factors such as the amount of waste already in the landfill, the rate of waste receipt, the chemistry of the leachate (i.e., is it clean?), the availability of other disposal units, and similar considerations. Therefore, no single approach will be selected at this time. If necessary, an interim solution could be implemented while the evaluation and permanent remediation were performed. Examples of potential approaches include the following:

- The surface of the waste could be graded to direct run-off into a shallow pond. The surface would be covered with the low-hydraulic conductivity layer (geomembrane). Precipitation would be pumped or evaporated from the pond and would not infiltrate the waste already in the lined landfill. Waste would be placed only during periods of dry weather, and stored at other onsite TSD units at other times. This type of approach also could be used to reduce leakage immediately after the action leakage rate was exceeded, while other remediation options were evaluated.
• Partial construction of the final closure cover could begin earlier than planned. This would reduce infiltration into the lined landfill, and possibly reduce the leakage rate if the cover were constructed over the failed area.

• A layer of low-hydraulic conductivity soil could be placed over the existing waste, perhaps in conjunction with a geomembrane, to create a second 'primary' liner higher in the lined landfill. This new liner would intercept precipitation and allow its removal.

• A rigid frame or air-supported structure could be constructed over the landfill to ensure that no infiltration occurs. Although costly, this approach could be less expensive than constructing a new landfill.

In general, the selected remediation efforts will be progressive. Those remediation methods that are judged the least difficult and the most cost effective will be used first. If these efforts are not effective, more difficult or expensive options would be used.

4.3.6.2 Equivalent Capacity

The CDN drainage layers used will be available commercially and will have equivalent flow capacity to a 30.5-centimeter layer of granular drainage material with a hydraulic conductivity of $1 \times 10^{-2}$ centimeter per second.

4.3.6.3 Grading and Drainage

In accordance with EPA guidance, all areas of the lined landfill floor (except the sump bottoms) are graded at a slope of at least 2 percent towards the centerline of each cell. The centerline of each cell has a 1 percent slope lengthwise towards the sump, to facilitate drainage and avoid ponding on the liners. Grading tolerances have been established to ensure proper slope is maintained.

4.3.6.4 Maximum Leachate Head

The maximum head (leachate depth) on the primary liner is less than 30.5 centimeters (1 ft), except for in the LCRS sump trough and during rare storm events as discussed in Section C.4.3.6.1. The sump was sized and designed to provide adequate surge storage to prevent leachate build-up on the primary liner.

4.3.6.5 System Compatibility

The primary and secondary LCRSs is composed of inert geologic materials (sand and gravel), HDPE, and other geosynthetic materials such as polypropylene. As described in Section 4.3.5.2, the geosynthetics were evaluated for compatibility with the expected leachate. To ensure that the geosynthetics used in the lined landfill are similar chemically to those evaluated, manufacturers will be required to submit quality control certificates and other manufacturing information on all materials.

Before a new waste constituent, not previously analyzed (based on a dangerous waste number), is allowed in the lined landfill, the waste constituent will be evaluated for compatibility with the liner (e.g., identified in 9090A test results or other appropriate testing methods, etc.). Other materials could contact the leachate, for example:

• HDPE and Polyvinyl chloride piping will be used.

• Polyvinyl chloride and other plastics in miscellaneous uses.

• Leachate tank will use a chemically resistant flexible geomembrane liner system.

Compatibility of these materials with the expected leachate was considered in the landfill liner system design. Compatibility of these materials will be of lesser concern, because items that consist of these materials will be located entirely within the containment area. Failure of these items would not result in a dangerous waste release, and the materials would be replaced or repaired.
4.3.6.6  C.4.4.4 System Strength

Stability of drainage layer, strength of piping, and prevention of clogging are discussed in the following sections.

4.3.6.6.1—Stability of Drainage Layers

As described in Sections 4.3.3.3 and 4.3.5.3, the stability of the liners and LCRSs on the side slopes was evaluated as part of detailed design (Appendix 4AC1). To provide sufficiently high shear strengths at the interfaces between geosynthetic components, textured geomembranes and thermally bonded CDNs are used to provide sufficiently high shear strengths at the interfaces between geosynthetic components.

Bearing capacity of the drainage and sump gravels is expected to be adequate, based on typical strength values for granular materials.

The transmissivity of the drainage layers under the combined load of the waste and cover was addressed in the design and will be adequate to support leachate removal.

4.3.6.6.2—Strength of Piping

The drainpipes in the primary drainage and sump gravel and side slope riser pipes are HDPE pipe. During detailed design, the required wall thickness of the pipe was determined according to the manufacturer’s recommendations and standard analytical methods used by the piping industry (Appendix 4AC1). In these analyses, the ultimate load (derived from the estimated weight of the waste and cover) was used, the allowable deflections were limited to 5 percent, and conservative values for soil modulus and lateral confinement were assumed.

4.3.6.7  C.4.4.5 Prevention of Clogging

The geotextiles that separate the drainage layers from adjacent soil layers was selected based on the ability of the geotextiles to retain the soil and to prevent the soil from entering the LCRSs. In addition, the amount of fine material in the drainage and sump gravels was limited by specification to less than a few percent; therefore, gravel material and is not expected to cause clogging problems (Appendix 4A). Because the waste disposed in the lined landfill will be required to satisfy LDR [Revised Code of Washington [RCW] 70A-105.05300.070(2), WAC 173-303-140, and 40 CFR 268), the amount of organic material is minimal, and consequently biologic clogging will not be a problem.

4.3.7  C.4.5 Liner System - Construction and Maintenance

Details relating to the liner system construction and maintenance are discussed in the following sections. System geometry was completed and material specifications were developed during the detailed design process. The LCRS design complies with WAC 173-303 requirements and applicable guidance. Drainage and sump gravel consists of hard, durable, rounded to subrounded material. The gravel was washed and the amount of fine material (i.e., passing the number 200 sieve) was limited to a few percent. Each sump has a thick layer of gravel designed to provide high hydraulic conductivity and storage capacity.

Geosynthetic layers in the LCRS were deployed, overlapped, and joined (e.g., tying for geonets, sewing for geotextiles) according to standard industry practice and the manufacturers’ recommendations. Drainage and riser pipes were installed in the landfill. Pipes were bedded carefully, and the landfill was backfilled to provide adequate lateral support. Pumps and other mechanical components are installed according to manufacturers’ recommendations.

4.3.7.1—Material Specifications

Material specifications are provided in the following sections for each of the materials used in the liner system.
4.3.7.1.1 Synthetic Liners

As described in Section 4.3.3.1, both the primary and secondary geomembrane liners consist of HDPE. As described in Section 4.3.3.1.4, the primary barrier also contains a geosynthetic clay liner placed on the floor area only. Detailed specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.2 Soil Liners

As described in Section 4.3.3.1, the soil liner consists of imported bentonite (expansive clay) blended with fine soil deposits on or next to the IDF. The fine soil was free of roots, woody vegetation, rocks greater than 2.54 centimeter in diameter, and other deleterious material. The bentonite content is dependent on the characteristics of the fine soil. Mixing was performed under carefully controlled conditions in a pugmill or other approved alternatives. The admix was placed and compacted to achieve an in-place hydraulic conductivity of $1 \times 10^{-7}$ centimeter per second or less. The final surface of the soil liner was rolled smooth before placing the overlying geomembrane. Additional specifications were prepared for the lined landfill as part of the design process.

4.3.7.1.3 Leachate Collection and Removal System

Drainage and sump gravel consisted of hard, durable, rounded to subrounded material. The gravel was washed and the amount of fine material (i.e., passing the number 200 sieve) was limited to a few percent. The hydraulic conductivity of the gravel is $1 \times 10^{-2}$ centimeter per second or greater. Additional specifications were prepared as part of the design process.

4.3.7.2 Construction Specifications

Construction requirements for major components of the lined landfill are summarized in the following sections.

4.3.7.2.1 Liner System Foundation

The excavated subgrade surfaces was moisture conditioned and compacted as required to achieve the specified compaction before placing the admix layer.

4.3.7.2.2 Soil Liners

The soil and bentonite was blended thoroughly and moisture conditioned so that the admix is uniform and homogeneous throughout. The admix layer was placed in loose lifts and compacted so that the compacted lift meets the requirements of the Construction Quality Assurance Plan. Each new lift of admix was kneaded into the previously placed lift. The methods for admix preparation, type of compaction equipment, number of passes, and other details of the placement process was determined by constructing a test fill section before placing admix in the lined landfill.

4.3.7.2.3 Synthetic Liners

To protect the overlying geomembranes, the admix surface is smooth and free of deleterious material. In all cases, the HDPE liner was deployed with the length of the roll parallel to the slope. Adjacent panels were overlapped and thermally seamed using fusion or extrusion methods. Seams were inspected continuously using air pressure tests. A vacuum box was used in areas where air pressure tests cannot be used (e.g., extrusion weld areas). Destructive seam tests (ASTM D4437) (peel and adhesion) were performed on samples taken at regular intervals. Placing the overlying geosynthetic layers when practicable will protect the geomembranes.
4.3.7.2.4 Leachate Collection and Removal Systems

Drainage and sump gravel was placed and spread carefully over the underlying geosynthetics using suitable equipment to prevent damage. Hauling and placing equipment will operate on a minimum thickness of soil above any geosynthetic layer to avoid damage. Geosynthetic layers in the LCRS were deployed, overlapped, and joined (e.g., tying for geonets, sewing for geotextiles) according to standard industry practice and the manufacturers’ recommendations. Drainage and riser pipes were installed in the landfill. Pipes were bedded carefully and the landfill was backfilled to provide adequate lateral support. Pumps and other mechanical components are installed according to manufacturers’ recommendations.

4.3.7.3 C.4.5.1 Construction Quality Control Program

A CQA certification report was prepared for the IDF landfill (RPP-RPT-29276, Integrated Disposal Facility, CQA Final Certification Report for IDF Cell Nos. 1 and 2).

4.3.7.4 C.4.5.2 Maintenance Procedures for Leachate Collection and Removal Systems

The accessible components of the LCRS will be maintained according to preventive maintenance methods. These methods will require periodic testing to prove that the equipment, controls, and instrumentation are functional and are calibrated properly. Testing intervals will be derived from applicable regulations and manufacturer’s recommendations. All pumps and motors will be started or bumped monthly or at intervals suggested by the manufacturer, first, to demonstrate that the pumps and motors are functional and second, to move the bearing(s) so that the bearing surfaces do not seize or become distorted. Instruments will be calibrated annually or at intervals suggested by the manufacturer. When applicable, the preventive maintenance methods will include calibration instructions. The following instruments will require annual calibration:

- LCRS sump level indicator.
- LDS sump level indicator.

Other instrumentation inside the leachate handling and storage facilities will also require routine maintenance.

4.3.7.5 C.4.5.3 Liner Repairs During Operations

Because of the 0.9–meter (3 ft)–thick operations layer, damage to the liner system is not expected. Surveillances are conducted regularly and after a significant storm event to inspect for any damage or erosion to the trench (IDF Addendum I). However, if an inspection identifies any damage or erosion, there will be an assessment to determine the extent of repairs necessary. If damage occurs, the operations layer will be removed laterally as far as required. Underlying geosynthetic and gravel layers will be removed until an undamaged layer is encountered. The damaged layers will be repaired or replaced from the lowest layer upwards using similar methods to those employed during construction. Most repairs to the geomembranes will be performed using a patch, which will be placed, welded, and tested by construction quality assurance personnel. If erosion occurs, backfill would be placed to ensure landfill functionality. The Washington State Department of Ecology (Ecology) will be...
notified if liner repairs are required, and documentation of the repairs will be maintained in the IDF portion of the Hanford Facility Operating Record.

4.3.8.4.6 Run-On and Runoff Control Systems

Because of the sandy soils, small drainage area, and arid climate of the Hanford Site at the IDF, stormwater run-on and run-off will not be expected to require major engineered structures. Storm water run-on and runoff, Interceptor and drainage ditches will be adequate for run-on and runoff control. The 25-year, 24-hour precipitation event was the design storm used to size the lined landfill's systems. Beyond this, surface water evaluation is highly site-specific, and appropriate analyses were performed as part of detailed design for each lined landfill.

4.3.8.1 C.4.6.1 Run-On Control System

Run-on will be controlled by drainage ditches or berms around the perimeter of the lined landfill. The drainage ditches or berms were constructed with conventional earthmoving equipment such as graders and small dozers. Any overland flow approaching the landfill will be intercepted by the ditches or berms and will be conveyed to existing drainage systems or suitable discharge points. All the drainage ditches and berms were designed to handle the peak 25-year flow from the potential drainage area. By using low channel slopes, design flow velocities in the ditches will be maintained below established limits for sand channels.

Between the landfill crest and the perimeter road, the area will be graded to provide drainage toward the perimeter road. The perimeter road will be sloped outward, at a grade of approximately 2 percent, to provide drainage away from the landfill. On the outside of the perimeter road, drainage ditches will be excavated to provide drainage away from the landfill.

4.3.8.1.1 Design and Performance

Design and performance details were determined for the landfill as part of the detailed design process.

4.3.8.1.2 C.4.6.1.2 Calculation of Peak Flow

Computation of design discharge for the drainage ditches or berms was performed using standard analytical methods, such as the Rational Method or the U.S. Army Corps of Engineers (USACE) computer program (USACE, 1981, HEC-1 (USACE 1981 Flood Hydrograph Package, Computer Program 723-X6-L2010). As described in Appendix C1, a precipitation value of 4 cm (1.56 in.) in 24 hours reportedly can be expected to occur once every 25 years. The 25-year, 24-hour precipitation depth is 4.0 centimeters, based on precipitation data recorded from 1947 to 1969 (PNL-4622). The tributary area for each section of ditch or berm was based on local topography.

4.3.8.2 C.4.6.2 Runoff Control System

There will be no runoff from the lined landfill because the landfill will be constructed below grade. Any precipitation falling on the IDF landfill will be removed by either evapotranspiration or the LCRSs. Therefore, a run-off control system will not be needed.

4.3.8.3 Construction

The drainage ditches or berms around the lined landfill were constructed with conventional earthmoving equipment such as graders and small dozers.
4.3.8.4 C.4.6.3 Maintenance

Soil stabilization materials will be applied, as needed, to prevent soil erosion in and around the landfill. The drainage ditches or berms require periodic maintenance to ensure proper performance. The most frequent maintenance activity, beyond periodic inspection, will be cleaning the ditches or berms to remove obstructions caused by windblown soil and vegetation (e.g., tumbleweeds). After rare storm events, regrading of the ditch bottom or repair of the berm might be required to repair erosion damage. This is expected to occur infrequently; however, inspections will be conducted after 25-year storm events or at least annually. Inspections are detailed in Addendum I.

C.4.7 Facility Filling Plan

The IDF disposal cells accept waste that is disposal-ready and meets the LDR treatment standards of WAC 173-303-140, which includes by reference 40 CFR 268. The disposal cells also accept WTP ILAW glass that have been approved for a LDR Treatability Variance. This variance allows waste vitrification to satisfy LDR treatment requirements (19-NWP-165).

Waste placement will occur concurrently within the two disposal cells, in a series of horizontal lifts. The planned lift thickness corresponds to the waste stack height (typically 2.3 m [7.5 ft], the height of the ILAW glass containers) and cover soil layer (typically 1 m [3.3 ft]). Waste packages with heights less than to slightly greater than 2.3 m (7.5 ft) would be accommodated into one lift. Lifts will generally progress in parallel as much as practicable to ensure efficient disposal, but multiple lifts may be used to accommodate different waste container dimensions, melters, etc. Forklifts, tire cranes, and track cranes place waste containers for disposal, avoiding riser pipes associated with the LCRS. The space between individual waste containers and miscellaneous units within each lift is filled with a loosely-compacted (i.e., low-density) backfill material using a chute or similar delivery method. After each lift is emplaced, a highly-compacted (i.e., high-density) backfill is placed on top of the waste containers/miscellaneous units and serves as an operational layer for subsequent lifts. Cover soil will be added after the final lift is placed and sloped to support runoff during precipitation events. Nominally, four lifts are possible for the waste planned to be disposed in the IDF.

When a waste is disposed in IDF, the location is documented in the waste tracking system according to the three-dimensional location of each waste, based on grid coordinates, in accordance with WAC 173-303-665(5). Records are maintained in the IDF portion of the Hanford Facility Operating Record, as described in Section C.12.

4.3.9 C.4.8 Control of Wind Dispersal

The IDF will use varied methods to prevent wind dispersal of mixed waste and backfill materials, depending on the waste form. Methods to prevent wind dispersal include containerizing, stabilizing, grouting, spray fixitants, and backfill. In other instances, the operating contractor implements a wind speed restriction during handling, and immediately backfills the waste to prevent wind dispersal. Containers are kept closed at all times during storage and disposal. Opening of a container for treatment will not be performed during windy conditions. Therefore, containerized waste is not exposed to windy conditions. Methods to control wind dispersal of mixed waste particulate matter in the cells include backfilling the disposed waste. Backfilling is performed to cover the disposed waste, reducing exposure to windy conditions within the cells. Backfilling is the process of surrounding the disposed waste with cover soil, pea gravel, or other similar material. The conditions of the cells and subsequently, the integrity of the soil cover, are inspected in accordance with IDF Addendum I. Inspections concerning these conditions are also performed after a significant storm event to evaluate for signs of deterioration or damage. If such signs are identified, then the discrepancies will be documented for corrective action.
Methods to control wind dispersal of natural particulate matter (e.g., dirt, dust) around the perimeter of the cells include the use of nonhazardous liquid (e.g., water) dust suppressants. Nonhazardous liquids are applied by a water truck equipped with spray nozzles, or equivalent. The use of nonhazardous liquids for dust control activities will be performed in a manner that prevents the accumulation of recoverable liquids (i.e., ponding). Dust control activities are conducted when weather conditions are conducive to the form of dust control being performed (e.g., not raining or freezing).

4.3.10 C.4.9 Liquids in Landfills

Containers holding free liquids will not be accepted at IDF unless WAC 173-303-140(4)(b)(ii) requirements are met except as allowed by Chapter 3.0, Section 1.2. Waste received at the IDF must comply with waste acceptance requirements.

4.3.11 C.4.10 Containerized Waste

Containerized waste received in the IDF lined landfill will be limited to a maximum of 10 percent void space. Several inert materials (diatomaceous earth, sand, lava rock) will be used as acceptable void space fillers for waste that does not fill the container. To mitigate significant voids prior to disposal, containerized waste accepted into the IDF land fill will be limited to a maximum of 10 percent void space in accordance with WAC 173-303-665(12). Void filling with compatible materials (e.g., concrete, Portland cement) will be performed on the treatment pad as necessary to meet the void space requirements. Waste in containers for disposal at the IDF will be in a form that minimizes settling and subsidence and meets the criteria specified by the preliminary fire hazards analysis for the IDF. The exception is for waste that cannot be containerized (e.g., long-length equipment), which will be approved on a case-by-case basis.

C.4.11 Uncontainerized Waste

Uncontainerized waste consists of waste that cannot be packaged due to abnormal size or shape. This waste includes long-length equipment and used LAW melters.

Used LAW melters are approximately 9.4 x 6.4 x 4.9 m (31 x 21 x 16 ft) steel units, weighing approximately 318 metric tons (350 tons). The melters are designed to immobilize mixed waste into a glass matrix at the WTP. Cooling of melters is required during operations, which is met through the use of nineteen cooling loops. The cooling loops hold non-dangerous water, and have an operating volume of approximately 4,353 L (1,150 gal).

Once the melters are removed from WTP, they are transferred to IDF for disposal. The used melters will not be containerized, and will be placed directly into the landfill. Removal of the cooling water within the melters is not required. The melter cooling system design precludes reasonable removal of cooling water prior to disposal. IDF has demonstrated that the disposal of used LAW melters without removal of cooling water does not present a risk of groundwater contamination, and does not accelerate the transport of dangerous waste through the vadose to the groundwater beneath IDF [WAC 173-303-140(4)(b)(v)]. Since the melters are designated as miscellaneous units, they are not required to meet void requirements per WAC 173-303-665(12), but may include measures to minimize subsidence within the disposal cells. After a melter is placed in the landfill, the melter will be backfilled to minimize subsidence, in accordance with C.4.7. Treatment of the used melters is not required, because the vitrified glass remaining in the melters meets the criteria associated with the LDR treatment variance approved by the Ecology.
C.4.12 Action Leakage Rate and Response Actions

The ALR is the maximum design flow rate that the LCRS can remove without the fluid head on the secondary liner exceeding 0.3 m (1 ft). WAC 173-303-665(9) regulations require the owner or the operator of a landfill unit to have an approved Response Action Plan (RAP) before receipt of waste. The RAP is included in Appendix C5. As part of the RAP, the ALR was calculated to be 780 L (206 gal) per acre per day, or approximately 6,810 L (1,800 gal) per day per cell (each cell area is approximately 8.5 acres).

During operations, the leakage rate through the primary liner is calculated to ensure that it is less than the threshold value of the ALR. Should the ALR be exceeded, the RAP (Appendix C5) will be utilized to ensure compliance with WAC 173-303-665(9).

C.5 SPECIAL REQUIREMENTS FOR HAZARDOUS WASTE CODES F020, F021, F022, F023, F026, AND F027

Hazardous wastes designated as F020, F021, F022, F023, F026, and F027 will not be placed in any landfill. Confirmation and verification processes to ensure that prohibited waste is not disposed in the IDF are described in the WAP (Addendum B).

C.6 SPECIAL REQUIREMENTS FOR IGNITABLE OR REACTIVE WASTE

Wastes exhibiting ignitable or reactive characteristics are not accepted at the IDF.

C.7 SPECIAL REQUIREMENTS FOR INCOMPATIBLE WASTE

Incompatible wastes are treated prior to acceptance and rendered LDR-compliant prior to land disposal. Waste acceptance criteria for determining the chemical compatibility of wastes for disposal are provided in the WAP (Addendum B).

C.8 AIR EMISSION STANDARDS

This section addresses air emission standards from the following requirements:


C.8.1 Applicability of Subpart AA Standards

The air emission standards in 40 CFR 264, Subpart AA apply to process vents associated with distillation, fractionation, thin-film evaporation, solvent extraction, or air or steam stripping operations for hazardous wastes with organic concentrations of at least 10 parts per million (ppm) by weight. Because IDF does not have any process vents, Subpart AA standards do not apply.

C.8.2 Applicability of Subpart BB Standards

The air emission standards in 40 CFR 264, Subpart BB apply to equipment that contains or contacts hazardous waste with a total organic concentration of 10 percent by weight or more. Subpart BB is applicable to equipment associated with pipe runs, such as valves, pumps, compressors, pressure-relief devices, sampling systems, open-ended valves or lines, and flanges and other connectors. This type of equipment is used in the leachate collection and removal system and does come into contact with mixed waste (leachate).
However, the mixed waste disposed in the IDF will be LDR compliant and will consist primarily of vitrified, solidified, or encapsulated waste. Treating mixed waste in this manner will eliminate the generation of leachate which could meet or exceed the total organic concentration limitation of 10 percent by weight.

C.8.3 Applicability of Subpart CC Standards

Air emission standards from 40 CFR 264, Subpart CC, apply to tank, surface impoundment, and container storage units that manage hazardous waste with average volatile organic concentrations equal to or exceeding 500 ppm by weight, based on the waste composition at the point of origination. However, containers that solely manage mixed waste are exempt per 40 CFR 264.1080(b)(6), Applicability. Because IDF only contains mixed waste, Subpart CC standards do not apply.

C.9 MONITORING AND INSPECTION

Inspection frequencies and requirements for the IDF are provided in Addendum I.

C.10 SURVEYING AND RECORDKEEPING

In accordance with WAC 173-303-665(5), the following items will be maintained in the Hanford Facility Operating Record (IDF portion):

- A map showing the exact location and dimensions, including depth, of each cell in respect to permanently surveyed benchmarks.
- The contents of each cell and the approximate location of each disposed waste within each cell.

The three-dimensional location of each waste container disposed in the IDF will be recorded as geographical coordinates.

C.11 CLOSURE AND POST-CLOSURE CARE

Closure requirements are outlined in Addendum H, “Closure Plan.” Postclosure requirements are outlined in Addendum K, “Post-Closure Plan.”

C.12 RECORDKEEPING

The Permittees will place documentation into the Hanford Facility Operating Record (IDF portion) as required by Hanford Facility RCRA Permit Condition II.I (WAC 173-303-380), including approved waste profile documentation (Hanford Facility RCRA Permit Condition II.I.1.j) and confirmation records (Hanford Facility RCRA Permit Condition II.I.1.b). LDR records will be maintained in the Hanford Facility Operating Record (IDF portion) in accordance with WAC 173-303-380(1)(m).

C.13 TRAINING

For training requirements related to duties described in this addendum, refer to Addendum G, “Personnel Training.”

C.14 REFERENCES


260.10, Definitions.


Subpart CC, *Air Emission Standards for Tanks, Surface Impoundments, and Containers.*


268.2, *Definitions applicable in this part.*


268.42, *Treatment standards expressed as specified technologies.*


Addendum C
Figure 4-1 Integrated Disposal Facility Lined Landfill
Figure 4.2 Example of a Typical Liner
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