DEPARTMENT OF ENERGY
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

11-EMD-0004

OCT 29 2010

Ms. J. A. Hedges, Program Manager
Nuclear Waste Program
State of Washington
Department of Ecology
3100 Port of Benton Boulevard
Richland, Washington 99354

Dear Ms. Hedges:

CLASS 3 MODIFICATION TO THE HANFORD FACILITY RESOURCE CONSERVATION AND RECOVERY ACT (RCRA) PERMIT, LIQUID EFFLUENT RETENTION FACILITY (LERF) AND 200 AREA EFFLUENT TREATMENT FACILITY (TSD: S-2-8)

In accordance with Hanford Facility RCRA Permit (Permit) Condition I.C.3, enclosed is a Class 3 modification package for the LERF and 200 Area Effluent Treatment Facility. The modifications pertain to the unit specific Permit conditions, Waste Analysis Plan, Process Information, and LERF Groundwater Monitoring Plan. A tentative agreement on this package has been achieved through workshops with the State of Washington Department of Ecology and the U.S. Environmental Protection Agency. The U.S Department of Energy, Richland Operations Office would like to discuss the process to modify the Permit as an Agency initiated modification [Washington Administrative Code (WAC) 173-303-830(3)] or a Permittee initiated modification (WAC 173-303-830(4)(c)].

The Class 3 modification is needed in order to maintain a current LERF Groundwater Monitoring Plan in the Permit. If this Class 3 modification is processed as a Permittee initiated modification, the notification of this modification to the Hanford Facility mailing list will be made consistent with the provisions of Permit Condition I.C.3.c, and will include an announcement of a 60 day comment period.

If you have any questions, please contact me, or your staff may contact Ray J. Corey, Assistant Manager for Safety and Environment, on (509) 376-0108.

Sincerely,

Matt McCormick
Manager

EMD:ACM

Enclosure

cc w/encl: See Page 2

cc w/encl:
Environmental Portal, LMSI, A3-95
Ecology NWP Library, H0-57
HF Operating Record (S. Thompson, MSA, H7-28)
Administrative Record, H6-08 (TSD: S-2-8)

cc w/o encl:
R. W. Bond, Ecology
K. A. Conaway, Ecology
E. R. Skinnarland, Ecology
M. N. Jaraysi, CHPRC
L. T. Blackford, CHPRC

Hanford Facility RCRA Permit Modification Notification Forms
Part III, Operating Unit 3
Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Index

Page 2 of 7: Part III, OU-3, Permit Conditions
Page 3 of 7: Permit Condition III.3.C
Page 4 of 7: Permit Condition III.3.C
Page 5 of 7: Chapter 3.0, §3.1
Page 6 of 7: Chapter 4.0, §4.5.2.2
Page 7 of 7: Addendum D, Groundwater Monitoring Plan

Submitted by Co-Operator:

Leonard T. Blackford — 9/20/10 Date

Reviewed by DOE Program Office:

Richard A. Holten — 10/28/10 Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:
Part III, OU-3, Permit Conditions:

PART III, OPERATING UNIT GROUP 3 PERMIT CONDITIONS

Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Unit Description:

The Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility (LERF and 200 Area ETF) consists of an aqueous waste treatment system that provides storage and treatment for a variety of aqueous mixed waste located in the 200 East Area.

This document sets forth the operating conditions for the LERF and 200 Area ETF.

Operating Unit Group 3:

Chapter 1.0	Part A Form, dated October 1, 2008
Chapter 3.0	Waste Analysis Plan, dated September 2010~~June 30, 2007~~
Chapter 4.0	Process Information, dated September 2010~~December 31, 2007~~
~~Chapter 5.0~~	~~Groundwater Monitoring (PNNL-11620 & WHC-SD-EN-AP-024), dated June 30, 2008~~
Addendum D	LERF Groundwater Monitoring Plan, dated September 2010
Chapter 6.0	Procedures to Prevent Hazards, dated June 30, 2007 (also refer to Permit Attachment 3~~3, §6.1~~)
Addendum J	Contingency Plan, dated September 30, 2010
Chapter 8.0	Personnel Training, dated June 30, 2008
Chapter 11.0	Closure and Post Closure Requirements, dated October 2006
Chapter 12.0	Reporting and Recordkeeping (refer to Permit Attachment 6~~33, Table 12.1~~)

III.3.A. COMPLIANCE WITH UNIT SPECIFIC PERMIT CONDITIONS

III.3.A.1 The Permittees shall comply with all requirements set forth in the Hanford Facility RCRA Permit (Permit) as specified in Permit Attachment 9~~3~~, Permit Applicability Matrix, including all approved modifications. All chapters, addenda, subsections, figures, tables, and appendices included in the following unit specific Permit Conditions are enforceable in their entirety.

III.3.A.2 In the event that the Part III, Unit Specific Conditions for Operating Unit 3, LERF and 200 Area ETF conflict with the Part I, Standard Conditions and/or Part II, General Facility Conditions of the Permit, the unit specific conditions for Operating Unit 3, LERF and 200 Area ETF prevail.

WAC 173-303-830 Modification Class	Class 1	Class 1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)
Enter wording of WAC 173-303-830, Appendix I Modification citation:
Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below) Reason for denial:	Reviewed by Ecology: G. P Davis Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:
Permit Condition III.3.C, Groundwater Monitoring:

III.3.C GROUNDWATER MONITORING

III.3.C.1 The Permittees will evaluate, on an annual basis, data from waste streams accepted by the LERF basins for purposes of evaluating the adequacy of constituents subject to monitoring pursuant to Addendum D, LERF Ground water Monitoring Plan. The purpose of this evaluation will be to identify any dangerous constituents that are present in wastes accepted by one or more of the LERF basins, which may be candidates for monitoring constituents in the LERF Groundwater Monitoring Plan. The following factors are to be considered:

III.3.C.1.a The concentration and total quantity of each constituent accepted for management in the LERF basins;

III.3.C.1.b Environmental fate and transport of each constituent;

III.3.C.1.c Analytical detectability of each constituent.

III.3.C.2 The evaluation will be documented in the Hanford Facility Operating Record, LERF & 200 Area File. If the evaluation indicates that Addendum D, LERF Groundwater Monitoring Plan, needs to be modified, the Permittees will submit a permit modification to Ecology per WAC 173 303 645(9)(h).

III.3.C.3 Continue monitoring as per the existing wells

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)
Enter wording of WAC 173-303-830, Appendix I Modification citation:
Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below)
Reason for denial:

Reviewed by Ecology:

G. P Davis Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:

Permit Condition III.3.C, Groundwater Monitoring:

III.3.C.4 Groundwater Monitoring Network

III.3.C.4.a The Permittees will drill and, if saturated aquifer conditions are present, install a resource protection well north of the Waste Management Area by May 31, 2011. The well will be completed in the uppermost aquifer encountered. The well location will be agreed upon by Ecology prior to installation.

III.3.C.4.b If a new well can be completed at the location in Permit Condition III.3.C.3.a, perform the following:

III.3.C.4.b.1 Within 30 days following completion of the well, obtain groundwater samples from the new well and the four existing wells (299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79) and analyze the samples for all constituents in the Addendum D, Groundwater Monitoring Plan.

III.3.C.4.b.2 Within 60 days following completion of the new well, perform field hydrologic testing and evaluation to estimate aquifer hydraulic parameters.

III.3.C.4.b.3 Within 90 days following completion of field hydrologic testing of the new well, provide a report to Ecology for review containing evaluation results that conclude whether or not the new well can provide samples representative of the uppermost aquifer. If the new well can provide samples representative of the uppermost aquifer, a well use designation (upgradient or downgradient) will be proposed. If data obtained during the 90-day period are not conclusive for well use designation, this proposal may be deferred until adequate data are obtained and evaluated, but may not exceed one year following completion of the well hydrologic testing.

III.3.C.4.b.4 Within 60 days following Ecology comments on the report provided in Permit Condition III.3.C.4.b.3, the Permittees will complete actions required by Permit Conditions III.3.C.4.c, or III.3.C.4.d, depending on the results and conclusions of the report.

III.3.C.4.c If the new well yields groundwater samples representative of the uppermost aquifer, submit a revised Groundwater Monitoring Plan as a Class 2 Permit modification to include the new well in the network. The permit modification will specify whether the new well will be an upgradient well or an additional downgradient point-of-compliance well. The permit modification will specify the appropriate statistical method, based on the revised groundwater monitoring system.

III.3.C.4.d If the new well does not yield groundwater samples representative of groundwater, the well will not be incorporated into the Groundwater Monitoring Plan. The Permittees will make a recommendation regarding whether the remaining groundwater monitoring system meets the requirements of WAC 173-303-645.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)

Enter wording of WAC 173-303-830, Appendix I Modification citation:

Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below) Reason for denial:	Reviewed by Ecology: G. P Davis Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:
Chapter 3.0, §3.1:

3.1 INTRODUCTION

...

This WAP meets the specific requirements of the following:

- Land Disposal Restrictions Treatment Exemption for the LERF under 40 CFR 268.4, U.S. Environmental Protection Agency, December 6, 1994 (EPA 1994)
- Final Delisting for 200 Area ETF, 40 CFR 261, Appendix IX, Table 2,70 FR 44496 (EPA 2005)
- Washington State Waste Discharge Permit, No. ST 4500, as amended, (Ecology 2000)
- Hanford Facility RCRA Permit WA7890008967 (Permit)
- This plan also includes the specific elements of a WAP, as identified in the *Dangerous Waste Permit Application Requirements* (Ecology 1996a).
- ~~Chapter 5.0, Groundwater Monitoring addresses groundwater monitoring~~.

The conditions of the Washington State Discharge Permit, Number ST 4500 (Discharge Permit) are included in this WAP for completeness, although they are not within the scope of RCRA or WAC 173-303. Therefore, revisions of this WAP that are not governed by the requirements of WAC 173-303 will not be considered as a modification subject to review or approval by Ecology.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)
Enter wording of WAC 173-303-830, Appendix I Modification citation:
Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below) Reason for denial:	Reviewed by Ecology: G. P Davis Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:
Chapter 4.0, §4.5.2.2:

4.5.2.2 Liner System Location Relative to High-Water Table

The lowest point of each LERF basin is the northwest corner of the sump, where the typical subgrade elevation is 175 meters above mean sea level. Based on data collected from the groundwater monitoring wells at the LERF site, the seasonal high-water table is located approximately 62 meters or more below the lowest point of the basins. This substantial thickness of unsaturated strata beneath the LERF provides ample protection to the liner from hydrostatic pressure because of groundwater intrusion into the soil/bentonite layer. Further discussion of the unsaturated zone and site hydrogeology is provided in ~~Chapter 5.0.~~Addendum D.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)
Enter wording of WAC 173-303-830, Appendix I Modification citation:
Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below) Reason for denial:	Reviewed by Ecology: G. P Davis — Date

Hanford Facility RCRA Permit Modification Notification Form

Unit:	Permit Part
Liquid Effluent Retention Facility & 200 Area Effluent Treatment Facility	**Part III, Operating Unit 3**

Description of Modification:
Addendum D, Groundwater Monitoring Plan

Remove Chapter 5.0, Groundwater Monitoring dated June 30, 2008 and replace with Addendum D, Groundwater Monitoring Plan dated July 2010.

WAC 173-303-830 Modification Class	Class 1	Class [1]1	Class 2	Class 3
Please mark the Modification Class:				X

Enter relevant WAC 173-303-830, Appendix I Modification citation number: WAC 173-303-830(3)(d)
Enter wording of WAC 173-303-830, Appendix I Modification citation:
Other modifications: The Permittee requests that the modification be classified and reviewed as a Class 3.

Modification Approved/Concur ☐ Yes ☐ Denied (state reason below) Reason for denial:	Reviewed by Ecology: G. P Davis Date

This page intentionally left blank.

Hanford Facility RCRA Permit Modification
Part III, Operating Unit 11
Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Remove and replace the following sections for Part III, Operating Unit 3:

- Remove Permit Conditions dated June 30, 2009 and replace with Permit Conditions dated September 2010
- Remove Chapter 3.0, Waste Analysis Plan dated June 30, 2007 and replace with Chapter 3.0, Waste Analysis Plan dated September 2010
- Remove Chapter 4.0, Process Information dated December 31, 2007, and replace with Chapter 4.0, Process Information dated September 2010
- Remove Chapter 5.0, Groundwater Monitoring dated June 30, 2008 and replace with Addendum D, Groundwater Monitoring Plan dated September 2010

This page intentionally left blank.

PART III, OPERATING UNIT GROUP 3 PERMIT CONDITIONS

Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility

Unit Description:

The Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility (LERF and 200 Area ETF) consists of an aqueous waste treatment system that provides storage and treatment for a variety of aqueous mixed waste located in the 200 East Area.

This document sets forth the operating conditions for the LERF and 200 Area ETF.

Operating Unit Group 3

Chapter 1.0	Part A Form, dated October 1, 2008
Chapter 3.0	Waste Analysis Plan, dated September 2010
Chapter 4.0	Process Information, dated December 31, 2007
Addendum D	LERF Groundwater Monitoring Plan, dated September 2010
Chapter 6.0	Procedures to Prevent Hazards, dated June 30, 2007 (also refer to Permit Attachment 3)
Addendum J	Contingency Plan, dated September 30, 2010
Chapter 8.0	Personnel Training, dated June 30, 2008
Chapter 11.0	Closure and Post Closure Requirements, dated October 2006
Chapter 12.0	Reporting and Recordkeeping (refer to Permit Attachment 6)

III.3.A COMPLIANCE WITH UNIT SPECIFIC PERMIT CONDITIONS

III.3.A.1 The Permittees shall comply with all requirements set forth in the Hanford Facility RCRA Permit (Permit) as specified in Permit Attachment 9, Permit Applicability Matrix, including all approved modifications. All chapters, addenda, subsections, figures, tables, and appendices included in the following unit specific Permit Conditions are enforceable in their entirety.

III.3.A.2 In the event that the Part III, Unit Specific Conditions for Operating Unit 3, LERF and 200 Area ETF conflict with the Part I, Standard Conditions and/or Part II, General Facility Conditions of the Permit, the unit specific conditions for Operating Unit 3, LERF and 200 Area ETF prevail.

III.3.B UNIT SPECIFIC CONDITIONS FOR LERF AND 200 AREA ETF

III.3.B.1 Portions of Permit Attachment 4, *Hanford Emergency Management Plan,* (DOE/RL-94-02) that are not made enforceable by inclusion in the applicability matrix for that document are not made enforceable by reference in this document.

III.3.C GROUNDWATER MONITORING

III.3.C.1 The Permittees will evaluate, on an annual basis, data from waste streams accepted by the LERF basins for purposes of evaluating the adequacy of constituents subject to monitoring pursuant to Addendum D, LERF Ground water Monitoring Plan. The purpose of this evaluation will be to identify any dangerous constituents that are present in wastes accepted by one or more of the LERF basins, which may be candidates for monitoring constituents in the LERF Groundwater Monitoring Plan. The following factors are to be considered:

III.3.C.1.a The concentration and total quantity of each constituent accepted for management in the LERF basins;

III.3.C.1.b Environmental fate and transport of each constituent;

III.3.C.1.c Analytical detectability of each constituent.

III.3.C.2 The evaluation will be documented in the Hanford Facility Operating Record, LERF & 200 Area File. If the evaluation indicates that Addendum D, LERF Groundwater Monitoring Plan, needs to be modified, the Permittees will submit a permit modification to Ecology per WAC 173 303 645(9)(h).

III.3.C.3 Continue monitoring as per the existing wells

III.3.C.4 Groundwater Monitoring Network

III.3.C.4.a The Permittees will drill and, if saturated aquifer conditions are present, install a resource protection well north of the Waste Management Area by May 31, 2011. The well will be completed in the uppermost aquifer encountered. The well location will be agreed upon by Ecology prior to installation.

III.3.C.4.b If a new well can be completed at the location in Permit Condition III.3.C.3.a, perform the following:

III.3.C.4.b.1 Within 30 days following completion of the well, obtain groundwater samples from the new well and the four existing wells (299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79) and analyze the samples for all constituents in the Addendum D, Groundwater Monitoring Plan.

III.3.C.4.b.2 Within 60 days following completion of the new well, perform field hydrologic testing and evaluation to estimate aquifer hydraulic parameters.

III.3.C.4.b.3 Within 90 days following completion of field hydrologic testing of the new well, provide a report to Ecology for review containing evaluation results that conclude whether or not the new well can provide samples representative of the uppermost aquifer. If the new well can provide samples representative of the uppermost aquifer, a well use designation (upgradient or downgradient) will be proposed. If data obtained during the 90-day period are not conclusive for well use designation, this proposal may be deferred until adequate data are obtained and evaluated, but may not exceed one year following completion of the well hydrologic testing.

III.3.C.4.b.4 Within 60 days following Ecology comments on the report provided in Permit Condition III.3.C.4.b.3, the Permittees will complete actions required by Permit Conditions III.3.C.4.c, or III.3.C.4.d, depending on the results and conclusions of the report.

III.3.C.4.c If the new well yields groundwater samples representative of the uppermost aquifer, submit a revised Groundwater Monitoring Plan as a Class 2 Permit modification to include the new well in the network. The permit modification will specify whether the new well will be an upgradient well or an additional downgradient point-of-compliance well. The permit modification will specify the appropriate statistical method, based on the revised groundwater monitoring system.

III.3.C.4.d If the new well does not yield groundwater samples representative of groundwater, the well will not be incorporated into the Groundwater Monitoring Plan. The Permittees will make a recommendation regarding whether the remaining groundwater monitoring system meets the requirements of WAC 173-303-645.

Chapter 3.0 Waste Analysis Plan

3.0 WASTE ANALYSIS 3.1

3.1 INTRODUCTION 3.2
3.1.1 Liquid Effluent Retention Facility and Effluent Treatment Facility Description 3.3
3.1.2 Sources of Aqueous Waste 3.4

3.2 INFLUENT WASTE ACCEPTANCE PROCESS 3.5
3.2.1 Acceptance Process 3.5
3.2.2 Waste Management Decision Process 3.8
3.2.3 Re-Evaluation Process 3.12
3.2.4 Record/Information and Decision 3.13

3.3 SPECIAL MANAGEMENT REQUIREMENTS 3.15
3.3.1 Conditions on Process Condensate for Newly Identified Waste Numbers 3.15
3.3.2 Land Disposal Restriction Compliance at Liquid Effluent Retention Facility 3.16

3.4 INFLUENT AQUEOUS WASTE SAMPLING AND ANALYSIS 3.16
3.4.1 Sampling Procedures 3.16
3.4.2 Analytical Rationale 3.17

3.5 TREATED EFFLUENT SAMPLING AND ANALYSIS 3.18
3.5.1 Rationale for Effluent Analysis Parameter Selection 3.18
3.5.2 Effluent Sampling Strategy: Methods, Location, Analyses, and Frequency 3.19

3.6 EFFLUENT TREATMENT FACILITY GENERATED WASTE SAMPLING AND ANALYSIS 3.19
3.6.1 Secondary Waste Generated from Treatment Processes 3.20
3.6.2 Operations and Maintenance Waste Generated at the 200 Area Effluent Treatment Facility 3.24
3.6.3 Other Waste Generated at the 200 Area Effluent Treatment Facility 3.25

3.7 QUALITY ASSURANCE/QUALITY CONTROL 3.26
3.7.1 Sampling Program 3.26
3.7.2 Analytical Program 3.26
3.7.3 Conclusion 3.28

3.8 REFERENCES 3.28

3.9 ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATIVE METHODS, AND HOLDING TIMES 3.29

Figures

Figure 3.1. 200 Area Effluent Treatment Facility Floor Plan 3.7

Tables

Table 3.1. General Limits for Liner Compatibility 3.14
Table 3.2. Waste Acceptance Criteria 3.15
Table 3.3. Target Parameters for Influent Aqueous Waste Analyses 3.18
Table 3.4. Rationale for Parameters to Be Monitored in Treated Effluent 3.22
Table 3.5. 200 Area Effluent Treatment Facility Generated Waste - Sampling and Analysis 3.25
Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent 3.29
Table 3.7. Sample Containers, Preservative Methods, and Holding Times for 200 Area ETF Generated Waste 3.32

3.0 WASTE ANALYSIS

Metric Conversion Chart

Into metric units			Out of metric units		
If you know	Multiply by	To get	If you know	Multiply by	To get
Length			Length		
inches	25.40	millimeters	millimeters	0.0393	inches
inches	2.54	centimeters	centimeters	0.393	inches
feet	0.3048	meters	meters	3.2808	feet
yards	0.914	meters	meters	1.09	yards
miles	1.609	kilometers	kilometers	0.62	miles
Area			Area		
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092	square meters	square meters	10.7639	square feet
square yards	0.836	square meters	square meters	1.20	square yards
square miles	2.59	square kilometers	square kilometers	0.39	square miles
acres	0.404	hectares	hectares	2.471	acres
Mass (weight)			Mass (weight)		
ounces	28.35	grams	grams	0.0352	ounces
pounds	0.453	kilograms	kilograms	2.2046	pounds
short ton	0.907	metric ton	metric ton	1.10	short ton
Volume			Volume		
fluid ounces	29.57	milliliters	milliliters	0.03	fluid ounces
quarts	0.95	liters	liters	1.057	quarts
gallons	3.79	liters	liters	0.26	gallons
cubic feet	0.03	cubic meters	cubic meters	35.3147	cubic feet
cubic yards	0.76456	cubic meters	cubic meters	1.308	cubic yards
Temperature			Temperature		
Fahrenheit	subtract 32 then multiply by 5/9ths	Celsius	Celsius	multiply by 9/5ths, then add 32	Fahrenheit
Force			Force		
pounds per square inch	6.895	kilopascals	kilopascals	1.4504×10^{-4}	pounds per square inch

Source: *Engineering Unit Conversions*, M. R. Lindeburg, P.E., Second Ed., 1990, Professional Publications, Inc., Belmont, California.

3.1 INTRODUCTION

In accordance with the federal and state regulations set forth in 40 Code of Federal Regulations (CFR) 264.13 and in Washington State Department of Ecology (Ecology) Dangerous Waste Regulations, Washington Administrative Code (WAC) 173-303-300, this waste analysis plan (WAP) has been prepared for operation of the Liquid Effluent Retention Facility (LERF) and the 200 Area Effluent Treatment Facility (200 Area ETF) located in the 200 East Area on the Hanford Site, Richland, Washington.

The Permittees shall comply with all the requirements, subsections, figures, tables, and appendices, included this Waste Analysis Plan for Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility.

The purpose of this WAP is to document the sampling and analytical methods, and describe the procedures used for all dangerous waste managed in the specific treatment storage, and disposal (TSD) units identified in Chapter 1.0 (Part A Form). This WAP also documents the requirements for generators sending aqueous waste to the LERF or 200 Area ETF for treatment. Throughout this WAP, the term generator includes any Hanford Site unit, including TSD units, whose process produces an aqueous waste.

The TSD units include a surface impoundment (LERF), which provides treatment and storage, a tank system at 200 Area ETF, which provides treatment and storage, and a container management area at 200 Area ETF, which provides drum storage and treatment. Additionally, this WAP discusses the sampling and analytical methods for the treated effluent (treated aqueous waste) that is discharged from 200 Area ETF as a non-dangerous, delisted waste to the State-Approved Land Disposal Site (SALDS). Specifically, the WAP delineates the following:

- **Influent Waste Acceptance Process**: determines the acceptability of a particular aqueous waste at the LERF or 200 Area ETF pursuant to applicable Permit conditions, regulatory requirements, and operating capabilities prior to acceptance of the waste at the LERF or 200 Area ETF for treatment or storage. Refer to Section 3.2.
- **Special Management Requirements:** identifies the special management requirements for aqueous wastes managed in the LERF or 200 Area ETF. Refer to Section 3.3.
- **Influent Aqueous Waste Sampling and Analysis:** describes influent sampling and analyses used to characterize an influent aqueous waste to ensure proper management of the waste and for compliance with the special management requirements. Also includes rationale for analyses. Refer to Section 3.4.
- **Treated Effluent Sampling and Analysis:** describes sampling and analyses of treated effluent (i.e., treated aqueous waste) for compliance with State Waste Discharge Permit (Ecology 2000) and Final Delisting [40 CFR 261, Appendix IX, Table 2, 70 FR 44496 (EPA, 2005)] limits. Also includes rationale for analyses. Refer to Section 3.5.
- **200 Area ETF Generated Waste Sampling and Analysis:** describes the sampling and analyses used to characterize the secondary waste streams generated from the treatment process and to characterize waste generated from maintenance and operations activities. Also includes rationale for analyses. Refer to Section 3.6.
- **Quality Assurance and Quality Control:** ensures the accuracy and precision of sampling and analysis activities. Refer to Section 3.7.

This WAP meets the specific requirements of the following:

- Land Disposal Restrictions Treatment Exemption for the LERF under 40 CFR 268.4, U.S. Environmental Protection Agency, December 6, 1994 (EPA 1994)
- Final Delisting for 200 Area ETF, 40 CFR 261, Appendix IX, Table 2,70 FR 44496 (EPA 2005)
- Washington State Waste Discharge Permit, No. ST 4500, as amended, (Ecology 2000)

- Hanford Facility RCRA Permit WA7890008967 (Permit)
- This plan also includes the specific elements of a WAP, as identified in the *Dangerous Waste Permit Application Requirements* (Ecology 1996a).

The conditions of the Washington State Discharge Permit, Number ST 4500 (Discharge Permit) are included in this WAP for completeness, although they are not within the scope of RCRA or WAC 173-303. Therefore, revisions of this WAP that are not governed by the requirements of WAC 173-303 will not be considered as a modification subject to review or approval by Ecology.

3.1.1 Liquid Effluent Retention Facility and Effluent Treatment Facility Description

The LERF and 200 Area ETF comprise an aqueous waste treatment system located in the 200 East Area. Both LERF and 200 Area ETF may receive aqueous waste through several inlets. 200 Area ETF can receive aqueous waste through three inlets. First, 200 Area ETF can receive aqueous waste directly from the LERF. Second, aqueous waste can be transferred from the Load-In Station to 200 Area ETF. Third, aqueous waste can be transferred from containers (e.g., carboys, drums) to the 200 Area ETF through either the Secondary Waste Receiving Tanks or the Concentrate Tanks. The Load-In Station is located just east of 200 Area ETF and currently consists of two 37,854-liter storage tanks and a pipeline that connects to either LERF or 200 Area ETF through fiberglass pipelines with secondary containment.

The LERF can receive aqueous waste through four inlets. First, aqueous waste can be transferred to LERF through a dedicated pipeline from the 200 West Area. Second, aqueous waste can be transferred through a pipeline that connects LERF with the 242-A Evaporator. Third, aqueous waste also can be transferred to LERF from a pipeline that connects LERF to the Load-In Station at 200 Area ETF. Finally, aqueous waste can be transferred into LERF through a series of sample ports located at each basin.

The LERF consists of three lined surface impoundments with a nominal capacity of 29.5 million liters each. Aqueous waste from LERF is pumped to 200 Area ETF through a double-walled fiberglass pipeline. The pipeline is equipped with leak detection located in the annulus between the inner and outer pipes. Each basin is equipped with six available sample risers constructed of 6-inch-perforated pipe. A seventh sample riser in each basin is dedicated to influent waste receipt piping, and an eighth riser in each basin contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the bottom of the basin. Detailed information on the construction and operation of the LERF is provided in Chapter 4.0.

200 Area ETF is designed to treat the contaminants anticipated in process condensate (PC) from the 242-A Evaporator and other aqueous wastes from the Hanford Site. Section 3.1.2 provides more information on the sources of these wastes.

The capabilities of 200 Area ETF were confirmed through pilot plant testing. A pilot plant was used to test surrogate solutions that contained constituents of concern anticipated in aqueous wastes on the Hanford Site. The pilot plant testing served as the basis for a demonstration of the treatment capabilities of 200 Area ETF in the *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL-92-72).

200 Area ETF consists of a primary and a secondary treatment train (Figure 3.1). The primary treatment train removes or destroys dangerous and mixed waste components from the aqueous waste. In the secondary treatment train, the waste components are concentrated and dried into a powder. This waste is containerized, and transferred to a waste TSD unit.

Each treatment train consists of a series of operations. The primary treatment train includes the following:

- Surge tank
- Rough filter
- Ultraviolet light oxidation (UV/OX)
- pH adjustment
- Hydrogen peroxide decomposer

- Fine filter
- Degasification
- Reverse osmosis (RO)
- Polisher [ion exchange (IX) column]
- Final pH adjustment and verification

The secondary treatment train uses the following systems:

- Secondary waste receiving tanks
- Evaporator (mechanical vapor recompression)
- Concentrate tank
- Thin film dryer
- Container handling
- Supporting systems

A dry powder waste is generated from the secondary treatment train, from the treatment of an aqueous waste. The secondary waste treatment system typically receives and processes by-products generated from the primary treatment train. However, in an alternate operating scenario, some aqueous wastes may be fed to the secondary treatment train before the primary treatment train. Detailed information on the treatment trains and the unit operations is provided in Chapter 4.0.

The treated effluent is contained in verification tanks where the effluent is sampled to confirm that the effluent meets the 'delisting' criteria. Under 40 CFR 261, Appendix IX, Table 2, 70 FR 44496, the treated effluent from 200 Area ETF is considered a delisted waste; that is, the treated effluent is no longer a dangerous or hazardous waste subject to the hazardous waste management requirements of RCRA. The treated effluent is discharged under the Discharge Permit as a nondangerous, delisted waste to the SALDS, located in the 600 Area, north of the 200 West Area. Treated wastewater from the Verification Tanks is recycled throughout the facility; for example, it is used to dilute bulk acid and caustic to meet processing needs reducing the demand for process water.

3.1.2 Sources of Aqueous Waste

200 Area ETF was intended and designed to treat a variety of mixed wastes. However, PC from the 242-A Evaporator was the only mixed waste identified for storage and treatment in the LERF and 200 Area ETF. As cleanup activities at Hanford progress, many of the aqueous wastes generated from site remediation and waste management activities are sent to the LERF and 200 Area ETF for treatment and storage.

The PC is a dangerous waste because it is derived from a listed, dangerous waste stored in the Double-Shell Tank (DST) System. The DST waste is transferred to the 242-A Evaporator where the waste is concentrated through an evaporation process. The concentrated slurry waste is returned to the DST System, and the evaporated portion of the waste is recondensed, collected, and transferred as PC to the LERF.

Other aqueous wastes that are treated and stored at the LERF and 200 Area ETF include, but are not limited to the following Hanford wastes: contaminated groundwater from pump-and-treat remediation activities, such as groundwater from the 200-UP-1 Operable Unit; purgewater from groundwater monitoring activities; water from deactivation activities, such as water from the spent fuel storage basins at deactivated reactors (e.g., N Reactor); laboratory aqueous waste from unused samples and sample analyses; and leachate from landfills, such as the Environmental Restoration Disposal Facility.

Most of these aqueous wastes are accumulated in batches in a LERF basin for interim storage and treatment through pH and flow equalization before final treatment in 200 Area ETF. However, some aqueous wastes, such as 200-UP-1 Groundwater, may flow through LERF en route to 200 Area ETF for final treatment. The constituents in these aqueous wastes are common to the Hanford Site and were considered in pilot plant testing or vendor tests, either as a constituent or as a family of constituents.

3.2 INFLUENT WASTE ACCEPTANCE PROCESS

Throughout the acceptance process, there are specific criteria required for an influent waste (i.e., aqueous waste) to be accepted at the LERF and/or 200 Area ETF. These criteria are identified in the following sections and summarized in Table 3.2. If an aqueous waste initially does not meet these criteria, it is not necessarily rejected. In many instances, ETF process or the LERF and 200 Area ETF unit-specific Permit Conditions can be modified to accommodate the treatment and storage of that waste. A discussion of the reevaluation process is provided in Section 3.2.3.

The first step in the waste acceptance process is for the generator to provide information on the influent waste stream. At this stage, the generator will work with LERF/200 Area ETF personnel to define what information must be provided to determine the acceptability of an aqueous waste for the treatment, storage, or disposal at the LERF and 200 Area ETF. At a minimum, the information required by WAC 173-303-300(2) will be obtained, which includes sampling and analysis of the aqueous waste stream. The LERF/200 Area ETF management will evaluate, on a case-by-case basis, whether the aqueous waste stream is acceptable for storage and treatment. The waste acceptance process contains the following steps.

Acceptance Process is performed as follows.

- Waste information--the generator of an aqueous waste works with LERF/200 Area ETF personnel to provide detailed information on the waste stream, i.e., a waste characterization.
- Waste management decision process--LERF/200 Area ETF management decision is based on a case-by-case evaluation of whether an aqueous waste stream is acceptable for treatment or storage, or whether to reject a stream. In addition, any special management practices required for an accepted stream may be specified at this time. The evaluation is divided into two categories.
  - Regulatory acceptability--a review to determine if there are any regulatory concerns that would prohibit the storage or treatment of an aqueous waste in the LERF or 200 Area ETF; e.g., treatment would meet permit conditions that would comply with applicable regulations.
  - Operational acceptability--an evaluation to determine if there are any operational concerns that would prohibit the storage or treatment of an aqueous waste in the LERF or 200 Area ETF; e.g., determine treatability and compatibility or safety considerations.

  Specific waste acceptance criteria are defined within the individual discussions on regulatory and operational acceptability.
- Re-evaluation Process is performed to ensure the characterization is accurate and current. This process also provides a mechanism for re-evaluating an aqueous waste stream that does not meet the waste acceptance criteria.
- Record Information/Decision Process provides that information used in the decision. The evaluation and the decision are documented as part of LERF & 200 Area ETF Operating Record.

3.2.1 Acceptance Process

When an aqueous waste stream is identified for treatment or storage in the LERF or 200 Area ETF, the generator is required to characterize the waste and document the characterization on an aqueous waste profile sheet (WPS). This requirement is the first waste acceptance criterion. The LERF and 200 Area ETF personnel work with the generators to ensure that the necessary information is collected for the characterization of a waste stream (i.e., the appropriate analyses or adequate process knowledge), and that the information provided on the WPS is complete. The completed WPS is maintained at 200 Area ETF.

3.2.1.1 Waste Characterization

Because the constituents in the individual aqueous waste streams vary, each stream is characterized and evaluated for acceptability on a case-by-case basis. The generator is required to designate an aqueous waste, which generally will be backed up by analytical data. However, a generator may use process

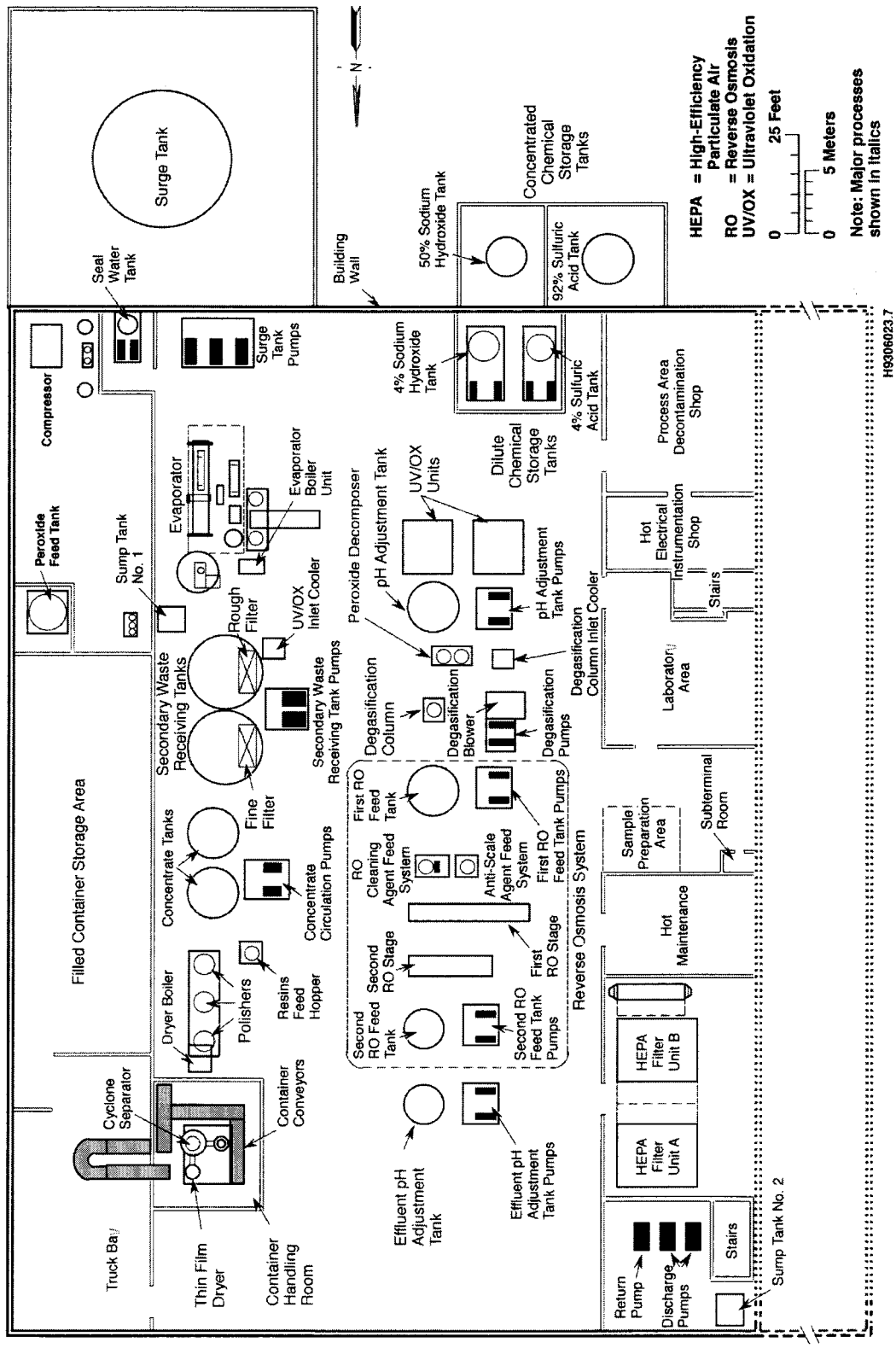
knowledge to substantiate the waste designation, or for general characterization information. Examples of acceptable process knowledge include the following:

- Documented data or information on processes similar to that which generated the aqueous waste stream
- Information/documentation that dangerous waste constituents are from specific, well documented processes, e.g., F-listed wastes
- Information/documentation that sampling/analyzing a waste stream would pose health and safety risks to personnel
- Information/documentation that the waste does not lend itself to collecting a laboratory sample, for example, wastewater collected (e.g., sump, tank) where the source water characterization is documented.

When a generator submits process knowledge for the characterization of a dangerous and/or mixed waste stream, LERF and 200 Area ETF personnel review the process knowledge as part of the waste acceptance process. Specifically, LERF and 200 Area ETF personnel review the generator's processes to verify the integrity of the process knowledge, and determine whether the process knowledge is current and consistent with current regulations. LERF/200 Area ETF management or their designee determines the final decision on the adequacy of the process knowledge. The persons reviewing generator process knowledge and those making decisions on the adequacy of process knowledge are trained according to the requirements of the Dangerous Waste Training Plan (Chapter 8.0).

The generator is also responsible for identifying Land Disposal Restrictions (LDRs) that would be applicable to the influent aqueous waste as part of the characterization, as required under 40 CFR 268.40 and WAC 173-303-140. Because the 200 Area ETF is a Clean Water Act - equivalent TSD unit (40 CFR 268.37(a)), the generator is not required to identify the underlying hazardous constituents (40 CFR 286.48).

Figure 3.1. 200 Area Effluent Treatment Facility Floor Plan



When analyzing an aqueous waste stream for characterization, a generator is required to use the target list of parameters identified in Table 3.3. Refer to Section 3.9 for the corresponding analytical methods. The generator may use process knowledge in lieu of some analyses, as determined by LERF/200 Area ETF management or their designee, if the process knowledge is adequate (as described above). For example, if a generator provides information that, the process generating an aqueous waste does not include or involve organic chemicals; analyses for organic compounds likely would not be required. Additional analyses could be required if historical information and/or process knowledge indicate that an aqueous waste contains constituents not included in the target list of parameters.

The LERF and 200 Area ETF personnel will work with the generator to determine which analyses are appropriate for the characterization. This approach ensures that the waste analyses adequately characterize the aqueous waste and defines the constituents of concern in a cost effective manner. The characterization and historical information are documented in the WPS, which is discussed in the following section.

3.2.1.2 Aqueous Waste Profile Sheet

The WPS documents the characterization of each new aqueous waste stream. The profile includes a detailed description of the volume, source, waste designation, and the chemical and physical nature of the aqueous waste. For an aqueous waste to be accepted for treatment or storage in the LERF or 200 Area ETF, each new waste stream generator is required to complete and provide this form to LERF and 200 Area ETF management. Each generator also is required to provide the analytical data and process knowledge used to designate the aqueous waste stream, and to determine the chemical and physical nature of the waste. The LERF and 200 Area ETF management determine whether the information on the WPS is sufficient. The LERF and 200 Area ETF management use this information to evaluate the acceptability of the aqueous waste for storage and treatment in the LERF and 200 Area ETF, and to determine if the aqueous waste can be handled properly.

3.2.2 Waste Management Decision Process

All aqueous waste under consideration for acceptance must be characterized using analytical data, and process knowledge. This information is used to determine the acceptability of an aqueous waste stream. The LERF and 200 Area ETF Facility Manager or their designee is responsible for making the decision to accept or reject an aqueous waste stream. The management decision to accept any aqueous waste stream is based on an evaluation of regulatory acceptability and operational acceptability. Each evaluation uses acceptance criteria, which were developed to ensure that an aqueous waste is managed in a safe, environmentally sound, and compliant manner. The following sections provide detail on the acceptance evaluation and the acceptance criteria.

In many instances, an aqueous waste that does not meet one of the waste acceptance criteria is not necessarily rejected. Section 3.2.3 discusses the process for re-evaluating an aqueous waste that does not initially meet the waste acceptance criteria. However, the final decision to reject an aqueous waste is made by LERF and 200 Area ETF management. An aqueous waste stream could be rejected for one of the following reasons:

- The paperwork and/or laboratory analyses from the generator are insufficient
- Discrepancies with the regulatory and operational acceptance criteria cannot be reconciled, including:
  - An aqueous waste is not allowed under the current Discharge Permit or Final Delisting, and LERF/200 Area ETF management elect not to pursue an amendment, or the Permit and Delisting cannot be amended (Section 3.2.2.1)
  - An aqueous waste is incompatible with LERF liner materials or with other aqueous waste in LERF and no other management method is available (Section 3.2.2.2).
- Adequate storage or treatment capacity is not available.

3.2.2.1 Regulatory Acceptability

Each aqueous waste stream is evaluated on a case-by-case basis to determine if there are any regulatory concerns that would preclude the storage or treatment of a waste in the LERF or 200 Area ETF. Before an aqueous waste can be stored or treated in either the LERF or 200 Area ETF, the waste designation must be determined. Information on the waste designation of an aqueous waste is documented in the WPS. This information is used to confirm that treating or storing the aqueous waste in the LERF or 200 Area ETF is allowed under and in compliance with WAC 173-303, RCRA Permit, Final Delisting for 200 Area ETF, and the Discharge Permit for 200 Area ETF.

3.2.2.1.1 Dangerous Waste Regulations/Permits

Before an aqueous waste stream is sent to the LERF or 200 Area ETF, the generator will characterize and designate the stream with the appropriate dangerous/hazardous waste numbers according to WAC 173-303-070. The LERF and 200 Area ETF Part A Form, and the Final Delisting for 200 Area ETF identify the specific waste numbers for dangerous/mixed waste that can be managed in the LERF and 200 Area ETF. Dangerous waste designated with waste numbers not specified in Chapter 1.0 (Part A Form) cannot be treated or stored in the LERF or 200 Area ETF, unless the Permit is modified.

Additionally, aqueous wastes designated with listed waste numbers identified in the Final Delisting will be managed in accordance with the conditions of the delisting, or an amended delisting. Accordingly, the acceptance criteria in this evaluation are satisfied through compliance with the Chapter 1.0, (Part A Form), and the Final Delisting.

3.2.2.1.2 State Waste Permit Regulations/Permit

Compliance with the Discharge Permit constitutes another waste acceptance criterion. In accordance with the conditions of the Discharge Permit, the constituents of concern in each new aqueous waste stream must be identified. The waste designation and characterization data provided by the generator are used to identify these constituents. A constituent of concern, under the conditions of the Discharge Permit, in an aqueous waste stream is defined as any contaminant with a maximum concentration greater than one of the following:

- Any limit in the Discharge Permit (Ecology 2000)
- Groundwater Quality Criteria (WAC 173-200)
- Final Delisting levels (EPA 2005)
- Background groundwater concentrations as measured at 200 Area ETF disposal site. The practical quantification limit (PQL) is used for the groundwater background concentration for constituents not analyzed or not detected in the SALDs background data.

The conditions of the Discharge Permit also require a demonstration that 200 Area ETF can treat the constituents of concern to below discharge limits.

3.2.2.2 Operational Acceptability

Because the operating configuration or operating parameters at the LERF and 200 Area ETF can be adjusted or modified, most aqueous waste streams generated on the Hanford Site can be effectively treated to below Delisting and Discharge Permit limits. Because of this flexibility, it would be impractical to define numerical acceptance or decision limits. Such limits would constrain the acceptance of appropriate aqueous waste streams for treatment at the LERF and 200 Area ETF. The versatility of the LERF and 200 Area ETF is better explained in the following examples:

- The typical operating configuration of 200 Area ETF is to process an aqueous waste through the UV/OX unit first, followed by the RO unit. However, high concentrations of nitrates may interfere with the performance of the UV/OX. In this case, 200 Area ETF could be configured to process the waste in the RO unit prior to the UV/OX unit.

- For a small volume aqueous waste with high concentrations of some anions and metals, the approach may be to first process the waste stream in the secondary treatment train. This approach would prevent premature fouling or scaling of the RO unit. The liquid portion (i.e., untreated overheads from 200 Area ETF evaporator and thin-film dryer) would be sent to the primary treatment train.
- An aqueous waste with high concentrations of chlorides and fluorides may cause corrosion problems when concentrated in the secondary treatment train. One approach is to adjust the corrosion control measures in the secondary treatment train. An alternative may be to blend this aqueous waste in a LERF basin with another aqueous waste, which has sufficient dissolved solids, such that the concentration of the chlorides in the secondary treatment train would not pose a corrosion concern.
- Some metal salts (e.g., barium sulfate) tend to scale the RO membranes. In this situation, descalants used in the treatment process may be increased.
- Any effluent that does not meet these limits in one pass through 200 Area ETF treatment process is recycled to 200 Area ETF for re-processing.

There are some aqueous wastes whose chemical and physical properties preclude that waste from being treated or stored at the LERF or 200 Area ETF. Accordingly, an aqueous waste is evaluated to determine if it is treatable, if it would impair the efficiency or integrity of the LERF or 200 Area ETF, and if it is compatible with materials in these units. This evaluation also determines if the aqueous waste is compatible with other aqueous wastes managed in the LERF.

The waste acceptance criteria in this category focus on determining treatability of an aqueous waste stream, and on determining any operational concerns that would prohibit the storage or treatment of an aqueous waste stream in the LERF or 200 Area ETF. The chemical and physical properties of an aqueous waste stream are determined as part of the waste characterization, and are documented on the WPS and compared to the design of the units to determine whether an aqueous waste stream is appropriate for storage and treatment in the LERF and 200 Area ETF.

3.2.2.2.1 Treatability

The process of determining treatability involves two steps. The first step is to establish the treatment efficiencies for the constituents of concern in an influent aqueous waste. The treatment efficiencies must be sufficient such that the treated effluent will meet the Discharge Permit and Delisting limits. The pilot plant testing provided destruction and removal (i.e., treatment) efficiencies for most of the anticipated constituents in aqueous waste streams at the Hanford Site, and are documented in the *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL-92-72). Information or studies from the vendors of the individual treatment units' studies may also be used on a case-by-case basis to develop treatment efficiencies for 200 Area ETF or for the individual treatment units. Chapter 4.0 provides a detailed discussion of the individual treatment units. Treatment efficiencies also may be determined or confirmed by 200 Area ETF operating data.

The second step in determining treatability is to identify those physical and chemical properties in an aqueous waste that would interfere with, or foul 200 Area ETF treatment process. This step focuses on the potential of a waste stream to interfere with the destruction efficiency of organic compounds in the UV/OX system, rejection rates of the RO membranes, or foul the filtration systems. Generally, the operating parameters or operating configuration at the LERF or 200 Area ETF can be adjusted or modified to accommodate these properties. However, in those cases where a treatment process or operating configuration cannot be modified, the aqueous waste stream will be excluded from treatment or storage at the LERF or 200 Area ETF.

Additionally, an aqueous waste stream is evaluated for the potential to deposit solids in a LERF basin (i.e., an aqueous waste that contains sludge). This evaluation will also consider whether the blending or mixing of two or more aqueous waste streams will result in the formation of a precipitate. However, because the waste streams managed in the LERF and 200 Area ETF are generally dilute, the potential for mixing waste streams and forming a precipitate is low; no specific compatibility tests are performed. If

necessary, filtration at the waste source could be required before acceptance into LERF based on total suspended solids analysis or process knowledge of the waste.

To determine if an aqueous waste meets the criterion of treatability, specific information is required. Treatment efficiencies will be developed from characterization data provided by the generator. Generators will also provide characterization data to identify those physical and chemical properties that would interfere with, or foul 200 Area ETF treatment process. In some instances, process knowledge may be adequate to identify a chemical or physical property that would be of concern. For example, the generator could provide process knowledge that the stream has two phases (an oily phase and an aqueous phase). In this case, if the generator could not physically separate the two phases, the aqueous waste stream would be rejected because the oily phase could compromise some of the treatment equipment. Typically, analyses for the following parameters are required to evaluate treatability and operational concerns:

- total dissolved solids
- total organic carbon
- total suspended solids
- specific conductivity
- pH
- alkalinity
- ammonia
- barium
- calcium
- chloride
- fluoride
- iron
- magnesium
- nitrate
- nitrite
- phosphate
- potassium
- silicon
- sodium
- sulfate

These constituents are identified in Table 3.2.

3.2.2.2.2 Compatibility

Corrosion Control. Because of the materials of construction used in 200 Area ETF, corrosion is generally not a concern with new aqueous waste streams. Additionally, these waste streams are managed in a manner that minimizes corrosion. To ensure that a waste will not compromise the integrity of 200 Area ETF tanks and process equipment, each waste stream is assessed for its corrosion potential as part of the compatibility evaluation. This assessment usually focuses on chloride and fluoride concentrations; however, the chemistry of each new waste also is evaluated for other parameters that could cause corrosion.

Compatibility with Liquid Effluent Retention Facility Liner and Piping. As part of the acceptance process, the criteria of compatibility with the LERF liner materials are evaluated for each aqueous waste stream. The evaluation for liner compatibility is documented as part of the waste acceptance process. The chemical parameters or constituents considered for liner compatibility are identified in Table 3.1. The analytical methods for these parameters and constituents are provided in Section 3.9.

The high-density polyethylene liners in the LERF basins potentially are vulnerable to the presence of certain constituents that might be present in some aqueous waste. Using EPA SW-846 Method 9090, the liner materials were tested to evaluate compatibility between aqueous waste stored in the LERF and synthetic liner components. Based on the data from the compatibility test and vendor data on the liner materials, several constituents and parameters were identified as potentially harmful (at high concentrations) to the integrity of the liners. From these data and the application of safety factors, concentration limits in Table 3.1 were established.

The strategy for protecting the integrity of a LERF liner is to establish upfront that an aqueous waste is compatible before the waste is accepted into LERF. Characterization data on each new aqueous waste stream are compared to the limits outlined in Table 3.1 to ensure compatibility with the LERF liner material before acceptance into the LERF.

Before a waste stream is processed at the 242-A Evaporator, the generator reviews DST analytical data and a PC profile is developed to ensure that PC is compatible with the LERF liner. For flow-through aqueous wastes like the 200-UP-1 Groundwater, characterization data will be reviewed quarterly to ensure that liner compatibility is maintained.

In some instances, process knowledge may be adequate to determine that an aqueous waste is compatible with the LERF liner. In those instances where process knowledge is adequate, the waste characterization would likely not require analysis for these parameters and constituents. Stormwater is an example where process knowledge is adequate to determine that this aqueous waste is compatible with the LERF liner.

Compatibility with Other Waste. Some aqueous wastes, especially small volumes, are accumulated in the LERF with other aqueous waste. Before acceptance into the LERF, the aqueous waste stream is evaluated for its compatibility with the resident aqueous waste(s). The evaluation focuses on the potential for an aqueous waste to react with another waste (40 CFR 264, Appendix V, *Examples of Potentially Incompatible Wastes*). However, the potential for problems associated with commingling aqueous wastes is very low due to the dilute nature of the wastes; this evaluation confirms the compatibility of two or more aqueous wastes from different sources. Compatibility is determined by evaluating parameters such as pH, ammonia, and chloride. No specific analytical test for compatibility is performed.

If it is determined that an aqueous waste stream is incompatible with other aqueous waste streams, alternate management scenarios are available. For example, another LERF basin that contains a compatible aqueous waste(s) might be used, or the aqueous waste stream might be fed directly into 200 Area ETF for treatment. In any case, potentially incompatible waste streams are not mixed, and all aqueous waste is managed in a way that precludes a reaction, degradation of the liner, or interference with 200 Area ETF treatment process.

3.2.3 Re-Evaluation Process

In accordance with 40 CFR 264.13 and WAC 173-303-300(4)(a), an influent aqueous waste will be re-evaluated as necessary to ensure that the characterization is accurate and current. At a minimum, an aqueous waste stream will be re-evaluated in the following situations.

- The LERF and 200 Area ETF management have been notified, or have reason to believe that the process generating the waste has changed.
- The LERF and 200 Area ETF management note an increase or decrease in the concentration of a constituent in an aqueous waste stream, beyond the range of concentrations that was described or predicted in the waste characterization.

In these situations, LERF and 200 Area ETF management will review the available information. If existing analytical information is not sufficient, the generator may be asked to review and update the current waste characterization, to supply a new WPS, or re-sample and re-analyze the aqueous waste, as necessary. Other situations that might require a re-evaluation of a waste stream are discussed in the following sections.

3.2.3.1 Re-Evaluation for Aqueous Wastes not Meeting Waste Acceptance Criteria

An aqueous waste that does not meet one of the acceptance criteria is not necessarily rejected. Several options are available in the event that an aqueous waste is not acceptable following an initial evaluation. For example, a more extensive evaluation could be required to determine if the 200 Area ETF process can be modified to treat an aqueous waste to required discharge levels. Additionally, a more extensive evaluation might be required to determine if a modification of the Discharge Permit or the Final Delisting is required and is feasible (e.g., to treat waste with new listed waste numbers).

3.2.3.2 Re-Evaluation for Treated Effluent not Meeting 200 Area Effluent Treatment Facility Permit Limits

If the treated effluent does not meet the Discharge Permit and Delisting limits in one pass through 200 Area ETF treatment process, the acceptability of the influent aqueous waste would be re-evaluated. This situation generally would apply to large volumes of aqueous waste (such as 200-UP-1 Groundwater) or to aqueous waste that is sent to the LERF or 200 Area ETF in batches on some frequency (such as monthly transfers of an aqueous waste). Small volumes of aqueous waste generally would be reprocessed until permit limits are met.

3.2.3.3 Re-Evaluation Requirements for Flow-Through Aqueous Waste

Aqueous waste like the 200-UP-1 Groundwater is unique because of the constant-flow source, and because the waste is pumped into a LERF basin throughout the lifetime of the pump-and-treat remediation activity. Also, rather than being accumulated in the LERF in a batch mode, this aqueous waste will generally flow through the LERF to 200 Area ETF for final treatment. Though this aqueous waste has been characterized upfront for acceptability, special sampling and analysis requirements must be met during the pump-and-treat operation to ensure that it continues to meet acceptance criteria.

Accordingly, flow-through wastes like the 200-UP-1 Groundwater are, and will be sampled quarterly to update the initial characterization. The LERF and 200 Area ETF personnel monitor this on-going characterization. If the data from a sampling event suggest that contaminant concentrations have increased beyond that described in the initial characterization, the acceptability of the waste stream will be re-evaluated. Details on the sampling and analysis of flow-through aqueous waste, like the 200-UP-1 Groundwater, are provided in Section 3.4.

3.2.4 Record/Information and Decision

The information and data collected throughout the acceptance process, and the evaluation and decision on whether to accept an influent aqueous waste stream for treatment or storage in the LERF or 200 Area ETF are documented as part of LERF and 200 Area ETF Operating Record, which is maintained at 200 Area ETF. Specifically, the Operating Record contains the following components on a new influent aqueous waste stream:

- The signed WPS for each aqueous waste stream and analytical data
- Process knowledge used to characterize a dangerous/mixed waste (under WAC 173-303), and information supporting the adequacy of the process knowledge
- The evaluation on whether an aqueous waste stream meets the waste acceptance criteria, including:
  - The evaluation for regulatory acceptability including appropriate regulator approvals
  - The evaluation for liner compatibility and for compatibility with other aqueous waste

Table 3.1. General Limits for Liner Compatibility

Chemical Family	Constituent(s) or Parameter(s)[1]	Limit (mg/L)[2] (sum of constituent concentrations)
Alcohol/glycol	1-butanol	500,000
Alkanone[3]	acetone,	200,000
Alkenone[4]	none targeted	NA
Aromatic/cyclic hydrocarbon	acetophenone, benzene, carbozole, chrysene, cresol, di-n-octyl phthalate, diphenylamine, isophorone, pyridine, tetrahydrofuran,	2000
Halogenated hydrocarbon	arochlors, carbon tetrachloride, chloroform,hexachlorobenzene, lindane (gamma-BHC), hexachlorocyclopentadiene, methylene chloride, p-chloroaniline, tetrachloroethylene, 2,4,6-trichlorophenol	2000
Aliphatic hydrocarbon	none targeted	500,000
Ether	dichloroisopropyl ether	2000
Other hydrocarbons	acetontrile, carbon disulfide, n-nitrosodimethylamine, tributyl phosphate	2000
Oxidizers	none targeted	NA
Acids, Bases, Salts	ammonia, cyanide, anions, cations	100,000
pH	pH	0.5 < pH < 13.0

[1] Analytical methods for the parameters and constituents are provided in Section 3.9.

[2] Analytical data are evaluated using the following 'sum of the fraction' technique. The individual constituent concentration is evaluated against the compatibility limit for its chemical family. The sum of the evaluations must be less than 1. pH is not part of this evaluation.

$$\sum_{n=1}^{i}\left(\frac{Conc_n}{LIMIT_n}\right) \leq 1$$

[3] Ketone containing saturated alkyl group(s)

[4] Ketone containing unsaturated alkyl group(s)

Where 'i' is the number of organic constituents detected

mg/L = milligrams per liter

NA = not applicable

Table 3.2. Waste Acceptance Criteria

General criteria category	Criteria description
1. Characterization	A. Each generator must provide an aqueous waste profile.
	B. Each generator must designate the aqueous waste stream.
	C. Each generator must provide analytical data and/or process knowledge.
2. Regulatory acceptability	A. The LERF and 200 Area ETF can store and treat influent aqueous wastes with waste numbers identified in Chapter 1.0 (Part A Form) for the LERF and 200 Area ETF, and the Final Delisting for 200 Area ETF.
	B. The aqueous waste must comply with conditions of the Discharge Permit.
3. Operational acceptability	A. Determine whether an aqueous waste stream is treatable, considering: 1. Whether the removal and destruction efficiencies on the constituents of concern will be adequate to meet the Discharge Permit and Delisting levels 2. Other treatability concerns; analyses for this evaluation may include: total dissolved solids — iron total organic carbon — magnesium total suspended solids — nitrate specific conductivity — nitrite alkalinity — phosphate ammonia — potassium barium — silicon calcium — sodium chloride — sulfate fluoride — pH
	B. Determine whether an aqueous waste stream is compatible, considering: 1. Whether an aqueous waste stream presents corrosion concerns; analysis may include chloride and fluoride 2. Whether an aqueous waste stream is compatible with LERF liner materials, compare characterization data to the liner compatibility limits (Table 3.1). 3. Whether an aqueous waste stream is compatible with other aqueous waste(s). (A 40 CFR 264 Appendix V type of comparison will be employed).

200 Area ETF = 200 Area Effluent Treatment Facility
LERF = Liquid Effluent Retention Facility

3.3 SPECIAL MANAGEMENT REQUIREMENTS

Special management requirements for aqueous wastes that are managed in the LERF or 200 Area ETF are discussed in the following sections.

3.3.1 Conditions on Process Condensate for Newly Identified Waste Numbers

In January 1995, the U.S. Department of Energy, Richland Operations Office (DOE-RL) notified Ecology and the U.S. Environmental Protection Agency that small amounts of listed waste might have been introduced to the DST System, upstream of the LERF and 200 Area ETF. This listed waste previously had not been identified in the Part A Form for the DST System, LERF, or 200 Area ETF. In a March 7, 1995 letter from Ecology to DOE-RL (Ecology 1995b), Ecology exercised its enforcement discretion with respect to the designation of this waste so long as several conditions are met. As long as these conditions are met, the waste numbers will not be included in Chapter 1.0 (Part A Form), for the LERF and 200 Area 200 Area ETF. These conditions only apply to PC. The constituents vanadium, formate, and cyanide will be analyzed in the PC to meet these conditions.

3.3.2 Land Disposal Restriction Compliance at Liquid Effluent Retention Facility

Because LERF provides treatment through flow and pH equalization, a surface impoundment treatment exemption from the land disposal restrictions was granted in accordance with 40 CFR 268.4 (EPA 1994 and Ecology 1996b). This treatment exemption is subject to several conditions, including a requirement that the WAP address the sampling and analysis of the treatment 'residue' [40 CFR 268.4(a)(2)(i) and WAC 173-303-300(5)(h)(i) and (ii)] to ensure the 'residue' meets applicable treatment standards. Though the term 'residue' is not specifically defined, this condition further requires that sampling must be designed to represent the "sludge and the supernatant" indicating that a residue may have a sludge (solid) and supernatant (liquid) component.

Solid residue is not anticipated to accumulate in a LERF basin for the following reasons:

- Aqueous waste streams containing sludge would not be accepted into LERF under the acceptance criteria of treatability (Section 3.2.2.2.1)
- No solid residue was reported from PC discharged to LERF in 1995
- The LERF basins are covered and all incoming air first passes through a breather filter
- No precipitating or flocculating chemicals are used in flow and pH equalization.

Therefore, the residue component subject to this condition is the supernatant (liquid component). As indicated above, solids are not anticipated to accumulate in a LERF basin. Additionally, an aqueous waste stream is evaluated for the potential to deposit solids in a LERF basin (i.e., an aqueous waste that contains sludge). If necessary, filtration at the waste source could be required before acceptance into LERF. The contingency for removal of solids will be addressed during closure [as indicated in Chapter 11.0, Closure Plan.

The conditions of the treatment exemption also require that treatment residues (i.e., aqueous wastes), which do not meet the LDR treatment standards "must be removed at least annually" [40 CFR 268.4(a)(2)(ii)]. To address the conditions of this exemption, an influent aqueous waste is sampled and analyzed and the LDR status of the aqueous waste is established as part of the acceptance process. The LERF basins are then managed such that any aqueous waste(s), which exceeds an LDR standard, is removed annually from a LERF basin, except for a heel of approximately 1 meter. A heel is required to stabilize the LERF liner. The volume of the heel is approximately 1.9 million liters.

3.4 INFLUENT AQUEOUS WASTE SAMPLING AND ANALYSIS

The following sections provide a summary of the sampling procedures, frequencies, and analytical parameters that will be used in the characterization of influent aqueous waste (Section 3.2) and in support of the special management requirements for aqueous waste in the LERF (Section 3.3).

3.4.1 Sampling Procedures

With a few exceptions, generators are responsible for the characterization, including sampling and analysis, of an influent aqueous waste. PC is either sampled at the 242-A Evaporator or accumulated in a LERF basin following a 242-A Evaporator campaign and sampled. Flow-through aqueous wastes, such as the 200-UP-1 Groundwater, will be characterized before acceptance; however, these aqueous wastes will also be sampled at LERF quarterly. Other exceptions will be handled on a case-by-case basis and the operating record will be maintained at the unit for inspection by Ecology. The following section discusses the sampling locations, methodologies, and frequencies for these aqueous wastes. Aqueous waste generators are referred to WAC 173-303-110(2) (40 CFR 261, Appendix I) for the sampling procedures that are applicable to their waste. For samples collected at the LERF and 200 Area ETF, unit-specific sampling protocol is followed. The sample containers, preservation materials, and holding times for each analysis are listed in Section 3.10.

3.4.1.1 Batch Samples

In those cases where an aqueous waste is sampled in a LERF basin, samples are collected from four of the six available sample risers located in each basin, i.e., four separate samples. When LERF levels are low, fewer than four samples can be taken provided that the sampling approach is still representative. Though there are eight sample risers at each basin, one is dedicated to liquid level instrumentation and another is dedicated as an influent port. Operating experience indicates that four samples adequately capture the variability of an aqueous waste stream. Specifically, sections of stainless steel (or other compatible material) tubing are inserted into the sample riser to an appropriate depth. Using a portable pump, the sample line is flushed with the aqueous waste and the sample collected. The grab sample containers typically are filled for volatile organic compounds (VOC) first, followed by the remainder of the containers for the other parameters.

Several sample ports are also located at 200 Area ETF, including a valve on the recirculation line at 200 Area ETF surge tank, and a sample valve on a tank discharge pump line at 200 Area ETF Load-In Station. All samples are obtained at the LERF or 200 Area ETF are collected in a manner consistent with SW-846 procedures (EPA as amended).

3.4.1.2 Flow-Through Samples at the Liquid Effluent Retention Facility

Flow-through samples are collected from a valve located at a transfer pipeline connection to the LERF. Samples of flow-through aqueous wastes, such as 200-UP-1 Groundwater, are collected quarterly or more frequently if there is change in the source (e.g., a change in the well-head), or if it is determined that there is an increase in the concentration of contaminants beyond the range described in the initial characterization. For flow-through grab samples, VOC sample containers are typically filled first, followed by the remainder of the containers for the other parameters.

3.4.2 Analytical Rationale

As stated previously, each generator is responsible for designating and characterizing its aqueous waste stream. Accordingly, each generator samples and analyzes an influent waste stream using the target list of parameters (Table 3.3) for the waste acceptance process. At the discretion of the LERF and 200 Area ETF management, a generator may provide process knowledge in lieu of some analyses as discussed in Section 3.2.1.1. The LERF and 200 Area ETF personnel will work with the generator to determine which parameters are appropriate for the characterization.

The analytical methods for these parameters are provided in Section 3.9. All methods are EPA methods. Additional analyses may be required if historical information and process knowledge indicate that an influent aqueous waste contains constituents not included in the target list of parameters. For example, if process knowledge indicates that an aqueous waste contains a parameter that is regulated by the Groundwater Quality Criteria (WAC 173-200), that parameter(s) would be added to the suite of analyses required for that aqueous waste stream.

The analytical data for the parameters presented in Table 3.3, including VOC, SVOC, metals, anions, and general chemistry parameters are used to define the physical and chemical properties of the aqueous waste to:

- Set operating conditions in the LERF and 200 Area ETF (e.g., to determine operating configuration - refer to Section 3.2.2.2)
- Identify concentrations of some constituents which may also interfere with, or foul 200 Area ETF treatment process (e.g., fouling of the RO membranes - refer to Section 3.2.2.2)
- Evaluate LERF liner and piping material compatibility
- Determine treatability to evaluate if applicable constituents in the treated effluent will meet Discharge Permit and Delisting limits

- Estimate concentrations of some constituents in the waste generated in the secondary treatment train (i.e., dry powder waste).

Some analyses also are performed to address special conditions (Section 3.3) or for other specific purposes as indicated below:

- Formate, cyanide, and vanadium analysis is required for compliance with special conditions for PC (refer to Section 3.3.2).
- Total dissolved solids analysis to predict volume of powder waste from the secondary treatment train.

Table 3.3. Target Parameters for Influent Aqueous Waste Analyses

VOLATILE ORGANIC COMPOUNDS		SEMIVOLATILE ORGANIC COMPOUNDS
Acetone		Acetophenone
Acetonitrile		Cresol (o, p, m)
Benzene		Dichloroisopropyl ether (bis(2-chloropropyl)ether)
1-Butanol		Di-n-octyl phthalate
Carbon disulfide		Diphenylamine
Carbon tetrachlorideChloroform		Hexachlorobenzene
Methylenechloride		Hexachlorocyclopentadiene
Tetrachloroethylene		Iosophorone
Tetrahydrofuran		Lindane (gamma-BHC)
		N-nitrosodimethylamine
		Pyridine
		Tributyl phosphate
		2,4,6-Trichlorophenol
TOTAL METALS		**ANIONS**
Arsenic	Magnesium	Chloride
Barium	Mercury	Fluoride
Beryllium	Nickel	Formate[1]
Cadmium	Potassium	Nitrate
Calcium	Selenium	Nitrite
Chromium	Silicon	Phosphate Sulfate
Copper	Silver	**GENERAL CHEMISTRY PARAMETERS**
Iron	Sodium	
Lead	Vanadium	Ammonia
	Zinc	Total Kjeldahl nitrogen
		Cyanide
		pH
		Total suspended solids
		Total dissolved solids
		Total organic carbon
		Specific conductivity

[1] Parameter only required for 242-A Evaporator process condensate (refer to Section 3.3.2)

3.5 TREATED EFFLUENT SAMPLING AND ANALYSIS

The treated aqueous waste, or effluent, from 200 Area ETF is collected in three 2,540,000-liter verification tanks before discharge to the SALDS. To determine whether the Discharge Permit early warning values, enforcement limits, and the Delisting criteria are met, the effluent routinely is sampled at the verification tanks. The sampling and analyses performed are described in the following sections.

3.5.1 Rationale for Effluent Analysis Parameter Selection

The parameters measured in the treated effluent are required by the following regulatory documents:

- Delisting criteria from the Final Delisting (EPA 2005)
- Effluent limits from the State Waste Discharge Permit (Ecology 2000)
- Early warning values from the State Waste Discharge Permit (Ecology 2000).

The Final Delisting provides two testing regimes for the treated effluent. Initial verification-testing is performed when a new influent wastestream is processed through the 200 Area ETF. For each 200 Area ETF influent, the first generated verification tank must be sampled and analyzed for all delisting constituents and conductivity. Subsequent verification sampling and analysis of all delisting parameters is performed on every 15th tank of that 200 Area ETF influent type. If the concentration of any analyte is found to exceed a Discharge Permit enforcement limit or a Delisting criterion, the contents of the verification tank are reprocessed and/or re-analyzed. The next verification tank generated is also sampled for all delisting constituents. If the concentration of any analyte exceeds an early warning value an early warning value report is prepared and submitted to Ecology.

3.5.2 Effluent Sampling Strategy: Methods, Location, Analyses, and Frequency

Effluent sampling methods and locations, the analyses performed, and frequency of sampling are discussed in the following sections.

3.5.2.1 Effluent Sampling Method and Location

Samples of treated effluent are collected and analyzed to verify the treatment process using 200 Area ETF-specific sampling protocol. These verification samples are collected at a sampling port on the verification tank recirculation line. Section 3.9 presents the sample containers, preservatives, and holding times for each parameter monitored in the effluent.

3.5.2.2 Analyses of Effluent

The parameters required by the current Discharge Permit and Delisting conditions are presented in Table 3.4. The analytical methods and PQLs associated with each parameter are provided in Section 3.9. The methods and PQLs are equivalent to those used in the analysis of influent aqueous waste. With the exception of formic acid (analyzed as formate), analyses for the constituents associated with the newly listed waste numbers (Section 3.3.2) already are required analyses for the effluent. An analysis for formate is not required unless this constituent is identified in the influent aqueous waste.

3.5.2.3 Frequency of Sampling

Treated effluent is tested for all parameters listed in Table 3.4 on a frequency consistent with the conditions of the Discharge Permit and the Final Delisting. This effluent must meet the Discharge Permit and Delisting limits associated with these parameters. Grab samples are collected from each verification tank.

During operation of 200 Area ETF, if one or more of the constituents exceeds a Delisting criterion, the Delisting conditions require the analysis of samples from the following verification tank volume before effluent can be discharged. Treated effluent that does not meet Delisting criteria and Discharge Permit is not discharged to the SALDS until the tank has been retreated and/or analyzed.

3.6 EFFLUENT TREATMENT FACILITY GENERATED WASTE SAMPLING AND ANALYSIS

The wastes discussed in this section include the wastes generated at 200 Area ETF and are managed in the container storage areas of 200 Area ETF. This section describes the characterization of the following secondary waste streams generated within 200 Area ETF:

- Secondary waste generated from the treatment process, including the following waste forms:
  - dry powder waste
  - concentrate tanks slurry
  - sludge removed from process tanks
- Waste generated by operations and maintenance activities
- Miscellaneous waste generated within 200 Area ETF

For each waste stream, the waste is described, a characterization methodology and rationale are provided, and sampling requirements are addressed.

3.6.1 Secondary Waste Generated from Treatment Processes

The following terms used in this Section, including powder, dry powder, waste powder, and dry waste powder, are equivalent to the term 'dry powder waste'.

A dry powder waste is generated from the secondary treatment train, from the treatment of an aqueous waste. Waste is received in the secondary treatment train in waste receiving tanks where it is fed into an evaporator. Concentrate waste from the evaporator is then fed to a concentrate tank. From these tanks, the waste is fed to a thin film dryer and dried into a powder, and collected into containers. The containers are filled via a remotely controlled system. The condensed overheads from the evaporator and thin film dryer are returned to the surge tank to be fed to the primary treatment train.

Occasionally, salts from the treatment process (e.g., calcium sulfate and magnesium hydroxide) accumulate in process tanks as sludge. Because processing these salts could cause fouling in the thin film dryer, and to allow uninterrupted operation of the treatment process, the sludge is removed and placed in containers. The sludge is dewatered and the supernate is pumped back to 200 Area ETF for treatment.

The secondary treatment system typically receives and processes the following by-products generated from the primary treatment train:

- Concentrate from the first RO stage
- Backwash from the rough and fine filters
- Regeneration waste from the ion exchange system
- Spillage or overflow collected in the process sumps.

In an alternate operating scenario, some aqueous wastes may be fed to the secondary treatment train before the primary treatment train. A more complete description of these processes can be found in Chapter 4.0.

3.6.1.1 Rationale for Selection of Parameters for Analysis

200 Area ETF secondary waste is anticipated to consist primarily of sulfate salts with minor amounts of metals. The designation of 200 Area ETF secondary waste is based on influent characterization data. These data are used to assign applicable listed waste numbers to the secondary waste and to determine if the secondary waste would designate as a characteristic waste because of toxic metals.

Concentrations of metals in the secondary waste are projected by comparing the influent metals data to the removal efficiencies of 200 Area ETF treatment process. When the influent data indicate that the secondary waste will not designate as a characteristic waste, the secondary waste, as slurry, sludge, or dry powder, is not sampled and analyzed for metals.

The influent data, in conjunction with knowledge of 200 Area ETF treatment processes, also are used to determine the LDR status of 200 Area ETF secondary waste. Knowledge of the treatment process indicates that VOCs and SVOCs (i.e., listed waste constituents) are not expected in the secondary waste because of the organic destruction capability of the UV/OX and the temperatures of the thin film dryer. Accordingly, when the influent data indicate that the secondary waste meets the LDR treatment standards, the secondary waste, as slurry, sludge, or dry powder, is not sampled and analyzed for VOCs or SVOCs.

The parameters for analysis of 200 Area ETF secondary waste are provided in Table 3.5. The specific analytical methods for these analyses are provided in Section 3.9. Additionally, samples of slurry or sludge undergo a total solids analysis to convert the analytical data on other parameters to dry weight concentrations.

3.6.1.2 Sampling Methods

The dry powder waste and containerized sludge are sampled from containers using the principles presented in SW-846 (EPA as amended) and ASTM Methods (American Society for Testing Materials),

as referenced in WAC 173-303-110(2). The sample container requirements, sample preservation requirements, and maximum holding times for each of the parameters analyzed in either matrix are presented in Section 3.9.

Concentrate tank waste samples are collected from recirculation lines, which provide mixing in the tank during pH adjustment and prevent caking. The protocol for concentrate tank sampling prescribes opening a sample port in the recirculation line to collect samples directly into sample containers. The sample port line is flushed before collecting a grab sample. The VOC sampling typically is performed first for grab samples. Each VOC sample container will be filled such that cavitation at the sample valve is minimized and the container has no headspace. The remainder of the containers for the other parameters will be filled next.

Table 3.4. Rationale for Parameters to Be Monitored in Treated Effluent

Parameter	(Cas No.)	Final Delisting[1]	Discharge Permit[2]	
			Enforcement Limit	Early Warning Value
VOLATILE ORGANIC COMPOUNDS				
Acetone	(67-64-1)	X		
Acetonitrile	(75-05-8)	X		
Benzene	(71-43-2)	X		X
1-Butanol	(71-36-3)	X		
Carbon disulfide	(75-15-0)	X		
Carbon tetrachloride	(56-23-5)	X	X	
Chloroform	(67-66-3)			X
Methylene Chloride	(75-09-2)		M	
Tetrachloroethylene	(127-18-4)		X	
Tetrahydrofuran	(109-99-9)	X		X
SEMIVOLATILE ORGANIC COMPOUNDS				
Acetophenone	(98-86-2)		X	
Carbazole	(86-74-8)	X		
p-Chloroaniline	(106-47-8)	X		
Chrysene	(218-01-9)	X		
Cresol (total)	(1319-77-3)	X		
Dichloroisopropyl ether (bis(2-chloroisopropyl)ether)	(108-60-1)	X		
Di-n-octyl phthalate	(117-84-0)	X		
Diphenylamine	(122-39-4)	X		
Hexachlorobenzene	(118-74-1)	X		
Hexachlorocyclopentadiene	(77-47-4)	X		
Isophorone	(78-59-1)	X		
Lindane (gamma-BHC)	(58-89-9)	X		
N-nitrosodimethylamine	(62-75-9)	X	X	
Pyridine	(110-86-1)	X		
Tributyl phosphate	(126-73-8)	X		
2,4,6-Trichlorophenol	(88-06-2)	X		
PCBs				
Aroclor 1016	(12674-11-2)	X		
Aroclor 1221	(11104-28-2)	X		
Aroclor 1232	(11141-16-5)	X		
Aroclor 1242	(53469-21-9)	X		
Aroclor 1248	(12672-29-6)	X		
Aroclor 1254	(11097-69-1)	X		
Aroclor 1260	(11096-82-5)	X		

Table 3.4. Rationale for Parameters to Be Monitored in Treated Effluent

Parameter	(Cas No.)	Final Delisting[1]	Discharge Permit[2]	
			Enforcement Limit	Early Warning Value
TOTAL METALS[3]				
Arsenic	(7440-38-2)	X	X	
Barium	(7440-39-3)	X		
Beryllium	(7740-41-7)	X	X	
Cadmium	(7440-43-9)	X		X
Chromium	(7440-47-3)	X	X	
Copper	(7440-50-8)			X
Lead	(7439-92-1)	X		X
Mercury	(7439-97-6)	X		X
Nickel	(7440-02-0)	X		
Selenium	(7782-49-2)	X		
Silver	(7440-22-4)	X		
Vanadium	(7440-62-2)	X		
Zinc	(7440-66-6)	X		
ANIONS				
Chloride	(16887-00-6)		X	
Fluoride	(16984-48-8)	X		
Nitrate (as N)	(14797-55-8)		X	
Nitrite (as N)	(1479765-0)		X	
Sulfate	(14808-79-8)		X	
OTHER ANALYSES				
Ammonia	(7664-41-7)	X	X	
Cyanide	(57-12-5)	X		
Total dissolved solids				X
Total organic carbon			X	
Total suspended solids			X	
Specific conductivity			M	

[1] Parameters required by the current conditions of the Final Delisting, 40 CFR 261, Appendix IX, Table 2,70 FR 44496 (EPA 2005)
[2] Parameters required by the current conditions of the State Waste Discharge Permit, No. ST 4500 (Ecology 2000)
[3] Metals reported as total concentrations
X Rationale for measuring this parameter in treated effluent
M Monitor only; no limit defined
PCBs = polychlorinated biphenyls

3.6.1.3 Sampling Frequency

200 Area ETF secondary waste is sampled on a batch basis. A batch is defined as any volume of aqueous waste that is being treated under consistent and constant process conditions. The secondary waste will be resampled under the following changes in process conditions:

- Change in an influent source
- Change in process chemistry, as indicated by in-line monitoring of conductivity and pH.

One representative sample will be collected from the concentrate tank, if waste from the concentrate tank is used for characterization of a batch of influent waste. The sample will be analyzed for the appropriate parameters identified in Table 3.5 based on the needs identified from evaluating influent sampling and analysis data. When personnel exposures are of concern, analytical results from concentrate tank samples or influent data will be used to represent the powder waste generated from the treatment of that aqueous waste(s). The dry powder, solidified waste block, or concentrate tanks will be re-sampled in the following situations:

- The LERF and 200 Area ETF management have been notified, or have reason to believe that the process generating the waste has changed (for example, a source change such as a change in the well-head for groundwater that significantly changes the aqueous waste characterization).
- The LERF and 200 Area ETF management note an increase or decrease in the concentration of a constituent in an aqueous waste stream, beyond the range of concentrations that was described or predicted in the waste characterization.

3.6.1.4 Special Requirements Pertaining to Land Disposal Restrictions

Containers of 200 Area ETF secondary waste are transferred to a storage or final disposal unit, as appropriate (e.g., the Central Waste Complex or to the Environmental Restoration Disposal Facility). 200 Area ETF personnel provide the analytical characterization data and necessary process knowledge for the waste to be tracked by the receiving staff, and for the appropriate LDR documentation.

The following information on the secondary waste is included on the LDR documentation provided to the receiving unit:

- Dangerous waste numbers (as applicable)
- Determination on whether the waste is restricted from land disposal according to the requirements of 40 CFR 268/WAC 173-303-140 (i.e., the LDR status of the waste)
- The waste tracking information associated with the transfer of waste
- Waste analysis results.

3.6.2 Operations and Maintenance Waste Generated at the 200 Area Effluent Treatment Facility

Operation and maintenance of process and ancillary equipment generates additional routine waste. These waste materials are segregated to ensure proper handling and disposition, and to minimize the commingling of potentially dangerous waste with nondangerous waste. The following waste streams are anticipated to be generated during routine operation and maintenance of 200 Area ETF. This waste might or might not be dangerous waste, depending on the nature of the material and its exposure to a dangerous waste.

- Spent lubricating oils and paint waste from pumps, the dryer rotor, compressors, blowers, and general maintenance activities
- Spent filter media and process filters
- Spent ion exchange resin

- HEPA filters
- UV light tubes
- RO membranes
- Equipment that cannot be returned to service
- Other miscellaneous waste that might contact a dangerous waste (e.g., plastic sheeting, glass, rags, paper, waste solvent, or aerosol cans).

These waste streams are stored at 200 Area ETF before being transferred for final treatment, storage, or disposal as appropriate. This waste is characterized and designated using process knowledge (from previously determined influent aqueous waste composition information); analytical data; and material safety data sheets (MSDS) of the chemical products present in the waste or used (the data sheets are maintained at 200 Area ETF). Sampling of these waste streams is not anticipated; however, if an unidentified or unlabeled waste is discovered, that waste is sampled. This 'unknown' waste is sampled and analyzed for the parameters in Table 3.5 as appropriate, and will be designated according to Washington state regulatory requirements. The specific analytical methods for these analyses are provided in Section 3.9.

3.6.3 Other Waste Generated at the 200 Area Effluent Treatment Facility

There are two other potential sources of waste at 200 Area ETF: spills and/or overflows, and discarded chemical products. Spilled material that potentially might be dangerous waste generally is routed to 200 Area ETF sumps where the material is transferred either to the surge tank for treatment or to the secondary treatment train. A spilled material also could be containerized and transferred to another TSD unit. In most cases, process knowledge and the use of MSDSs are sufficient to designate the waste material. If the source of the spilled material is unknown and the material cannot be routed to 200 Area ETF sumps, a sample of the waste is collected and analyzed according to Table 3.5, as necessary, for appropriate characterization of the waste. Unknown wastes will be designated according to Washington State regulatory requirements. The specific analytical methods for these analyses are provided in Section 3.9.

A discarded chemical product waste stream could be generated if process chemicals, cleaning agents, or maintenance products become contaminated or are otherwise rendered unusable. In all cases, these materials are appropriately containerized and designated. Sampling is performed, as appropriate, for waste designation.

Table 3.5. 200 Area Effluent Treatment Facility Generated Waste - Sampling and Analysis

Parameter[1]	Rationale
• Total solids or percent water[2]	• Calculate dry weight concentrations
• Volatile organic compounds[3]	• LDR - verify treatment standards
• Semivolatile organic compounds[3]	• LDR - verify treatment standards
• Metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver)	• Waste designation • LDR - verify treatment standards
• Cation and anions of concern	• Address receiving TSD unit waste acceptance requirements
• pH	• Waste designation

[1] For influent and concentrate tank samples, the total sample (solid plus liquid) is analyzed and the analytical result is expressed on a dry weight basis. The result for toxicity characteristic metal and organic is divided by a factor of 20 and compared to the toxicity characteristic (TC) constituent limits [WAC 173-303-090(8)]. If the TC limit is met or exceeded, the waste is designated accordingly. All measured parameters are compared against the corresponding treatment standards.

[2] Total solids or percent water are not determined for unknown waste and dry powder waste samples and are analyzed in maintenance waste and sludge samples, as appropriate (i.e., percent water might not be required for such routine maintenance waste as aerosol cans, fluorescent tubes, waste oils, batteries, etc., or sludge that has dried).

[3] VOC and/or SVOC analysis of secondary waste is required unless influent characterization data and process knowledge indicate that the constituent will not be in the final secondary waste at or above the LDR.

LDR = land disposal restrictions

TSD = treatment, storage, and/or disposal

3.7 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance/quality control (QA/QC) information for LERF and 200 Area ETF is provided as required by WAC 173-303-810(6). The sampling and analysis activities at LERF and 200 Area ETF conform to the requirements of an LERF and 200 Area ETF-specific quality assurance project plan and are in accordance with the following EPA guidance documents:

- *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, as amended, U.S. Environmental Protection Agency, Washington, DC, as amended, as referenced in WAC 173-303-110.
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79/020, U.S. Environmental Protection Agency, National Exposure Research Laboratory, Cincinnati, Ohio, March 1983.

3.7.1 Sampling Program

Typically, generators are responsible for the sampling and analysis of an influent aqueous waste. However, samples of influent aqueous waste can be collected at the LERF or the Load-In Station. Samples of treated effluent are collected at the verification tanks. Secondary waste generated from the treatment process is typically sampled in the dry powder form; however, the secondary waste also could be characterized based on influent data or by sampling while in slurry form. Sampling of influent aqueous waste, treated effluent, and secondary waste is discussed in Sections 3.4, 3.5, and 3.6, respectively, of the WAP.

Specific information on sample holding times, preservatives, and sample containers is provided in Section 3.9. The selection of the sample collection device depends on the type of sample, the sample container, the sampling location, and the nature and distribution of the waste components. In general, the methodologies used for specific materials correspond to those referenced to WAC 173-303-110(2). The selection and use of the sampling device is supervised or performed by a person thoroughly familiar with the sampling requirements. Samples are collected according to LERF and 200 Area ETF-specific sampling protocol.

Sampling equipment is constructed of nonreactive materials such as glass, plastic, aluminum, or stainless steel, as indicated by the nature and matrix of the waste. Care is taken in the selection of the sampling device to prevent contamination of the sample and to ensure compatibility of materials. For example, plastic bottles are not used to collect some organic wastes.

3.7.2 Analytical Program

The onsite laboratory employed by LERF and 200 Area ETF organization is required to have a program of quality control practices and procedures to ensure that precision and accuracy are maintained. The QA/QC program for sampling complies with the applicable requirements in the Tri-Party Agreement Action Plan, Section 6.5 (TPA) and the regulations. All analytical data are defensible and traceable to

specific, related QC samples and calibrations. Offsite laboratories employed by LERF and 200 Area ETF must meet the same QA/QC requirements as onsite laboratories and must demonstrate quality control practices that are comparable to the onsite laboratory's program. A review of an offsite laboratory may be conducted to ensure that the quality control of LERF and 200 Area ETF data is maintained. The SW-846 and EPA-600 analytical methods are followed (as indicated in Section 3.9). However, other methods may be substituted for a parameter if the PQL can be met.

The chemical parameters and associated analytical methods identified in Section 3.9 are used to characterize an influent aqueous waste, effluent waste, and 200 Area ETF secondary waste. The analytical data on these parameters are also used to establish that key decision limits pertinent to proper waste management are met. These key decision limits are numerical thresholds, which include:

- liner compatibility limits for an influent aqueous waste as managed in LERF (may include blending a waste with other wastes to meet these limits)
- the LDR status of 200 Area ETF secondary waste
- delisting limits for treated effluent

Where analytical data are used in key decision-making, the PQL of an analytical parameter (or sum of the PQLs, as indicated by the decision) must be at or below the key decision limit. In cases where the decision limit is below the PQL, the method detection limit (MDL) is used in the key decision-making process.

Good laboratory practices, which encompass sampling, sample handling, housekeeping, and safety, are maintained at all laboratories. The following section describe the specific practices which are implemented at the onsite laboratory to maintain the precision and accuracy goals in Section 3.9for quality control samples which include method blank, quality control check, matrix spike, and duplicate samples.

The decision to re-analyze if the stated precision and accuracy goals are not met will depend on the use of the analytical results. Generally, only analytical results used in key decisions would require re-analysis if precision and accuracy goals were not met. For example, if the precision and accuracy goals are not met in a liner compatibility analysis, the sample would generally be re-analyzed if the results were close to a compatibility limit. However, if the analytical results suggested that concentrations were an order of magnitude below a liner compatibility limit, generally re-analysis would not be required. The decision to re-analyze a waste in a key decision situation will be made on a case-by-case basis.

3.7.2.1 Contamination Evaluation

Method blank samples are prepared with each batch of samples (at least 1 in a batch of 20) and analyzed to ensure sample contamination has not occurred.

3.7.2.2 Quality Control Check Sample

A quality control check sample is analyzed with each batch (at least 1 in a batch of 20) for each analytical parameter determined. The results show that analytical procedures are properly performed and that calibration and standardization of instrumentation are within acceptable limits per the method.

3.7.2.3 Matrix Spike Analyses

Matrix spike samples are employed to monitor recoveries and demonstrate accuracy. Matrix spike samples are periodically analyzed to provide information about the effect of the sample matrix on the analyte in question. Typically, a ratio of one spike for each analytical batch of samples, or 1 in 20, is maintained.

3.7.2.4 Duplicate Analyses

A laboratory sample duplicate or a matrix spike duplicate is analyzed to assess analytical precision in the laboratory. Typically, a ratio of one duplicate sample for each analytical batch of samples, or 1 in 20, is maintained.

3.7.3 Conclusion

The aforementioned sampling and analytical quality practices help ensure that the data obtained are precise and accurate for the waste stream being sampled. The analytical results are used by LERF and 200 Area ETF management to decide whether to accept a particular waste stream and, upon acceptance, to determine the appropriate method of treatment, storage, and disposal. Results are also important to ensure that wastes are managed properly by LERF and 200 Area ETF and those incompatible wastes are not inadvertently combined. Just as these results are important, so is the quality of these results. Thus, the quality of the analytical data, the thoroughness and care with which the sampling and analyses are performed and reported, provides an important basis for day-to-day operational decisions.

3.8 REFERENCES

DOE/RL-92-72, *200 Area Effluent Treatment Facility Delisting Petition,* Revision 1, 1993, U.S. Department of Energy-Richland Operations Office, Richland, Washington.

Ecology, 1995b, *Listed Waste from Hanford Laboratories*, letter from M. Wilson, Washington State Department of Ecology, to J. Rasmussen, U.S. Department of Energy, Richland Operations Office, March 7, 1995.

Ecology, 1996b, The Washington State Department of Ecology (Ecology) Regulatory Interpretation of the Liquid Effluent Retention Facility (LERF) Land Disposal Restriction Exemption, letter from Washington State Department of Ecology to T. Teynor, U.S. Department of Energy and A. DiLiberto, Westinghouse Hanford Company, September 9, 1996.

Ecology, 2000, *State Waste Discharge Permit No. ST 4500*, as amended, for 200 Area Effluent Treatment Facility, Hanford Facility, Washington State Department of Ecology, Olympia, Washington, August 1, 2000.

EPA 1983, *Methods for Chemical Analysis of Water Wastes*, EPA-600/4-79/020, (as amended), National Exposure Research Laboratory, Cincinnati, Ohio

EPA, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846* (Third Edition, as amended), U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1994, Liquid Effluent Retention Facility (LERF) Land Disposal Restrictions Treatment Exemption-Regulatory Interpretation EPA/Ecology ID No: WA7890008967, letter from U.S. Environmental Protection Agency, Region 10 to J. Hennig, U.S. Department of Energy, December 6, 1994.

EPA, 2005, Final Delisting [Exclusion], issued to U.S. Department of Energy, 40 CFR 261, Appendix IX, Table 2 (70 FR 44496, August 3, 2005), U.S. Environmental Protection Agency, Washington, D.C

3.9 ANALYTICAL METHODS, SAMPLE CONTAINERS, PRESERVATIVE METHODS, AND HOLDING TIMES

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity[2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
VOLATILE ORGANIC COMPOUNDS				
Acetone	SW-846 8260	40	60-120	Sample container 3 x 40-mL amber glass with septum Preservative HCl to pH<2; 4EC Holding time 14 days
Acetonitrile		820	60-120	
Benzene		5	60-120	
1-Butanol		1600	60-120	
Carbon Disulfide		1500	60-120	
Carbon tetrachloride		5	60-120	
Chloroform		5	50-130	
Methylene chloride		5	50-150	
Tetrachloroethylene		5	65-140	
Tetrahydrofuran		100	60-120	
SEMIVOLATILE ORGANIC COMPOUNDS				
Acetophenone	SW-846 8270	10	70-110	Sample container 4 x 1-liter amber glass Preservative 4EC Holding time 7 days for extraction; 40 days for analysis after extraction
Carbazole		110	50-120	
p-Chloroaniline		76	50-120	
Chrysene		350	50-120	
Cresol (o, p, m)		760	50-120	
Di-n-octyl phthalate		300	50-120	
Diphenylamine		350	50-120	
Hexachlorobenzene		2	50-120	
Hexachlorocyclopentadiene		110	50-120	
Isophorone		2600	50-120	
Lindane (gamma-BHC)		1.9	50-120	
N-nitrosodimethylamine		10	50-120	
Pyridine		15	50-120	
Tributyl phosphate		76	50-120	
2.4.6-Trichlorophenol		230	50-120	
POLYCHLORINATED BIPHENYLs (PCBs)				
Aroclor-1016	SW-846 8082	0.4	50-110	Sample container 4 x 1-liter amber glass Preservative 4EC Holding time 7 days for extraction; 40 days for analysis after extraction
Aroclor-1221		0.4	50-110	
Aroclor-1232		0.4	50-110	
Aroclor-1242		0.4	50-110	
Aroclor-1248		0.4	50-110	
Aroclor-1254		0.4	50-110	
Aroclor-1260		0.4	50-110	

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity[2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
TOTAL METALS				
Arsenic	EPA-600 200.8	11	70-130	Sample container 1 x 0.5-liter plastic/glass Preservative 1:1 HNO_3 to pH<2 Holding time 180 days; mercury 28 days
Cadmium		5	70-130	
Chromium		20	70-130–	
Copper		70	70-130–	
Lead		10	70-130–	
Mercury		2	70-130–	
Selenium		20	70-130	
Barium	6010A/E PA-600 200.7	1200	75 - 125	
Beryllium		34	75 - 125	
Calcium		200	75 - 125	
Iron		100	75 - 125	
Magnesium		400	75 - 125	
Nickel		340	75 - 125	
Potassium		10,000	75 - 125	
Silicon		580	75 - 125	
Silver		83	75 - 125	
Sodium		2500	75 - 125	
Vanadium		120	75 - 125	
Zinc		5100	75 - 125	
GENERAL CHEMISTRY				
Chloride	EPA-600 300.0	1000	70-130	Sample container 1 x 1-liter glass Preservative 4EC Holding time 28 days
Fluoride		880	70-130	
Formate[6]		1250	70-130	
Nitrate (as N)		100	70-130	
Nitrite (as N)		100	70-130	
Phosphate		1500	70-130	
Sulfate		10,000	70-130	
Ammonia	EPA-600	40	70-130	Sample container 1 x 50- mL glass or plastic Preservative H_2SO_4 to pH<2; 4EC Holding time 28 days
Cyanide	EPA-600 335.2/335.3	350	70-130	Sample container 1 x 250- mL glass or plastic Preservative NaOH to pH>12; 4EC Holding time 14 days
Alkalinity	EPA-600 310.1/310.2	ND	ND	Sample container 1 x 50- mL glass or plastic Preservative 4EC Holding time 14 days

Table 3.6. Sample and Analysis Criteria for Influent Aqueous Waste and Treated Effluent

Parameter	Analytical Method[a]	Method PQL[b] Sensitivity[2]	Accuracy/ Precision for Method[3] (percent)	Sample container[4]/ Preservative[4]/ Holding time[5]
Total dissolved solids	EPA-600 160.1	ND	ND	Sample container 1 x 500-mL glass or plastic Preservative 4EC Holding time 7 days
Total suspended solids	EPA-600 160.2	ND	ND	Sample container 1 x 1-L glass or plastic Preservative 4EC Holding time 7 days
Specific conductivity	EPA-600 120.1 (in lab)	ND	ND	Sample container 1 x 100-mL glass or plastic Preservative 4EC Holding time 28 days
Ph[7]	EPA-600 150.1	ND	ND	Sample container 1 x 25-mL glass or plastic Preservative None Holding time Analyze immediately
Total organic carbon	SW-846 9060	ND	ND	Sample container 1 x 250-mL glass Preservative H_2SO_4 to pH<2; 4EC Holding time 28 days

[1] SW-846 or EPA-600 methods are presented unless otherwise noted. Other methods might be substituted if the applicable PQL can be met.
[2] ST4500 required method PQL or Delisting Exclusion targeted method sensitivity/detection limit, which ever is lower.Units are parts per billion unless otherwise noted.
[3] Accuracy/precision used to confirm or re-establish MDL
[4] Sample bottle and preservatives could be adjusted, as applicable, to minimize sample volume.
[5] Holding time = time between sampling and analysis.
[6] Analysis for formate only required if detected in the influent aqueous waste.
[7] pH monitored in influent aqueous waste only

L = liter
mL = milliliter
NA = not applicable
ND = not determined
MDL = method detection level
PQL = practical quantitation limit
RL = reporting limit

Table 3.7. Sample Containers, Preservative Methods, and Holding Times for 200 Area ETF Generated Waste

Parameter	Analytical Method	Method PQL	Accuracy/ Precision for Method (percent)	Sample container[1]/ Preservative[1]/ Holding time[2]
Liquid Matrix				
For methods other than total solids, analyze using the methods and QA/QC in Table 3.6. For each method, analyze the target compound list				
Total solids	EPA-600 160.3	ND	ND	Sample container 1 x 500-mL glass or plastic Preservative – 4EC Holding time –7 days
Solid Matrix				
Volatile organic compounds (combined method target compound lists)	SW-846 8260	Refer to Table 3.6	Refer to Table 3.6	Sample container 3 x 40-mL amber glass with septum Preservative –4EC Holding time –14 days
Semivolatile organic compounds (method target compound list)	SW-846 8270	Refer to Table 3.6	Refer to Table 3.6	Sample container glass – 50 g of sample Preservative –4EC Holding time –14 days for extraction; 40 days for analysis after extraction
PCBs (method target compound list)	SW-846 8082	Refer to Table 3.6	Refer to Table 3.6	Sample container glass – 50 g of sample Preservative –4EC Holding time –14 days for extraction; 40 days for analysis after extraction
RCRA Metals (method target compound list)	EPA-600 200.8	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 10 g of sample Preservative –none, mercury 4EC Holding time –180 days; mercury 28 days
Total Metals (method target compound list)	SW-846 6010	Refer to Table 3.6	Refer to Table 3.6	
Anions (method target compound list)	EPA-600 300.0	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 10 g of sample Preservative –none Holding time –6 months for extraction; 28 days for analysis after extraction, nitrate and nitrite 48 hours for analysis after extraction
Ammonia	EPA-600 300.7	Refer to Table 3.6	Refer to Table 3.6	Sample container glass or plastic – 100 g of sample Preservative –none Holding time –6 months for extraction; 28 days for analysis after extraction

Parameter	Analytical Method	Method PQL	Accuracy/ Precision for Method (percent)	Sample container[1]/ Preservative[1]/ Holding time[2]
pH	SW-846 9045	ND	ND	Sample container glass or plastic – 100 g of sample Preservative –none Holding time –none
Toxicity Characteristic Leaching Procedure[3]	SW-846 1311	NA	NA	Sample container Refer to specific method being performed after TCLP – 125 g of sample Preservative –None (after TCLP, preserve extract per method being performed) Holding time –Metals: 180 days for TCLP extraction, mercury 28 days for TCLP extraction SVOA: 14 days for TCLP extraction (after TCLP, refer to specific methods for time for analysis after extraction)

[1] Sample bottle and preservatives could be changed as directed by the laboratory, or as required by the analytical method.
[2] Holding time equals time between sampling and analysis.
[3] Extraction procedure, as applicable; extract analyzed by referenced methods [WAC 173-303-110(3)(c)]

g = grams NA = not applicable PQL = practical quantitation limit
mL = milliliter ND = not determined TCLP = toxicity characteristic leaching procedure

This page intentionally left blank.

Chapter 4.0 Process Information

4.0 PROCESS INFORMATION 4.3

4.1 LIQUID EFFLUENT RETENTION FACILITY PROCESS DESCRIPTION 4.3

4.2 EFFLUENT TREATMENT FACILITY PROCESS DESCRIPTION 4.4
4.2.1 Load-In Station 4.4
4.2.2 Effluent Treatment Facility Operating Configuration 4.5
4.2.3 Primary Treatment Train 4.5
4.2.4 Secondary Treatment Train 4.7
4.2.5 Other Effluent Treatment Facility Systems 4.9

4.3 CONTAINERS 4.11
4.3.1 Description of Containers 4.11
4.3.2 Container Management Practices 4.12
4.3.3 Container Labeling 4.12
4.3.4 Containment Requirements for Managing Containers 4.12

4.4 TANK SYSTEMS 4.13
4.4.1 Design Requirements 4.14
4.4.2 Additional Requirements for New Tanks 4.18
4.4.3 Secondary Containment and Release Detection for Tank Systems 4.18
4.4.4 Tank Management Practices 4.22
4.4.5 Labels or Signs 4.25
4.4.6 Air Emissions 4.25
4.4.7 Management of Ignitable or Reactive Wastes in Tanks Systems 4.25
4.4.8 Management of Incompatible Wastes in Tanks Systems 4.25

4.5 SURFACE IMPOUNDMENTS 4.26
4.5.1 List of Dangerous Waste 4.26
4.5.2 Construction, Operation, and Maintenance of Liner System 4.26
4.5.3 Prevention of Overtopping 4.33
4.5.4 Structural Integrity of Dikes 4.34
4.5.5 Piping Systems 4.35
4.5.6 Double Liner and Leak Detection, Collection, and Removal System 4.36
4.5.7 Construction Quality Assurance 4.37
4.5.8 Proposed Action Leakage Rate and Response Action Plan 4.37
4.5.9 Dike Structural Integrity Engineering Certification 4.38
4.5.10 Management of Ignitable, Reactive, or Incompatible Wastes 4.38

4.6 AIR EMISSIONS CONTROL 4.38
4.6.1 Applicability of Subpart AA Standards 4.38
4.6.2 Process Vents - Demonstrating Compliance 4.39
4.6.3 Applicability of Subpart CC Standards 4.40

4.7 ENGINEERING DRAWINGS 4.41
4.7.1 Liquid Effluent Retention Facility 4.41
4.7.2 200 Area Effluent Treatment Facility 4.41
4.7.3 Figure 4.16. Liner Anchor Wall and Cover Tension System 4.58

Figures

Figure 4.1. Liquid Effluent Retention Facility Layout 4.43
Figure 4.2. Plan View of the 200 Area Effluent Treatment Facility 4.44
Figure 4.3. 200 Area Effluent Treatment Facility Layout 4.45
Figure 4.4. 200 Area Effluent Treatment Facility 4.46
Figure 4.5. Example - 200 Area Effluent Treatment Facility Configuration 1 ..... 4.47
Figure 4.6. Example - 200 Area Effluent Treatment Facility Configuration 2 ..... 4.48
Figure 4.7. Surge Tank 4.49
Figure 4.8. Ultraviolet Light/Oxidation Unit 4.50
Figure 4.9. Reverse Osmosis Unit. 4.51
Figure 4.10. Ion Exchange Unit 4.52
Figure 4.11. Verification Tanks 4.53
Figure 4.12. Effluent Treatment Facility Evaporator 4.54
Figure 4.13. Thin Film Dryer 4.55
Figure 4.14. Container Handling System 4.56
Figure 4.15. Effluent Treatment Facility Sump Tanks 4.57
4.7.3 Figure 4.16. Liner Anchor Wall and Cover Tension System 4.58
Figure 4.17. Liner System Schematic 4.59
Figure 4.18. Detail of Leachate Collection Sump 4.60

Tables

Table 4.1. Liquid Effluent Retention Facility Containment System 4.41
Table 4.2. Liquid Effluent Retention Facility Piping and Instrumentation 4.41
Table 4.3. Effluent Treatment Facility and Load-In Station Secondary Containment Systems 4.42
Table 4.4. Major Process Units and Tanks at the Effluent Treatment Facility and Load-In Station 4.42
Table 4.5. 200 Area Effluent Treatment Facility Tank Systems Information 4.61
Table 4.6. 200 Area Effluent Treatment Facility Additional Tank System Information 4.62
Table 4.7. Ancillary Equipment and Material Data 4.63
Table 4.8. Concrete and Masonry Coatings 4.64
Table 4.9. Geomembrane Material Specifications 4.64
Table 4.10. Drainage Gravel Specifications 4.65

4.0 PROCESS INFORMATION

This chapter provides a detailed discussion of the LERF and ETF processes and equipment. The LERF and ETF comprise an aqueous waste treatment system located in the 200 East Area that provides storage and treatment for a variety of aqueous mixed waste. This aqueous waste includes process condensate from the 242-A Evaporator and other aqueous waste generated from onsite remediation and waste management activities.

The LERF consists of three lined surface impoundments, or basins. Aqueous waste from LERF is pumped to the ETF for treatment in a series of process units, or systems, that remove or destroy essentially all of the dangerous waste constituents. The treated effluent is discharged to a State-Approved Land Disposal Site (SALDS) north of the 200 West Area, under the authority of a Washington State Waste Discharge Permit (Ecology 2000) and the Final Delisting (40 CFR 261, Appendix IX, Table 2).

4.1 LIQUID EFFLUENT RETENTION FACILITY PROCESS DESCRIPTION

Each of the three LERF basins has an operating capacity of 29.5-million liters. The LERF receives aqueous waste through several inlets including the following:

- A pipeline that connects LERF with the 242-A Evaporator
- A pipeline from the 200 West Area
- A pipeline that connects LERF to the Load-In Station at the ETF
- A series of sample ports located at each basin.

Figure 4.1 presents a general layout of LERF and associated pipelines. Aqueous waste from LERF is pumped to the ETF through one of two double-walled fiberglass transfer pipelines. Effluent from the ETF also can be transferred back to the LERF through one of these transfer pipelines. These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes. In the event that these leak detectors are not in service, the pipelines are visually inspected during transfers for leakage by opening the secondary containment drain lines at the ETF end of the transfer pipelines.

Each basin is equipped with six available sample risers constructed of 6-inch perforated pipe. A seventh sample riser in each basin is dedicated to influent aqueous waste receipt piping (except for aqueous waste received from the 242-A Evaporator), and an eighth riser in each basin contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the bottom of the basin and allows samples to be collected from any depth. Personnel access to these sample ports is from the perimeter area of the basins.

A catch basin is provided at the northwest corner of each LERF basin for aboveground piping and manifolds for transfer pumps. Aqueous waste from the 242-A Evaporator is transferred through piping which ties into piping at the catch basins. Under routine operations, a submersible pump is used to transfer aqueous waste from a LERF basin to the ETF for processing or for basin-to-basin transfers. This pump is connected to a fixed manifold on one of four available risers.

Each basin consists of a multilayer liner system supported by a concrete anchor wall around the basin perimeter and a soil-bentonite clay underlayment. The multilayer liner system consists of a primary liner in contact with the aqueous waste, a layer of bentonite carpet, a geonet, a geotextile, a gravel layer, and a secondary liner that rests on the bentonite underlayment. Any aqueous waste leakage through the primary liner flows through the geonet to a leachate collection system. The leachate flows to a sump at the northwest corner of each basin, where the leachate is pumped up the side slope and back into the basin above the primary liner. Each liner is constructed of high-density polyethylene. A floating cover made of very low-density polyethylene is stretched over each basin above the primary liner. These covers serve to keep unwanted material from entering the basins, and to minimize evaporation of the liquid contents.

4.2 EFFLUENT TREATMENT FACILITY PROCESS DESCRIPTION

The ETF is designed as a flexible treatment system that provides treatment for contaminants anticipated in process condensate and other onsite aqueous waste. The design influent flow rate into the ETF is approximately 570 liters per minute, with planned outages for activities such as maintenance on the ETF systems. Maintenance outages typically are scheduled between treating a batch of aqueous waste, referred to as treatment campaigns. The effluent flow (or volume) is equivalent to the influent flow (or volume).

The ETF generally receives aqueous waste directly from the LERF. However, aqueous waste also can be transferred from tanker trucks at the Load-In Station to the ETF and from containers (e.g., carboys, drums) directly to ETF. Aqueous waste is treated and stored in the ETF process area in a series of tank systems, referred to as process units. Within the ETF, waste also is managed in containers through treatment and/or storage. Figure 4.2 provides the relative locations of the process and container storage areas within the ETF.

The process units are grouped in either the primary or the secondary treatment train. The primary treatment train provides for the removal or destruction of contaminants. Typically, the secondary treatment train processes the waste by-products from the primary treatment train by reducing the volume of waste. In the secondary treatment train, contaminants are concentrated and dried to a powder. The liquid fraction is routed to the primary treatment train. Figure 4.3 provides an overview of the layout of the ETF, 2025E Building). Figure 4.4 presents the ETF floor plan, the relative locations of the individual process units and associated tanks within the ETF, and the location of the Load-In Station.

The dry powder waste and maintenance and operations waste are containerized and stored or treated in the container storage areas or in collection or treatment areas within the Process Area. Secondary containment is provided for all containers and tank systems (including ancillary equipment) housed within the ETF. The trenches and floor of the ETF comprise the secondary containment system. The floor includes approximately a 15.2-centimeter rise (berm) along the containing walls of the process and container storage areas. Any spilled or leaked material from within the process area or container storage area is collected into trenches that feed into either sump tank 1 or sump tank 2. From these sump tanks, the spilled or leaked material (i.e., waste) is fed to either the surge tank and processed in the primary treatment train or the secondary waste receiving tanks and processed in the secondary treatment train. All tank systems outside of the ETF are provided with a secondary containment system.

In the following sections, several figures are provided that present general illustrations of the treatment units and the relation to the process.

4.2.1 Load-In Station

The ETF receives aqueous waste from LERF or the Load-In Station. The ETF Load-In Station, located due east of the surge tank and outside of the perimeter fence (Figure 4.4), was designed and constructed to provide the capability to unload, store, and transfer aqueous waste to the ETF or LERF from tanker trucks and other containers (such as drums). The Load-In Station consists of two truck bays equipped with load-in tanks, transfer pumps, filtration system, level instrumentation for tanker trucks, leak detection capabilities for the containment basin and transfer line, and an underground transfer line that connects to lines in the surge tank berm, allowing transfers to either the ETF surge tank or LERF. The Load-In Station is covered with a steel building for weather protection. Tanker trucks and other containers are used to unload aqueous waste at the Load-In Station. To perform unloading, the tanker truck is positioned on a truck pad, a 'load-in' transfer line is connected to the truck, and the tanker contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF. For container unloading, the container is placed on the truck pad and the container contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF.

During unloading operations, solids may be removed from the waste by pumping the contents of the tanker truck or container through a filtration system. If solids removal is not needed, the filtration system is not used and the solution is transferred directly to the Load-In Station tanks, surge tank, or to LERF.

Any leaks at the Load-In Station drain to the sump. A leak detector in the sump alarms locally and in the ETF control room. Alternatively, leaks can be visually detected.

4.2.2 Effluent Treatment Facility Operating Configuration

Because the operating configuration of the ETF can be adjusted or modified, most aqueous waste streams can be effectively treated to below Delisting and Discharge Permit limits. The operating configuration of the ETF depends on the unique chemistry of an aqueous waste stream(s). Before an aqueous waste stream is accepted for treatment, the waste is characterized and evaluated. Information from the characterization is used to adjust the treatment process or change the configuration of the ETF process units, as necessary, to optimize the treatment process for a particular aqueous waste stream.

Typically, an aqueous waste is processed first in the primary treatment train, where the ETF is configured to process an aqueous waste through the UV/OX unit first, followed by the RO unit. However, under an alternate configuration, an aqueous waste could be processed in the RO unit first. For example, high concentrations of nitrates in an aqueous waste might interfere with the performance of the UV/OX. In this case, the ETF could be configured to process the waste in the RO unit before the UV/OX unit.

The flexibility of the ETF also allows some aqueous waste to be processed in the secondary treatment train first. For example, for small volume aqueous waste with high concentrations of some anions and metals, the approach could be to first process the waste stream in the secondary treatment train. This approach would prevent premature fouling or scaling of the RO unit. The liquid portion (i.e., untreated overheads from the ETF evaporator and thin film dryer) would be sent to the primary treatment train.

Figures 4.5 and 4.6 provide example process flow diagrams for two different operating configurations.

4.2.3 Primary Treatment Train

The primary treatment train consists of the following processes:

- Influent Receipt/Surge tank - inlet, surge capacity
- Filtration - for suspended solids removal
- UV/OX - organic destruction
- pH adjustment - waste neutralization
- Hydrogen peroxide decomposition - removal of excess hydrogen peroxide
- Degasification - removal of carbon dioxide
- RO - removal of dissolved solids
- IX - removal of dissolved solids
- Verification - holding tanks during verification

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants such as dissolved solids and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

Influent Receipt/Surge Tank. Depending on the configuration of the ETF, the surge tank is one inlet used to feed an aqueous waste into the ETF for treatment. In Configuration 1 (Figure 4.5), the surge tank is the first component downstream of the LERF. The surge tank provides a storage/surge volume for chemical pretreatment and controls feed flow rates from the LERF to the ETF. However, in Configuration 2 (Figure 4.6), aqueous waste from LERF is fed directly into the treatment units. In this configuration, the surge tank receives aqueous waste that has been processed in the RO units and provides the feed stream to the remaining downstream process units. In yet another configuration, some

small volume aqueous waste could be received into the secondary treatment train first for processing. In this case, the aqueous waste would be received directly into the secondary waste receiving tanks. Finally, the surge tank also receives waste extracted from various systems within the primary and secondary treatment train while in operation.

The surge tank is located outside the ETF on the south side. In the surge tank (Figure 4.7), the pH of an aqueous waste is adjusted using the metered addition of sulfuric acid and sodium hydroxide, as necessary, to prepare the waste for treatment in downstream processes. In addition, hydrogen peroxide or biocides could be added to control biological growth in the surge tank. A pump recirculates the contents in the surge tank, mixing the chemical reagents with the waste to a uniform pH.

Filtration. Two primary filter systems remove suspended particles in an aqueous waste: a rough filter removes the larger particulates, while a fine filter removes the smaller particulates. The location of these filters depends on the configuration of the primary treatment train. However, the filters normally are located upstream of the RO units.

The solids accumulating on these filter elements are backwashed to the secondary waste receiving tanks with pulses of compressed air and water, forcing water back through the filter. The backwash operation is initiated either automatically by a rise in differential pressure across the filter or manually by an operator. The filters are cleaned chemically when the backwashing process does not facilitate acceptable filter performance.

Auxiliary fine and rough filters (e.g., disposable filters) have been installed to provide additional filtration capabilities. Depending on the configuration of the ETF, the auxiliary filters are operated either in series with the primary filters to provide additional filtration or in parallel, instead of the primary fine and rough filters, to allow cleaning of the primary fine and rough filters while the primary treatment train is in operation.

Ultraviolet Light/Oxidation. Organic compounds contained in an aqueous waste stream are destroyed in the UV/OX system (Figure 4.8). Hydrogen peroxide is mixed with the waste. The UV/OX system uses the photochemical reaction of UV light on hydrogen peroxide to form hydroxyl radicals and other reactive species that oxidize the organic compounds. The final products of the complete reaction are carbon dioxide, water, and inorganic ions.

Organic destruction is accomplished in two UV/OX units operating in parallel. During the UV/OX process, the aqueous waste passes through reaction chambers where hydrogen peroxide is added. While in the UV/OX system, the temperature of an aqueous waste is monitored. Heat exchangers are used to reduce the temperature of the waste should the temperature of the waste exceed the upper limits for the UV/OX or RO systems.

pH Adjustment. The pH of a waste stream is monitored and controlled at different points throughout the treatment process. Within the primary treatment train, the pH of a waste can be adjusted with sulfuric acid or sodium hydroxide to optimize operation of downstream treatment processes or adjusted before final discharge. For example, the pH of an aqueous waste would be adjusted in the pH adjustment tank after the UV/OX process and before the RO process. In this example, pH is adjusted to cause certain chemical species such as ammonia to form ammonium sulfate, thereby increasing the rejection rate of the RO.

Hydrogen Peroxide Decomposition. Typically, hydrogen peroxide added into the UV/OX system is not consumed completely by the system. Because hydrogen peroxide is a strong oxidizer, the residual hydrogen peroxide from the UV/OX system is removed to protect the downstream equipment. The hydrogen peroxide decomposer uses activated carbon to break down the hydrogen peroxide that is not consumed completely in the process of organic destruction. The aqueous waste is sent through a column of fluidized activated carbon that breaks down the hydrogen peroxide into water and oxygen. The gas generated by the decomposition of the hydrogen peroxide is vented to the vessel off gas system.

Degasification. The degasification column is used to purge dissolved carbon dioxide from the aqueous waste to reduce the carbonate loading to downstream dissolved solids removal processes within the ETF primary treatment train. The purged carbon dioxide is vented to the vessel off gas system.

Reverse Osmosis. The RO system (Figure 4.9) uses pressure to force clean water molecules through semi-permeable membranes while keeping the larger molecule contaminants, such as dissolved solids, and large molecular weight organic materials, in the membrane. The RO process uses a staged configuration to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of secondary waste produced.

The RO process is divided into first and second stages. Aqueous waste is fed to the first RO stage from the RO feed tank. The secondary waste receiving tanks of the secondary treatment train receive the retentate removed from the first RO stage, while the second RO stage receives the permeate (i.e., 'treated' aqueous waste from the first RO stage.) In the second RO stage, the retentate is sent to the first stage RO feed tank while the permeate is sent to the IX system or to the surge tank, depending on the configuration of the ETF.

Two support systems facilitate this process. An anti-scale system injects scale inhibitors as needed into the feed waste to prevent scale from forming on the membrane surface. A clean-in-place system using cleaning agents, such as descalants and surfactants, cleans the membrane pores of surface and subsurface deposits that have fouled the membranes.

Ion Exchange. Because the RO process removes most of the dissolved solids in an aqueous waste, the IX process (Figure 4.10) act as a polishing unit. The IX system consists of three columns containing beds of cation and/or anion resins. This system is designed to allow for regeneration of resins and maintenance of one column while the other two are in operation. Though the two columns generally are operated in series, the two columns also can be operated in parallel or individually.

Typically, the two columns in operation are arranged in a primary/secondary (lead/lag) configuration, and the third (regenerated) column is maintained in standby. When dissolved solids breakthrough the first IX column and are detected by a conductivity sensor, this column is removed from service for regeneration, and the second column replaces the first column and the third column is placed into service. The column normally is regenerated using sulfuric acid and sodium hydroxide. The resulting regeneration waste is collected in the secondary waste receiving tanks.

Spent resins are transferred into a disposal container should regeneration of the IX resins become inefficient. The container is designed to provide dewatering with remote monitoring of the resin and water levels within the container. Displaced air from the vessels is exhausted through an entrainment separator (to remove water drops) and a high-efficiency particulate air filter and into the vessel off gas system. Free water is removed from the container and returned to the surge tank. Dewatered resins are transferred to a final storage/disposal point.

Verification. The three verification tanks (Figure 4.11) are used to hold the treated effluent while a determination is made that the effluent meets discharge limits. The effluent can be returned to the primary treatment train for additional treatment, or to the LERF should a treated effluent not meet Discharge Permit or Final Delisting requirements.

The three verification tanks alternate between three operating modes: receiving treated effluent, holding treated effluent during laboratory analysis and verification, or discharging verified effluent. Treated effluent may also be returned to the ETF to provide 'clean' service water for operational and maintenance functions, e.g., for boiler water and for backwashing the filters. This recycling keeps the quantity of fresh water used to a minimum.

4.2.4 Secondary Treatment Train

The secondary treatment system typically receives and processes the following by-products generated from the primary treatment train: concentrate from the first RO stage, filter backwash, regeneration waste

from the ion exchange system, and spillage or overflow received into the process sumps. Depending on the operating configuration, however, some aqueous waste could be processed in the secondary treatment train before the primary treatment train (refer to Figures 4.5 and 4.6 for example operating configurations).

The secondary treatment train provides the following processes:

- Secondary waste receiving - tank receiving and chemical addition
- Evaporation - concentrates secondary waste streams
- Concentrate staging - concentrate receipt, pH adjustment, and chemical addition
- Thin film drying - dewatering of secondary waste streams
- Container handling - packaging of dewatered secondary waste

Secondary Waste Receiving. Waste to be processed in the secondary treatment train is received into two secondary waste receiving tanks, where the pH can be adjusted with sulfuric acid or sodium hydroxide for optimum evaporator performance. Chemicals, such as reducing agents, may be added to waste in the secondary waste receiving tanks to reduce the toxicity or mobility of constituents in the powder.

Evaporation. The ETF evaporator is fed alternately by the two secondary waste receiving tanks. One tank serves as a waste receiver while the other tank is operated as the feed tank. The ETF evaporator vessel (also referred to as the vapor body) is the principal component of the evaporation process (Figure 4.12).

Feed from the secondary waste receiving tanks is pumped through a heater to the recirculation loop of the ETF evaporator. In this loop, concentrated waste is recirculated from the ETF evaporator, to a heater, and back into the evaporator where vaporization occurs. As water leaves the evaporator system in the vapor phase, the concentration of the waste in the evaporator increases. When the concentration of the waste reaches the appropriate density, a portion of the concentrate is pumped to one of the concentrate tanks.

The vapor that is released from the ETF evaporator is routed to the entrainment separator, where water droplets and/or particulates are separated from the vapor. The 'cleaned' vapor is routed to the vapor compressor and heater. The steam from the vapor compressor/heater is used to heat the recirculating concentrate in the ETF evaporator. From the vapor compressor/heater, the steam is condensed and fed to the distillate flash tank, where the saturated condensate received from the heater drops to atmospheric pressure and cools to the normal boiling point through partial flashing (rapid vaporization caused by a pressure reduction). The resulting distillate is routed to the surge tank. A vacuum blower to the vessel off gas system exhausts noncondensible vapors, such as air.

Concentrate Staging. The concentrate tanks make up the head end of the thin film drying process. From the ETF evaporator, concentrate is pumped into two concentrate tanks, and pH adjusted chemicals, such as reducing agents, may be added to reduce the toxicity or mobility of constituents when converted to powder. Waste is transferred from the concentrate tanks to the thin film dryer for conversion to a powder. The concentrate tanks function alternately between concentrate receiver and feed tank for the thin film dryer.

Because low solubility solids (i.e., calcium and magnesium sulfate) tend to settle in the concentrate tanks, these solids must be removed to prevent fouling and to protect the thin film dryer, and to maintain concentrate tank capacity.

Thin Film Drying. From the concentrate tanks, feed is pumped through a preheater to the thin film dryer (Figure 4.13) that is heated by steam. As the concentrated waste flows down the length of the dryer, the waste is dried. The dried film, or powder, is scraped off the dryer cylinder by blades attached to a rotating shaft. The powder is funneled through a cone-shaped powder hopper at the bottom of the dryer and into the Container Handling System.

Overhead vapor released by the drying of the concentrate is condensed in the distillate condenser. Excess heat is removed from the distillate by a water-cooled heat exchanger. Part of the distillate is circulated back to the condenser spray nozzles. The remaining distillate is pumped to the surge tank. Any

noncondensible vapors and particulates from the spray condenser are exhausted to the vessel off gas system.

Container Handling. Before an empty container is moved into the Container Handling System (Figure 4.14), the lids are loosely placed on the containers and the container is placed on a conveyor. After the lid is removed, the containers are moved into the container filling area after passing through an air lock. The empty container is located under the thin film dryer, and raised into position. The container is sealed to the thin film dryer and a rotary valve begins the transfer of powder to the empty container. Air displaced from the container is vented to the entrainment separator attached to the ETF evaporator that exhausts to the vessel off gas system.

The container is filled to a predetermined level, recapped, and moved along the conveyor to the smear station airlock. At the smear station airlock, the container is moved onto the conveyor by remote control. The airlock is opened, the smear sample (surface wipe) is taken, and the contamination level counted. A 'C' ring is installed to secure the container lid. If the container has contaminated material on the outside, the container is moved to the wash down station and washed. The container wash water drains to sump tank 1. The washed container is air-dried and retested. Filled containers that pass the smear test are labeled, placed on pallets, and moved by forklift to the filled container storage area. Section 4.3 provides a more detailed discussion of container handling.

4.2.5 Other Effluent Treatment Facility Systems

The ETF is provided with support systems that facilitate treatment in the primary and secondary treatment trains and that provide for worker safety and environmental protection. An overview of the following systems is provided:

- Monitor and control system
- Vessel off gas system
- Sump collection system
- Chemical injection feed system
- Verification tank recycle system
- Utilities

4.2.5.1 Monitor and Control System

The operation of the ETF is monitored and controlled by a centralized computer system (i.e., monitor and control system or MCS). The MCS continuously monitors data from various field indicators, such as pH, flow, tank level, temperature, pressure, conductivity, alarm status, and valve switch positions. Data gathered by the MCS enable operations and engineering personnel to document and adjust the operation of the ETF.

4.2.5.2 Vessel Off gas System

Ventilation for various tanks and vessels is provided through the vessel off gas system. The system includes a moisture separator, duct heater, pre-filter, high-efficiency particulate air filters, carbon absorber (when required to reduce organic emissions), exhaust fans, and ductwork. Gasses ventilated from the tanks and vessels enter the exhaust system through the connected ductwork. The vessel off gas system draws vapors and gasses off the following tanks and treatment systems:

- Surge tank
- ETF evaporator
- pH adjustment tank
- Concentrate tanks
- Degasification system
- First and second RO stages
- Dry powder hopper
- Effluent pH adjustment tank
- Drum capping station

- Secondary waste receiving tanks
- Resin dewatering system
- Distillate condenser (off the thin film dryer)
- Sump tanks 1 and 2

The vessel off gas system maintains a negative pressure with respect to the atmosphere, which produces a slight vacuum within tanks, vessels, and ancillary equipment for the containment of gas vapor. This system also provides for the collection, monitoring, and treatment of confined airborne in-vessel contaminants to preclude over-pressurization. The high-efficiency particulate air filters remove particulates and condensate from the air stream before these are discharged to the heating, ventilation, and air conditioning system.

4.2.5.3 Sump Collection System

Sump tanks 1 and 2 compose the sump collection system that provides containment of waste streams and liquid overflow associated with the ETF processes. The process area floor is sloped to two separate trenches that each drain to a sump tank located under the floor of the ETF (Figure 4.15). One trench runs the length of the primary treatment train and drains to Sump Tank 2, located underneath the verification tank pump floor. The second trench collects spillage primarily from the secondary treatment train and flows to Sump Tank 1, located near the ETF evaporator. Sump tanks 1 and 2 are located below floor level (Figure 4.15). An eductor in these tanks prevents sludge from accumulating.

4.2.5.4 Chemical Injection Feed System

At several points within the primary and secondary treatment trains, sulfuric acid and sodium hydroxide (or dilute solutions of these reagents) are metered into specific process units to adjust the pH. For example, a dilute solution of 4 percent sulfuric acid and 4 percent sodium hydroxide could be added to the secondary waste receiving tanks to optimize the evaporation process.

4.2.5.5 Verification Tank Recycle System

To reduce the amount of water added to the process, verification tank water (i.e., verified effluent) is recycled throughout the ETF process. The following tanks and ancillary equipment use verification tank water:

- 4% H^2SO4 solution tank and ancillary equipment
- 4% NaOH solution tank and ancillary equipment
- Clean-in-place tank and ancillary equipment
- ETF evaporator boiler and ancillary equipment
- Thin film dryer boiler and ancillary equipment.

4.2.5.6 Utilities

The ETF maintains the following utility supply systems required for the operation of the ETF:

- Cooling water system - removes heat from process water via heat exchangers and a cooling tower
- Compressed air system - provides air to process equipment and instrumentation
- Seal water system - provides cool, clean, pressurized water to process equipment for pump seal cooling and pump seal lubrication, and provides protection against failure and fluid leakage
- Demineralized water system - removes solids from raw water system to produce high quality, low ion-content, water for steam boilers, and for the hydrogen peroxide feed system.
- Heating, ventilation, and air conditioning system - provides continuous heating, cooling, and air humidity control throughout the ETF.

The following utilities support ETF activities:

- Electrical power

- Sanitary water
- Communication systems
- Raw water

4.3 CONTAINERS

This section provides specific information on container storage and treatment operations at the ETF, including descriptions of containers, labeling, and secondary containment structures.

A list of dangerous and/or mixed waste managed in containers at the ETF is presented in Chapter 1.0. The types of dangerous and/or mixed waste managed in containers in the ETF could include the following secondary waste generated by the ETF processes:

- Waste generated from the treatment process
- Miscellaneous waste generated by operations and maintenance activities.

The secondary treatment train processes the waste by-products from the primary treatment train, which are concentrated and dried into a powder. Containers are filled with dry powder waste from the thin film dryer via a remotely controlled system. Miscellaneous waste generated from maintenance and operations activities are stored at the ETF. The waste could include process waste, such as used filter elements; spent RO membranes; damaged equipment, and decontamination and maintenance waste, such as contaminated rags, gloves, and other personal protective equipment. Liquids generally are packaged with absorbents at a 2 to 1 ratio.

Several container collection areas could be located within the ETF process and container handling areas. These collection areas are used only to accumulate waste in containers. Once a container is filled, the container is transferred to a container storage area (Figure 4.3 and Figure 4.4), to another TSD unit, or to a less-than-90-day storage pad. Containers stored in the additional storage area (Figure 4.4) are elevated or otherwise protected from contact with accumulated liquids. The container storage area within ETF is a 22.9 x 8.5-meter room located adjacent to the ETF process area. The containers within the container storage area are clearly labeled, and access to these containers is limited by barriers and by administrative controls. The ETF floor provides secondary containment, and the ETF roof and walls protects all containers from exposure to the elements.

Waste also could be placed in containers for treatment as indicated in Chapter 1.0. For example, sludge that accumulates in the bottoms of the process tanks is removed periodically and placed into containers. In this example, the waste is solidified by decanting the supernate from the container and the remainder of the waste is allowed to evaporate, or absorbents are added, as necessary, to address remaining liquids. Following treatment, this waste either is stored at the ETF or transferred to another TSD unit.

4.3.1 Description of Containers

The containers used to collect and store dry powder waste are 208-liter steel containers. Most of the maintenance and operation waste is stored in 208-liter steel containers; however, in a few cases, the size of the container could vary to accommodate the size of a particular waste. For example, some process waste, such as spent filters, might not fit into a 208-liter container. In the case of spent resin from the IX columns, the resin is dewatered and could be packaged in a special disposal container. In these few cases, specially sized containers could be required. In all cases, however, only approved containers are used and are compatible with the associated waste. Typically, 208-liter containers are used for treatment.

Current operating practices indicate the use of new 208-liter containers that have either a polyethylene liner or a protective coating. Any reused or reconditioned container is inspected for container integrity before use. Overpack containers are available for use with damaged containers. Overpack containers typically are unlined steel or polyethylene.

Per Chapter 1.0, a maximum of 147,630 liters of dangerous and/or mixed waste could be stored in containers in the ETF.

4.3.2 Container Management Practices

Before use, each container is checked for signs of damage such as dents, distortion, corrosion, or scratched coating. For dry powder loading, empty containers on pallets are raised by a forklift and manually placed on the conveyor that transports the containers to the automatic filling station in the container handling room (Figure 4.14). The container lids are removed and replaced automatically during the filling sequence. After filling, containers exit the container handling room via the filled drum conveyor. Locking rings are installed, the container label is affixed, and the container is moved by dolly or forklift to the container storage area.

Containers used for storing maintenance and operations secondary waste are labeled before being placed in the container storage area or in a collection area. Lids are secured on these containers when not being filled. When the containers in a collection area are full, the containers are transferred by dolly or forklift to the container storage area or to an appropriate TSD unit. Containers used for treating waste also are labeled. The lids on these containers are removed as required to allow for treatment. During treatment, access to these containers is controlled through physical barriers and/or administrative controls.

The filled containers in the container storage area are inventoried, checked for proper labeling, and placed on pallets or in a separate containment device as necessary. Each pallet is moved by forklift. Within the container storage area, palletized containers are stacked no more then three pallets high and in rows no more than two containers wide. Unobstructed aisles with a minimum of 76-centimeter aisle space separate rows.

4.3.3 Container Labeling

Labels are affixed on containers used to store dry powder when the containers leave the container handling room. Labels are affixed on other waste containers before use. Every container is labeled with the date that the container was filled. Appropriate major risk labels, such as "corrosive", "toxic", or "F-listed", also are added. Each container also has a label with an identification number for tracking purposes.

4.3.4 Containment Requirements for Managing Containers

Secondary containment is provided in the container management areas within the ETF. The secondary containment provided for tank systems also serves the container management areas. This section describes the design and operation of the secondary containment structure for these areas.

4.3.4.1 Secondary Containment System Design

For the container management areas, the reinforced concrete floor and a 15.2-centimeter rise (berm) along the walls of the container storage area of the ETF provide secondary containment. The engineering assessment required for tanks (Mausshardt 1995) also describes the design and construction of the secondary containment provided for the ETF container management areas. All systems were designed to national codes and standards (e.g., American Society for Testing Materials, American Concrete Institute standards).

The floor is composed of cast-in-place, pre-formed concrete slabs, and has a minimum thickness of 15.2 centimeters. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint. The floor and berms are coated with a chemically resistant; high-solids epoxy coating system consisting of primer, filler, and top coating. This coating material is compatible with the waste managed in containers and is an integral part of the secondary containment system for containers.

The floor is sloped to drain any solution in the container storage area to floor drains along the west wall. Each floor drain consists of a grating over a 20.3-centimeter diameter drain port connected to a 4-inch stainless steel transfer pipe. The pipe passes under this wall and connects to a trench running along the east wall of the adjacent process area. This trench drains solution to sump tank 1.

The container storage area is separated from the process area by a common wall and a door for access to the two areas (Figure 4.3). These two areas also share a common floor and trenches that, with the 15.2-centimeter rise of the containing walls, form the secondary containment system for the process area and the container storage area.

4.3.4.2 Structural Integrity of Base

Engineering calculations were performed showing the floor of the container storage area is capable of supporting the weight of containers. These calculations were reviewed and certified by a professional engineer (Mausshardt 1995). The concrete was inspected for damage during construction. Cracks were identified and repaired to the satisfaction of the professional engineer. Documentation of these certifications is included in the engineering assessment (Mausshardt 1995).

4.3.4.3 Containment System Capacity

The container storage area is primarily used to store dry powder and maintenance and operation waste. Where appropriate, absorbents are added to fix any trace liquids present. Large volumes of liquid are not stored in the container storage area. However, liquids might be present in those containers that are in the treatment process. The maximum volume of waste that can be stored in containers in the container storage area is 147,630 liters.

Both the process area and the container storage area are considered in the containment system capacity. The volume available for secondary containment in the process area is approximately 68,000 liters, as discussed in the engineering assessment (Mausshardt 1995). Using the dimensions of the container storage area (22.9 by 8.5 by 0.15 meters), and assuming that 50 percent of the floor area is occupied by containers, the volume of the container storage area is 14,900 liters. The combined volume of both the container storage and process areas available for secondary containment, therefore, is 82,900 liters. This volume is greater than 10 percent of the maximum total volume of containers allowed for storage in the ETF, as discussed previously.

4.3.4.4 Control of Run-on

The container management areas are located within the ETF, which serves to prevent run-on of precipitation.

4.3.4.5 Removal of Liquids from Containment Systems

The container storage area is equipped with drains that route solution to a trench in the process area, which drains to sump tank 1. The sump tanks are equipped with alarms that notify operating personnel that a leak is occurring. The sump tanks also are equipped with pumps to transfer waste to the surge tank or the secondary treatment train.

4.3.4.6 Prevention of Ignitable, Reactive, and Incompatible Wastes in Containers

Individual waste types (i.e., ignitable, corrosive, and reactive) are stored in separate containers. A waste that could be incompatible with other wastes is separated and protected from the incompatible waste. For example, acidic and caustic wastes are stored in separate containers. Free liquids are absorbed in containers that hold incompatible waste at a 2 to 1 ratio. Additionally, ETF-specific packaging requirements for these types of waste provide extra containment with each individual container. For example, each item of acidic waste is individually bagged and sealed within a lined container.

4.4 TANK SYSTEMS

This section provides specific information on tank systems and process units. This section also includes a discussion on the types of waste to be managed in the tanks, tank design information, integrity assessments, and additional information on the ETF tanks that treat and store dangerous and/or mixed waste. The ETF dangerous waste tanks are identified in Section 4.4.1.1, and the relative locations of the tanks and process units in the ETF are presented in Figure 4.3.

4.4.1 Design Requirements

The following sections provide an overview of the design specifications for the tanks within the ETF. A separate discussion on the design of the process units also is provided. In accordance with the new tank system requirements of WAC 173-303-640(3), the following tank components and specifications were assessed:

- Dimensions, capacities, wall thicknesses, and pipe connections
- Materials of construction and linings and compatibility of materials with the waste being processed
- Materials of construction of foundations and structural supports
- Review of design codes and standards used in construction
- Review of structural design calculations, including seismic design basis
- Waste characteristics and the affects of waste on corrosion

This assessment was documented in the *Final RCRA Information Needs Report* (Mausshardt 1995; the engineering assessment performed for the ETF tank systems by an independent professional engineer. A similar assessment of design requirements was performed for the load-in tanks and is documented in *200 Area Effluent BAT/AKART Implementation, ETF Truck Load-In Facility, Project W-291H Integrity Assessment Report* (KEH 1994).

The specifications for the preparation, design, and construction of the tank systems at the ETF are documented in the *Design Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). The preparation, design, and construction of the load-in tanks are provided in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994).

Most of the tanks in the ETF are constructed of stainless steel. According to the design of the ETF, it was determined stainless steel would provide adequate corrosion protection for these tanks. Exceptions include the verification tanks, which are constructed of carbon steel with an epoxy coating. The ETF evaporator/vapor body (and the internal surfaces of the thin film dryer) is constructed of a corrosion resistant alloy, known as alloy 625, to address the specific corrosion concerns in the secondary treatment train. Finally, the hydrogen peroxide decomposer vessels are constructed of carbon steel and coated with a vinyl ester lining.

The shell thicknesses of the tanks identified in Section4.4.1.1 represent a nominal thickness of a new tank when placed into operation. The tank capacities identified in this table represent the maximum operating volumes. For certain tanks (as indicated in the table), the maximum operating volume is also the nominal (routine) operating capacity. Nominal tank volumes represent the volume between the low-level and high-level shutoffs in a tank unit.

4.4.1.1 Codes and Standards for Tank System Construction

Specific standards for the manufacture of tanks and process systems installed in the ETF are briefly discussed in the following sections. In addition to these codes and industrial standards, a seismic analysis for each tank and process system is required [WAC 173-303-806(4)(a)(xi)]. The seismic analysis was performed in accordance with UCRL-15910 *Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards*, Section 4 (UCRL 1987). The results of the seismic analyses are summarized in the engineering assessment of the ETF tank systems (Mausshardt 1995).

Storage and Treatment Tanks. The following tanks store and/or treat dangerous waste at the ETF.

Tank name	Tank number
Surge tank	2025E-60A-TK-1
pH adjustment tank	2025E-60C-TK-1
Effluent pH adjustment tank	2025E-60C-TK-2
First RO feed tank	2025E-60F-TK-1
Second RO feed tank	2025E-60F-TK-2
Verification tanks (three)	2025E-60H-TK-1A/1B/1

Secondary waste receiving tanks (two)	2025E-60I-TK-1A/1B	
Concentrate tanks (two)	2025E-60J-TK-1A/1B	
Sump tanks (two)		2025E-20B-TK-1/2
Distillate flash tank	2025E-60I-TK-2	
Load-in tanks	TK-109/117	

The relative location of these tanks is presented in Figure 4.3. These tanks are maintained at or near atmospheric pressure. The codes and standards applicable to the design, construction, and testing of the above tanks and ancillary piping systems are as follows:

- ASME - B31.3 Chemical Plant and Petroleum Refinery Piping (ASME 1990)
- ASME Sect. VIII, Division I Pressure Vessels (ASME 1992a)
- AWS - D1.1 Structural Welding Code - Steel (AWS 1992)
- ANSI - B16.5 Pipe Flanges and Flanged Fittings (ANSI 1992)
- ASME Sect. IX Welding and Brazing Qualifications (ASME 1992b)
- API 620 Design and Construction of Large Welded Low Pressure Storage Tanks (API 1990)
- AWWA - D100 Welded Steel Tanks for Water Storage (AWWA 1989)
- AWWA - D103 Factory-Coated Bolted Steel Tanks for Water Storage (AWWA 1987)
- AWWA - D120 Thermosetting Fiberglass-Reinforced Plastic Tanks (AWWA 1984).

The application of these standards to the construction of ETF tanks and independent verification of completed systems ensured that the tank and tank supports had sufficient structural strength and that seams and connections were adequate to ensure tank integrity. In addition, each tank met strict quality assurance requirements. Each tank constructed offsite was tested for integrity and leak tightness before shipment to the Hanford Facility. Following installation, the systems were inspected for damage to ensure against leakage and to verify proper operation. If a tank was damaged during shipment or installation, leak tightness testing was repeated onsite.

4.4.1.2 Design Information for Tanks Located Outside of Effluent Treatment Facility

The load-in tanks, surge tank, and verification tanks are located outside the ETF. These tanks are located within concrete structures that provide secondary containment.

Load-In Tanks and Ancillary Equipment. The load-in tanks are heated and constructed of stainless steel, and have a nominal capacity of 37,900 liters. Ancillary equipment includes transfer pumps, a filtration system, a double encased, fiberglass transfer pipeline, level instruments for tanker trucks, and leak detection equipment. From the Load-In Station, aqueous waste can be routed to the surge tank or to the LERF through a double-encased line. The load-in tanks, sump, pumps, and truck pad are all provided with secondary containment.

Surge Tank and Ancillary Equipment. The surge tank is constructed of stainless steel and has a nominal capacity of 379,000 liters. Ancillary equipment to the surge tank includes two underground double encased (i.e., pipe-within-a-pipe) transfer lines connecting to LERF and three pumps for transferring aqueous waste to the primary treatment train. The surge tank is located at the south end of the ETF. The surge tank is insulated and the contents heated to prevent freezing. Eductors in the tank provide mixing.

Verification Tanks and Ancillary Equipment. The verification tanks are located north of the ETF. The verification tanks have a nominal capacity of 2,540,000 liters each. For support, the tanks have a center post with a webbing of beams that extend from the center post to the sides of the tank. The roof is constructed of epoxy covered carbon steel that is attached to the cross beams of the webbing. The tank floor also is constructed of epoxy covered carbon steel and is sloped. Eductors are installed in each tank to provide mixing.

Ancillary equipment includes a return pump that provides circulation of treated effluent through the eductors. The return pump also recycles effluent back to the ETF for retreatment and can provide service

water for ETF functions. Two transfer pumps are used to discharge treated effluent to SALDS or back to the LERF.

4.4.1.3 Design Information for Tanks Located Inside the Effluent Treatment Facility Building

Most of the ETF tanks and ancillary equipment that store or treat dangerous and/or mixed waste are located within the ETF. The structure serves as secondary containment for the tank systems.

pH Adjustment Tank and Ancillary Equipment. The pH adjustment tank has a nominal capacity of 9,800 liters. Ancillary equipment for this tank includes overflow lines to a sump tank and pumps to transfer waste to other units in the main treatment train.

Effluent pH Adjustment Tank and Ancillary Equipment. The effluent pH adjustment tank has a nominal capacity of 9,500 liters. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer waste to the verification tanks.

First and Second Reverse Osmosis Feed Tanks and Ancillary Equipment. The first RO feed tank is a vertical, stainless steel tank with a round bottom and has a nominal capacity of 11,400 liters. Conversely, the second RO feed tank is a rectangular vessel with the bottom of the tank sloping sharply to a single outlet in the bottom center. The second RO feed tank has a nominal capacity of 7,600 liters. Each RO tank has a pump to transfer waste to the RO arrays. Overflow lines are routed to a sump tank.

Secondary Waste Receiving Tanks and Ancillary Equipment. Two 57,000-liter secondary waste receiving tanks collect waste from the units in the main treatment train, such as reject solution (retentate) from the RO units and regeneration solution from the IX columns. These are vertical, cylindrical tanks with a semi-elliptical bottom and a flat top. Ancillary equipment includes overflow lines to a sump tank and pumps to transfer aqueous waste to the ETF evaporator.

Effluent Treatment Facility Evaporator and Ancillary Equipment. The ETF evaporator, the principal component of the evaporation process, is a cylindrical pressure vessel with a conical bottom. Aqueous waste is fed into the lower portion of the vessel. The top of the vessel is domed and the vapor outlet is configured to prevent carryover of liquid during the foaming or bumping (violent boiling) at the liquid surface. The ETF evaporator has a capacity of approximately 21,000 liters.

The ETF evaporator includes the following ancillary equipment:

- Preheater
- Recirculation pump
- Waste heater with steam level control tank
- Concentrate transfer pump
- Entrainment separator
- Vapor compressor with silencers
- Silencer drain pump.

Distillate Flash Tank and Ancillary Equipment. The distillate flash tank is a horizontal tank that has a nominal operating capacity of 570 liters. Ancillary equipment includes a pump to transfer the distillate to the surge tank for reprocessing.

Concentrate Tanks and Ancillary Equipment. Each of the two concentrate tanks has an approximate capacity of 18,900 liters. Ancillary equipment includes overflow lines to a sump tank and pumps for recirculation and transfer.

Sump Tanks. Sump tanks 1 and 2 are located below floor level. Both sump tanks are double-walled, rectangular tanks, placed inside concrete vaults. Both tanks have a working volume of 3,000 liters each. The sump tanks are located in pits below grade to allow gravity drain of solutions to the tanks. Each sump tank has two vertical pumps for transfer of waste to the secondary waste receiving tanks or to the surge tank for reprocessing.

4.4.1.4 Design Information for Effluent Treatment Facility Process Units

As with the ETF tanks, process units that treat and/or store dangerous and/or mixed waste are maintained at or near atmospheric pressure. These units were constructed to meet a series of design standards, as discussed in the following sections. Table 4.6 presents the materials of construction and the ancillary equipment associated with these process units. All piping systems are designed to withstand the effects of internal pressure, weight, thermal expansion and contraction, and any pulsating flow. The design and integrity of these units are presented in the engineering assessment (Mausshardt 1995).

Filters. The load-in fine and rough filter vessels (including the auxiliary filters) are designed to comply with the ASME Section VIII, Division I, Pressure Vessels (ASME 1992a). The application of these standards to the construction of the ETF filter system and independent inspection ensure that the filter and filter supports have sufficient structural strength and that the seams and connections are adequate to ensure the integrity of the filter vessels.

Ultraviolet Oxidation System. The UV/OX reaction chamber is designed to comply with manufacturers standards.

Degasification System. The codes and standards applicable to the design, fabrication, and testing of the degasification column are identified as follows:

- ASME Section VIII, Division I, Pressure Vessels (ASME 1992a)
- ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990)
- AWS - D1.1, Structural Welding Code - Steel (AWS 1992)
- ANSI - B16.5, Pipe Flanges and Flanged Fittings (ANSI 1992)

Reverse Osmosis System. The pressure vessels in the RO unit are designed to comply with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards.

Ion Exchange (Polishers). The IX columns are designed in accordance with ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. Polisher piping is fabricated of type 304 stainless steel or polyvinyl chloride (PVC) and meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Effluent Treatment Facility Evaporator. The ETF evaporator is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The ETF evaporator piping meets the requirements of ASME B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Thin Film Dryer System. The thin film dryer is designed to meet the requirements of ASME Section VIII, Division I, Pressure Vessels (ASME 1992a), and applicable codes and standards. The piping meets the requirements of ASME - B31.3, Chemical Plant and Petroleum Refinery Piping (ASME 1990).

Integrity Assessments. The integrity assessment for ETF (Mausshardt 1995) attests to the adequacy of design and integrity of the tanks and ancillary equipment to ensure that the tanks and ancillary equipment will not collapse, rupture, or fail over the intended life considering intended uses. For the load-in tanks, a similar integrity assessment was performed (KEH 1995). Specifically, the assessment documents the following considerations:

- Adequacy of the standards used during design and construction of the facility
- Characteristics of the solution in each tank
- Adequacy of the materials of construction to provide corrosion protection from the solution in each tank
- Results of the leak tests and visual inspections

The results of these assessments demonstrate that tanks and ancillary equipment have sufficient structural integrity and are acceptable for storing and treating dangerous and/or mixed waste. The assessments also

state that the tanks and building were designed and constructed to withstand a design-basis earthquake. Independent, qualified registered professional engineers certified these tank assessments.

The scope of the ETF tank integrity assessment was based on characterization data from process condensate. To assess the effect that other aqueous waste might have on the integrity of the ETF tanks, the chemistry of an aqueous waste will be evaluated for its potential to corrode a tank (e.g., chloride concentrations will be evaluated). The tank integrity assessment for the load-in tanks was based on characterization data from several aqueous waste streams. The chemistry of an aqueous waste stream not considered in the load-in tank integrity assessment also will be evaluated for the potential to corrode a load-in tank.

Consistent with the recommendations of the 1995 integrity assessment, a corrosion inspection program was developed. Periodic integrity assessments are scheduled for those tanks predicted to have the highest potential for corrosion. These inspections are scheduled annually or longer, based on age of the tank system, materials of construction, characteristics of the waste, and any other relevant factors. These tanks include the concentrate tanks, secondary waste receiving tanks, and verification tanks. One of each of these tanks will be inspected yearly to determine if corrosion or coating failure has occurred. Should significant corrosion or coating failure be found, an additional tank of the same type would be inspected during the same year. In the case of the verification tanks, if corrosion or coating failure is found in the second tank, the third tank also will be inspected. If significant corrosion were observed in all three sets of tanks, the balance of the ETF tanks would be considered for inspection. For tanks predicted to have lower potential for corrosion, inspections also are performed nonroutinely as part of the corrective maintenance program.

4.4.2 Additional Requirements for New Tanks

Procedures for proper installation of tanks, tank supports, piping, concrete, etc., are included in *Construction Specification, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (WHC 1992a). For the load-in tanks, procedures are included in the construction specifications in *Project W-291, 200 Area Effluent BAT/AKART Implementation ETF Truck Load-in Facility* (KEH 1994). Following installation, an independent, qualified, registered professional engineer inspected the tanks and secondary containment. Deficiencies identified included damage to the surge tank, damage to the verification tank liners, and ETF secondary containment concrete surface cracking. All deficiencies were repaired to the satisfaction of the engineer. The tanks and ancillary equipment were leak tested as part of acceptance of the system from the construction contractor. Information on the inspections and leak tests are included in the engineering assessment (Mausshardt 1995). No deficiencies were identified during installation of the load-in tanks and ancillary equipment.

4.4.3 Secondary Containment and Release Detection for Tank Systems

This section describes the design and operation of secondary containment and leak detection systems at the ETF.

4.4.3.1 Secondary Containment Requirements for All Tank Systems

The specifications for the preparation, design, and construction of the secondary containment systems at the ETF are documented (WHC 1992a). The preparation, design, and construction of the secondary containment for the load-in tanks are provided in the construction specifications (KEH 1994). All systems were designed to national codes and standards. Constructing the ETF per these specifications ensured that foundations are capable of supporting tank and secondary containment systems and that uneven settling and failures from pressure gradients should not occur.

4.4.3.1.1 Common Elements

The following text describes elements of secondary containment that are common to all ETF tank systems. Details on the secondary containment for specific tanks, including leak detection systems and liquids removal, are provided in Section 4.4.4.1.2.

Foundation and Construction. For the tanks within the ETF, except for the sump tanks, secondary containment is provided by a coated concrete floor and a 15.2-centimeter rise (berm) along the containing walls. The double-wall construction of the sump tanks provides secondary containment. Additionally, trenches are provided in the floor that also provides containment and drainage of any liquid to a sump pit. For tanks outside the ETF, secondary containment also is provided with coated concrete floors in a containment pit (load-in tanks) or surrounded by concrete dikes (the surge and verification tanks).

The transfer piping that carries aqueous waste into the ETF is pipe-within-a-pipe construction, and is buried approximately 1.2 meters below ground surface. The pipes between the verification tanks and the verification tank pumps within the ETF are located in a concrete pipe trench.

For this discussion, there are five discrete secondary containment systems associated with the following tanks and ancillary equipment that treat or store dangerous waste:

- Load-in tanks
- Surge tank
- Process area (including sump tanks)
- Verification tanks
- Transfer piping and pipe trenches.

All of the secondary containment systems are designed with reinforcing steel and base and berm thickness to minimize failure caused by pressure gradients, physical contact with the waste, and climatic conditions. Classical theories of structural analysis, soil mechanics, and concrete and structural steel design were used in the design calculations for the foundations and structures. These calculations are maintained at the ETF. In each of the analyses, the major design criteria from the following documents were included:

V-C018HC1-001	Design Construction Specification, Project C-018H, 242A Evaporator/PUREX Plant Process Condensate Treatment Facility (WHC 1992a)
DOE Order 6430.1A	General Design Criteria
SDC-4.1	Standard Architectural-Civil Design Criteria, Design Loads for Facilities (DOE-RL 1988)
UCRL-15910	Design and Evaluation Guidelines for Department of Energy Facilities Subjected to Natural Phenomena Hazards (UCRL 1987)
UBC-91	Uniform Building Code, 1991 Edition (ICBO 1991).

The design and structural analysis calculations substantiate the structural designs in the referenced drawings. The conclusions drawn from these calculations indicate that the designs are sound and that the specified structural design criteria were met. This conclusion is verified in the independent design review that was part of the engineering assessment (Mausshardt 1995).

Containment Materials. The concrete floor consists of cast-in-place and preformed concrete slabs. All slab joints and floor and wall joints have water stops installed at the mid-depth of the slab. In addition, filler was applied to each joint.

Except for the sump tank vaults, all of the concrete surfaces in the secondary containment system, including berms, trenches, and pits, are coated with a chemical-resistant, high-solids, epoxy coating that consists of a primer, filler, and a top coating. This coating material is compatible with the waste being treated, and with the sulfuric acid, sodium hydroxide, and hydrogen peroxide additives to the process. The coating protects the concrete from contact with any chemical materials that might be harmful to concrete and prevents the concrete from being in contact with waste material. Table 4.8 summarizes the specifies types of filler, primer, second, and finish coats specified for the concrete and masonry surfaces

in the ETF. The epoxy coating is considered integral to the secondary containment system for the tanks and ancillary equipment.

The concrete containment systems are maintained such that any cracks, gaps, holes, and other imperfections are repaired in a timely manner. Thus, the concrete containment systems do not allow spilled liquid to reach soil or groundwater. There are a number of personnel doorways and vehicle access points into the ETF process area. Releases of any spilled or leaked material to the environment from these access points are prevented by 15.2-centimeter concrete curbs, sloped areas of the floor (e.g., truck ramp), or trenches.

Containment Capacity and Maintenance. Each of these containment areas is designed to contain more than 100 percent of the volume of the largest tank in each respective system. Secondary containment systems for the surge tank, and the verification tanks, which are outside the ETF, also are large enough to include the additional volume from a 100-year, 24-hour storm event; i.e., 5.3 centimeters of precipitation.

Sprinkler System. The sprinkler system within the ETF supplies firewater protection to the process area and the container storage area. This system is connected to a site wide water supply system and has the capacity to supply sufficient water to suppress a fire at the ETF. However, in the event of failure, the sprinkler system can be hooked up to another water source (e.g., tanker truck).

4.4.3.1.2 Specific Containment Systems

The following discussion presents a description of the individual containment systems associated with specific tank systems.

Load-In Tank Secondary Containment. The load-in tanks are mounted on a 46-centimeter-thick reinforced concrete slab (Drawing H-2-817970). Secondary containment is provided by a pit with 30.5-centimeter-thick walls and a floor constructed of reinforced concrete. The load-in tank pit is sloped to drain solution to a sump. The depth of the pit varies with the slope of the floor, with an average thickness of about 1.1 meters. The volume of the secondary containment is about 79,000 liters, which is capable of containing the volume of at least one load-in tank (i.e., 37,800 liters). Leaks are detected by a leak detector that alarms locally and in the ETF control room and by visual inspection of the secondary containment.

Adjacent to the pit is a 25.4-centimeter-thick reinforced concrete pad that serves as secondary containment for the load-in tanker trucks, containers, transfer pumps, and filter system. The pad is 15.2 centimeters below grade with north and south walls gently sloped to allow truck access. The pad has drainpipes to route waste solution to the adjacent load-in tank pit.

Surge Tank Secondary Containment. The surge tank is mounted on a reinforced concrete ringwall. Inside the ringwall, the flat-bottomed tank is supported by a bed of compacted sand and gravel with a high-density polyethylene liner bonded to the ringwall. The liner prevents galvanic corrosion between the soil and the tank. The secondary containment is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The secondary containment area shares part of the southern wall of the main process area. The dike extends up 2.9 meters to provide a containment volume of 740,000 liters for the 379,000-liter surge tank.

The floor of the secondary containment slopes to a sump in the northwest corner of the containment area. Leaks into the secondary containment are detected by level instrumentation in the sump, which alarms in the ETF control room, and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

Process Area Secondary Containment. The process area contains the tanks and ancillary equipment of the primary and secondary treatment trains, and has a jointed, reinforced concrete slab floor. The concrete floor of the process area provides the secondary containment. This floor is a minimum of 15.2 centimeters thick. With doorsills 15.2 centimeter high, the process area has a containment volume of 76,200 liters. The largest tanks in the process area are the secondary waste receiving tanks, which each have a maximum capacity of 56,800 liters.

The floor of the process area is sloped to drain liquids to two trenches that drain to a sump. Each trench is approximately 38.1 centimeters wide with a sloped trough varying from 39.4 to 76.2 centimeters deep. Leaks into the secondary containment are detected by routine visual inspections of the floor area near the tanks, ancillary equipment, and in the trenches.

A small dam was placed in the trench that comes from the thin film dryer room to contain minor liquid spills originating in the dryer room to minimize the spread of contamination into the process area. The dryer room is inspected for leaks in accordance with the inspection schedule in Chapter 6.0. Operators clean up these minor spills by removing the liquid waste and decontaminating the spill area.

A small dam was also placed in the trench adjacent to the chemical feed skid when the chemical berm area was expanded to accommodate acid and caustic pumps, which were moved indoors from the top of the surge tank to resolve a safety concern. This dam was designed to contain minor spills originating in the chemical berm area and prevent them from entering the process sump.

The northwest corner of the process area consists of a pump pit containing the pumps and piping for transferring treated effluent from the verification tanks to SALDS. The pit is built 1.37 meters below the process area floor level and is sloped to drain to a trench built along its north wall that routes liquid to sump tank 1. Leaks into the secondary containment of the pump pit are detected by routine visual inspections.

Sump Tanks. The sump tanks support the secondary containment system, and collect waste from several sources, including:

- Process area drain trenches
- Tank overflows and drains
- Container washing water
- Resin dewatering solution
- Steam boiler blow down
- Sampler system drains.

These double-contained tanks are located within unlined, concrete vaults. The sump tank levels are monitored by remote level indicators or through visual inspections from the sump covers. These indicators are connected to high- and low-level alarms that are monitored in the control room. When a high-level alarm is activated, a pump is activated and the sump tank contents usually are routed to the secondary treatment train for processing. The contents also could be routed to the surge tank for treatment in the primary treatment train. In the event of an abnormally high inflow rate, a second sump pump is initiated automatically.

Verification Tank Secondary Containment. The three verification tanks are each mounted on ringwalls with high-density polyethylene liners similar to the surge tank. The secondary containment for the three tanks is reinforced concrete with a 15.2-centimeter thick floor and a 20.3-centimeter thick dike. The dike extends up 2.6 meters to provide a containment of 110 percent of the capacity of a single tank (i.e., 2,800,000 liters).

The floor of the secondary containment slopes to a sump along the southern wall of the dike. Leaks into the secondary containment are detected by level instrumentation in the sump that alarms in the control room and/or by routine visual inspections. A sump pump is used to transfer solution in the secondary containment to a sump tank.

4.4.3.2 Additional Requirements for Specific Types of Systems

This section addresses additional requirements in WAC 173-303-640 for double-walled tanks like the sump tanks and secondary containment for ancillary equipment and piping associated with the tank systems.

4.4.3.2.1 Double-Walled Tanks

The sump tanks are the only tanks in the ETF classified as 'double-walled' tanks. These tanks are located in unlined concrete vaults and support the secondary containment system for the process area. The sump tanks are equipped with a leak detector between the walls of the tanks that provide continuous monitoring for leaks. The leak detector provides immediate notification through an alarm in the control room. The inner tanks are contained completely within the outer shells. The tanks are contained completely within the concrete structure of the ETF so corrosion protection from external galvanic corrosion is not necessary.

4.4.3.2.2 Ancillary Equipment

The secondary containment provided for the tanks and process systems also serves as secondary containment for the ancillary equipment associated with these systems.

Ancillary Equipment. Section 4.4.4.1 describes the secondary containment systems that also serve most of the ancillary equipment within the ETF. Between the ETF and the verification tanks, a pipeline trench provides secondary containment for four pipelines connecting the transfer pumps (i.e., discharge and return pumps) in the ETF with the verification tanks (Figure 4.2). This concrete trench crosses under the road and extends from the verification tank pumps to the verification tanks. Treated effluent flows through these pipelines from the verification tank pumps to the verification tanks. The return pump is used to return effluent to the ETF for use as service water or for reprocessing.

For all of the ancillary equipment housed within the ETF, the concrete floor, trenches, and berms form the secondary containment system. For the ancillary equipment of the surge tank and the verification tanks, secondary containment is provided by the concrete floors and dikes associated with these tanks. The concrete floor and pit provide secondary containment for the ancillary equipment of the load-in tanks.

Transfer Piping and Pipe Trenches. The two buried transfer lines between LERF and the surge tank have secondary containment in a pipe-within-a-pipe arrangement. The 4-inch transfer line has an 8-inch outer pipe, while the 3-inch transfer, line has a 6-inch outer pipe. The pipes are fiberglass and are sloped towards the surge tank. The outer piping ends with a drain valve in the surge tank secondary containment.

These pipelines are equipped with leak detection located in the annulus between the inner and outer pipes; the leak detection equipment can continuously 'inspect' the pipelines during aqueous waste transfers. The alarms on the leak detection system are monitored in the control room. A low-volume air purge of the annulus is provided to prevent condensation buildup and minimize false alarms by the leak detection system. In the event that these leak detectors are not in service, the pipelines are inspected during transfers by opening a drain valve to check for solution in the annular space between the inner and outer pipe.

The 3-inch transfer line between the load-in tanks and the surge tank has a 6-inch outer pipe in a pipe-within-a-pipe arrangement. The piping is made of fiberglass-reinforced plastic and slopes towards the load-in tank secondary containment pit. The drain valve and leak detection system for the load-in tank pipelines are operated similarly to the leak detection system for the LERF to ETF pipelines.

As previously indicated, four reinforced concrete pipe trenches provide secondary containment for piping under the roadway between the ETF and the verification tanks. Each trench is 1.2 meters wide, 0.76 meter deep, and slopes towards the sump containing the transfer pumps to SALDS. The floor of the trenches is 30.5 centimeters thick and the sides are 15.2 centimeters thick. The concrete trenches are coated with water sealant and covered with metal gratings at ground level to allow vehicle traffic on the roadway.

4.4.4 Tank Management Practices

When an aqueous waste stream is identified for treatment or storage at ETF, the generating unit is required to characterize the waste. Based on characterization data, the waste stream is evaluated to

determine if the stream is acceptable for treatment or storage. Specific tank management practices are discussed in the following sections.

4.4.4.1 Rupture, Leakage, Corrosion Prevention

Most aqueous waste streams can be managed such that corrosion would not be a concern. For example, an aqueous waste stream with high concentrations of chloride might cause corrosion problems when concentrated in the secondary treatment train. One approach is to adjust the corrosion control measures in the secondary treatment train. An alternative might be to blend this aqueous waste in a LERF basin with another aqueous waste that has sufficient dissolved solids, such that the concentration of the chlorides in the secondary treatment train would not pose a corrosion concern.

Additionally, the materials of construction used in the tanks systems (Table 4.5) make it unlikely that an aqueous waste would corrode a tank. For more information on corrosion prevention, refer to the waste analysis plan Chapter 3.0.

When a leak in a tank system is discovered, the leak is immediately contained or stopped by isolating the leaking component. Following containment, the leaking tank system is evaluated by facility personnel to determine whether continued operation of affected system would jeopardize the safety of plant personnel, result in a release to the environment, or compromise facility equipment. If determined that a leak could have the aforementioned consequences, the affected system will be immediately removed from service until repairs can be implemented. If a leak would not result in the stated consequences, the tank system will be placed on a maintenance schedule for repair.

4.4.4.2 Overfilling Prevention

Operating practices and administrative controls used at the ETF to prevent overfilling a tank are discussed in the following paragraphs. The ETF process is controlled by the MCS. The MCS monitors liquid levels in the ETF tanks and has alarms that annunciate on high-liquid level to notify operators that actions must be taken to prevent overfilling of these vessels. As an additional precaution to prevent spills, many tanks are equipped with overflow lines that route solutions to sump tanks 1 and 2. These tanks include the pH adjustment tank; RO feed tanks, effluent pH adjustment tank, secondary waste receiving tanks, and concentrate tanks.

The following section discusses feed systems, safety cutoff devices, bypass systems, and pressure controls for specific tanks and process systems.

Tanks. All tanks are equipped with liquid level sensors that give a reading of the tank liquid volume. The surge tank, the verification tanks, the RO tanks, the secondary waste receiving tanks, and the concentrate tanks are equipped further with liquid level alarms that are actuated if the liquid volume is near the tank overflow capacity. In the actuation of the surge tank alarm, a liquid level switch trips, sending a signal to the valve actuator on the tank influent lines, and causing the influent valves to close.

The operating mode for each verification tank, i.e., receiving, holding, or discharging, can be designated through the MCS; modes also switch automatically. When the high-level set point on the receiving verification tank is reached, the flow to this tank is diverted and another tank becomes the receiver. The full tank is switched into verification mode. The third tank is reserved for discharge mode.

The liquid levels in the first and second RO feed tanks are maintained within predetermined operating ranges. Should the second RO feed tank overflow, the excess waste is piped along with any leakage from the feed pump to a sump tank.

When waste in a secondary waste-receiving tank reaches the high-level set point, the influent flow of waste is redirected to the second tank and the first tank becomes the feed tank for the ETF evaporator.

In a similar fashion, the concentrate tanks switch modes when the high-level set point of one tank is reached. The other tank switches from a discharging mode to a receiving mode and the first tank becomes the discharge tank feeding waste to the thin film dryer.

Filter Systems. All filters at ETF (i.e., the Load-In Station, rough, fine, and auxiliary filter systems) are in leak-tight steel casings. For the rough and fine filters, a high differential pressure, which could damage the filter element, activates a valve that shuts off liquid flow to protect the filter element from possible damage. To prevent a high-pressure situation, the filters are cleaned routinely with pulses of compressed air that force water back through the filter. Cleaning is terminated automatically by shutting off the compressed air supply if high pressure develops. The differential pressure across the auxiliary filters also is monitored. A high differential pressure in these filters would result in a system shutdown to allow the filters to be changed out.

The Load-In Station filtration system has pressure gauges for monitoring the differential pressure across each filter. A high differential pressure would result in discontinuing filter operation until the filter is replaced.

Ultraviolet Light/Oxidation System and Decomposers. A rupture disk on the inlet piping to each of the UV/OX reaction vessels relieves to the pH adjustment tank in the event of excessive pressure developing in the piping system. Should the rupture disk fail, the aqueous waste would trip the moisture sensor, shut down the UV lamps, and close the surge tank feed valve. Also provided is a level sensor to protect UV lamps against the risk of exposure to air. Should those sensors be actuated, the UV lamps would be shut down immediately.

The piping and valving for the hydrogen peroxide decomposers are configured to split the waste flow: half flows to one decomposer and half flows to the other decomposer. Alternatively, the total flow of waste can be treated in one decomposer or both decomposers can be bypassed. A safety relief valve on each decomposer vessel can relieve excess system pressure to a sump tank.

Degasification System. The degasification column is typically supplied aqueous waste feed by the pH adjustment tank feed pump. This pump transfers waste solution through the hydrogen peroxide decomposer, the fine filter, and the degasification column to the first RO feed tank.

The degasification column is designed for operation at a partial vacuum. A pressure sensor in the column detects the column pressure. The vacuum in the degasification column is maintained by a blower connected to the vessel off gas system. The column is protected from extremely low pressure developed by the column blower by the use of an intake vent that is maintained in the open position during operation. The column liquid level is regulated by a flow control system with a high- and low-level alarm. Plate-type heat exchanger cools the waste solution fed to the degasification column.

Reverse Osmosis System. The flow through the first and second RO stages is controlled to maintain constant liquid levels in the first and second stage RO feed tanks.

Polisher. Typically, two of the three columns are in operation (lead/lag) and the third (regenerated) column is in standby. When the capacity of the resin in the first column is exceeded, as detected by an increase in the conductivity of the column effluent, the third column, containing freshly regenerated IX resin, is brought online. The first column is taken offline, and the waste is rerouted to the second column, and to the third. Liquid level instrumentation and automatically operated valves are provided in the IX system to prevent overfilling.

Effluent Treatment Facility Evaporator. Liquid level instrumentation in the secondary waste receiving tanks is designed to preclude a tank overflow. A liquid level switch actuated by a high-tank liquid level causes the valves to reposition, closing off flow to the secondary waste receiving tanks. Secondary containment for these tanks routes liquids to a sump tank.

Valves in the ETF evaporator feed line can be positioned to bypass the secondary waste around the ETF evaporator and to transfer the secondary waste to the concentrate tanks.

Thin Film Dryer. The two concentrate tanks alternately feed the thin film dryer. One tank serves as a concentrate waste receiver while the other tank serves as the dryer feed tank. Liquid level instrumentation prevents tank overflow by diverting the concentrate flow from the full concentrate tank to the other concentrate tank. Secondary containment for these tanks routes liquids to a sump tank.

An alternate route is provided from the concentrate receiver tank to the secondary waste receiving tanks. Dilute concentrate in the concentrate receiver tank can be reprocessed through the ETF evaporator by transferring the concentrate back to a secondary waste-receiving tank.

4.4.5 Labels or Signs

Each tank or process unit in the ETF is identified by a nameplate attached in a readily visible location. Included on the nameplate are the equipment number and the equipment title. Those tanks that store or treat dangerous waste at the ETF (Section 4.4.1.1) are identified with a label, which reads "PROCESS WATER/WASTE". The labels are legible at a distance of at least fifty feet or as appropriate for legibility within the ETF. Additionally, these tanks bear a legend that identifies the waste in a manner, which adequately warns employees, emergency personnel, and the public of the major risk(s) associated with the waste being stored or treated in the tank system(s).

Caution plates are used to show possible hazards and warn that precautions are necessary. Caution signs have a yellow background and black panel with yellow letters and bear the word "CAUTION". Danger signs show immediate danger and signify that special precautions are necessary. These signs are red, black, and white and bear the word "DANGER".

Tanks and vessels containing corrosive chemicals are posted with black and white signs bearing the word "CORROSIVE". "DANGER - UNAUTHORIZED PERSONNEL KEEP OUT" signs are posted on all exterior doors of the ETF, and on each interior door leading into the process area. Tank ancillary piping is also labeled "PROCESS WATER" or "PROCESS LIQUID" to alert personnel which pipes in the process area contains dangerous and/or mixed waste.

All tank systems holding dangerous waste are marked with labels or signs to identify the waste contained in the tanks. The labels or signs are legible at a distance of at least 50-feet and bear a legend that identifies the waste in a manner that adequately warns employees, emergency response personnel, and the public, of the major risk(s) associated with the waste being stored or treated in the tank system(s).

4.4.6 Air Emissions

Tank systems that contain extremely hazardous waste that is acutely toxic by inhalation must be designed to prevent the escape of such vapors. To date, no extremely hazardous waste has been managed in ETF tanks and is not anticipated. However, the ETF tanks have forced ventilation that draws air from the tank vapor spaces to prevent exposure of operating personnel to any toxic vapors that might be present. The vapor passes through a charcoal filter and two sets of high-efficiency particulate air filters before discharge to the environment.

4.4.7 Management of Ignitable or Reactive Wastes in Tanks Systems

Although the ETF is permitted to accept waste that is designated ignitable or reactive, such waste would be treated or blended immediately after placement in the tank system so that the resulting waste mixture is no longer ignitable or reactive. Aqueous waste received does not meet the definition of a combustible or flammable liquid given in National Fire Protection Association (NFPA) code number 30 (NFPA 1996). The buffer zone requirements in NFPA-30, which require tanks containing combustible or flammable solutions be a safe distance from each other and from public way, are not applicable.

4.4.8 Management of Incompatible Wastes in Tanks Systems

The ETF manages dilute solutions that can be mixed without compatibility issues. The ETF is equipped with several systems that can adjust the pH of the waste for treatment activities. Sulfuric acid and sodium hydroxide are added to the process through the MCS for pH adjustment to ensure there will be no large pH fluctuations and adverse reactions in the tank systems.

4.5 SURFACE IMPOUNDMENTS

This section provides specific information on surface impoundment operations at the LERF, including descriptions of the liners and secondary containment structures, as required by WAC 173-303-650 and WAC 173-303-806(4)(d).

The LERF consists of three lined surface impoundments (basins) with a design operating capacity of 29.5 million liters each. The maximum capacity of each basin is 34 million liters. The dimensions of each basin at the anchor wall are approximately 103 meters by 85 meters. The typical top dimensions of the wetted area are approximately 89 meters by 71 meters, while the bottom dimensions are approximately 57 by 38 meters. Total depth from the top of the dike to the bottom of the basin is approximately 7 meters. The typical finished basin bottoms lie at about 4 meters below the initial grade and 175 meters above sea level. The dikes separating the basins have a typical height of 3 meters and typical top width of 11.6 meters around the perimeter of the impoundments.

4.5.1 List of Dangerous Waste

A list of dangerous and/or mixed aqueous waste that can be stored in LERF is presented in Chapter 1.0. The waste analysis plan for the LERF and ETF Chapter 3.0 also provides a discussion of the types of waste that are managed in the LERF.

4.5.2 Construction, Operation, and Maintenance of Liner System

General information concerning the liner system is presented in the following sections. Information regarding loads on the liner, liner coverage, UV light exposure prevention, and location relative to the water table are discussed.

4.5.2.1 Liner Construction Materials

The LERF employs a double-composite liner system with a leachate detection, collection, and removal system between the primary and secondary liners. Each basin is constructed with an upper or primary liner consisting of a high-density polyethylene geomembrane laid over a bentonite carpet liner. The lower or secondary liner in each basin is a composite of a geomembrane laid over a layer of soil/bentonite admixture with a hydraulic conductivity less than 10^{-7} centimeters per second. The synthetic liners extend up the dike wall to a concrete anchor wall that surrounds the basin at the top of the dike. A batten system bolts the layers in place to the anchor wall (Figure 4.16).

Figure 4.17 is a schematic cross-section of the liner system. The liner components, listed from the top to the bottom of the liner system, are the following:

- Primary 1.5-millimeter high-density polyethylene geomembrane
- Bentonite carpet liner
- Geotextile
- Drainage gravel (bottom) and geonet (sides)
- Geotextile
- Secondary 1.5-millimeter high-density polyethylene geomembrane
- Soil/bentonite admixture (91 centimeters on the bottom, 107 centimeters on the sides)
- Geotextile

The primary geomembrane, made of 1.5-millimeter high-density polyethylene, forms the basin surface that holds the aqueous waste. The secondary geomembrane, also 1.5-millimeter high-density polyethylene, forms a barrier surface for leachate that might penetrate the primary liner. The high-density polyethylene chemically is resistant to constituents in the aqueous waste and has a relatively high strength compared to other lining materials. The high-density polyethylene resin specified for the LERF contains carbon black, antioxidants, and heat stabilizers to enhance its resistance to the degrading effects of UV light. The approach to ensuring the compatibility of aqueous waste streams with the LERF liner materials and piping is discussed in the waste analysis plan Chapter 3.0.

Three geotextile layers are used in the LERF liner system. The layers are thin, nonwoven polypropylene fabric that chemically is resistant, highly permeable, and resistant to microbiological growth. The first two layers prevent fine soil particles from infiltrating and clogging the drainage layer. The second geotextile also provides limited protection for the secondary geomembrane from the drainage rock. The third geotextile layer prevents the mixing of the soil/bentonite admixture with the much more porous and granular foundation material.

A 30.5-centimeters-thick gravel drainage layer on the bottom of the basins between the primary and secondary liners provides a flow path for liquid to the leachate detection, collection, and removal system. A geonet (or drainage net) is located immediately above the secondary geomembrane on the basin sidewalls. The geonet functions as a preferential flow path for liquid between the liners, carrying liquid down to the gravel drainage layer and subsequently to the leachate sump. The geonet is a mesh made of high-density polyethylene, with approximately 13-millimeter openings.

The soil/bentonite layer is 97 centimeters thick on the bottom of the basins and 107 centimeters thick on the basin sidewalls; its permeability is less than 10-7 centimeters per second. This composite liner design, consisting of a geomembrane laid over essentially impermeable soil/bentonite, is considered best available technology for solid waste landfills and surface impoundments. The combination of synthetic and clay liners is reported in the literature to provide the maximum protection from waste migration (Forseth and Kmet 1983).

A number of laboratory tests were conducted to measure the engineering properties of the soil/bentonite admixture, in addition to extensive field tests performed on three test fills constructed near the LERF site. For establishing an optimum ratio of bentonite to soil for the soil/bentonite admixture, mixtures of various ratios were tested to determine permeability and shear strength. A mixture of 12 percent bentonite was selected for the soil/bentonite liner and tests described in the following paragraphs demonstrated that the admixture meets the desired permeability of less than 10-7 centimeters per second. Detailed discussion of test procedures and results is provided in Report of Geotechnical Investigation, 242-A Evaporation and PUREX Interim Storage Basins (Chen-Northern 1990).

Direct shear tests were performed according to ASTM D3080 test procedures (ASTM 1990) on soil/bentonite samples of various ratios. Based on these results, the conservative minimum Mohr-Coulomb shear strength value of 30 degrees was estimated for a soil/bentonite admixture containing 12 percent bentonite.

The high degree of compaction of the soil/bentonite layer [92 percent per ASTM D1557 (ASTM 1991)] was expected to maximize the bonding forces between the clay particles, thereby minimizing moisture transport through the liner. With respect to particle movement ('piping'), estimated fluid velocities in this low-permeability material are too low to move the soil particles. Therefore, piping is not considered a problem.

For the soil/bentonite layer, three test fills were constructed to demonstrate that materials, methods, and procedures used would produce a soil/bentonite liner that meets the EPA permeability requirement of less than 10-7 centimeters per second. All test fills met the EPA requirements. A thorough discussion of construction procedures, testing, and results is provided in *Report of Permeability Testing, Soil-bentonite Test Fill* (Chen-Northern 1991a).

The aqueous waste stored in the LERF is typically a dilute mixture of organic and inorganic constituents. Though isolated instances of soil liner incompatibility have been documented in the literature (Forseth and Kmet 1983), these instances have occurred with concentrated solutions that were incompatible with the geomembrane liners in which the solutions were contained. Considering the dilute nature of the aqueous waste that is and will be stored in LERF and the moderate pH, and test results demonstrating the compatibility of the high-density polyethylene liners with the aqueous waste [9090 Test Results (WHC 1991)], gross failure of the soil/bentonite layer is not probable.

Each basin also is equipped with a floating very low-density polyethylene cover. The cover is anchored and tensioned at the concrete wall at the top of the dikes, using a patented mechanical tensioning system. Figure 4.16 depict the tension mechanism and the anchor wall at the perimeter of each basin. Additional information on the cover system is provided in Section 4.5.2.5.

4.5.2.1.1 Material Specifications

Material specifications for the liner system and leachate collection system, including liners, drainage gravel, and drainage net are discussed in the following sections. Material specifications are documented in the *Final Specifications 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990a) and *Construction Specifications for 242-A Evaporator and PUREX Interim Retention Basins* (KEH 1990b).

Geomembrane Liners. The high-density polyethylene resin for geomembranes for the LERF meets the material specifications listed in Table 4.9. Key physical properties include thickness (1.5 millimeters [60 mil]) and impermeability (hydrostatic resistance of over 360,000 kilogram per square meter). Physical properties meet National Sanitation Foundation Standard 54 (NSF 1985). Testing to determine if the liner material is compatible with typical dilute waste solutions was performed and documented in *9090 Test Results* (WHC 1991).

Soil/Bentonite Liner. The soil/bentonite admixture consists of 11.5 to 14.5 percent bentonite mixed into well-graded silty sand with a maximum particle size of 4.75 millimeters (No. 4 sieve). Test fills were performed to confirm the soil/bentonite admixture applied at LERF has hydraulic conductivity less than 10^{-7} centimeters per second, as required by WAC 173-303-650(2)(j) for new surface impoundments.

Bentonite Carpet Liner. The bentonite carpet liner consists of bentonite (90 percent sodium montmorillonite clay) in a primary backing of woven polypropylene with nylon filler fiber, and a cover fabric of open weave spunlace polyester. The montmorillonite is anticipated to retard migration of solution through the liner, exhibiting a favorable cation exchange for adsorption of some constituents (such as ammonium). Based on composition of the bentonite carpet and of the type of aqueous waste stored at LERF, no chemical attack, dissolution, or degradation of the bentonite carpet liner is anticipated.

Geotextile. The nonwoven geotextile layers consist of long-chain polypropylene polymers containing stabilizers and inhibitors to make the filaments resistant to deterioration from UV light and heat exposure. The geotextile layers consist of continuous geotextile sheets held together by needle punching. Edges of the fabric are sealed or otherwise finished to prevent outer material from pulling away from the fabric or raveling.

Drainage Gravel. The drainage layer consists of thoroughly washed and screened, naturally occurring rock meeting the size specifications for Grading Number 5 in Washington State Department of Transportation construction specifications (WSDOT 1988). The specifications for the drainage layer are given in Table 4.10. Hydraulic conductivity tests (Chen-Northern 1992a, 1992b, 1992c) showed the drainage rock used at LERF met the sieve requirements and had a hydraulic conductivity of at least 1 centimeter per second, which exceeded the minimum of at least 0.1 centimeters per second required by WAC 173-303-650(2)(j) for new surface impoundments.

Geonet. The geonet is fabricated from two sets of parallel high-density polyethylene strands, spaced 1.3 centimeters center-to-center maximum to form a mesh with minimum two strands per 2.54 centimeter in each direction. The geonet is located between the liners on the sloping sidewalls to provide a preferential flow path for leachate to the drainage gravel and subsequently to the leachate sump.

Leachate Collection Sump. Materials used to line the 3.0-meter by 1.8-meter by 0.30-meter-deep leachate sump, at the bottom of each basin in the northwest corner, include [from top to bottom (Figure 4.18)]:

- 25 millimeter high-density polyethylene flat stock (supporting the leachate riser pipe)
- Geotextile
- 1.5-millimeter high-density polyethylene rub sheet

- Secondary composite liner:
- 1.5-millimeter high-density polyethylene geomembrane
- 91 centimeters of soil/bentonite admixture
- Geotextile

Specifications for these materials are identical to those discussed previously.

Leachate System Risers. Risers for the leachate system consist of 10-inch and 4-inch pipes from the leachate collection sump to the catch basin northwest of each basin (Figure 4.18). The risers lay below the primary liner in a gravel-filled trench that also extends from the sump to the concrete catch basin (Figure 4.19).

The risers are high-density polyethylene pipes fabricated to meet the requirements in ASTM D1248 (ASTM 1989). The 10-inch riser is perforated every 20.3 centimeters with 1.3-centimeter holes around the diameter. Level sensors and leachate pump are inserted in the 10-inch riser to monitor and remove leachate from the sump. To prevent clogging of the pump and piping with fine particulate, the end of the riser is encased in a gravel-filled box constructed of high-density polyethylene geonet and wrapped in geotextile. The 4-inch riser is perforated every 10.2 centimeters with 0.64-centimeter holes around the diameter. A level detector is inserted in the 4-inch riser.

Leachate Pump. A deep-well submersible pump, designed to deliver approximately 110 liters per minute, is installed in the 10-inch leachate riser in each basin. Wetted parts of the leachate pump are made of 316L stainless steel, providing both corrosion resistance and durability.

4.5.2.1.2 Loads on Liner System

The LERF liner system is subjected to the following types of stresses.

Stresses from Installation or Construction Operations. Contractors were required to submit construction quality control plans that included procedures, techniques, tools, and equipment used for the construction and care of liner and leachate system. Methods for installation of all components were screened to ensure that the stresses on the liner system were kept to a minimum.

Calculations were performed to estimate the risk of damage to the secondary high-density polyethylene liner during construction (*Calculations for LERF Part B Permit Application* [HNF 1997]). The greatest risk expected was from spreading the gravel layer over the geotextile layer and secondary geomembrane. The results of the calculations show that the strength of the geotextile was sufficiently high to withstand the stress of a small gravel spreader driving on a minimum of 15 centimeters of gravel over the geotextile and geomembrane. The likelihood of damage to the geomembrane lying under the geotextile was considered low.

To avoid driving heavy machinery directly on the secondary liner, a 28-meter conveyer was used to deliver the drainage gravel into the basins. The gravel was spread and consolidated by hand tools and a bulldozer. The bulldozer traveled on a minimum thickness of 30.5 centimeters of gravel. Where the conveyer assembly was placed on top of the liner, cribbing was placed to distribute the conveyer weight. No heavy equipment was allowed for use directly in contact with the geomembranes.

Additional calculations were performed to estimate the ability of the leachate riser pipe to withstand the static and dynamic loading imposed by lightweight construction equipment riding on the gravel layer (HNF 1997). Those calculations demonstrated that the pipe could buckle under the dynamic loading of small construction equipment; therefore, the pipe was avoided by equipment during spreading of the drainage gravel.

Installation of synthetic lining materials proceeded only when winds were less than 24 kilometers per hour, and not during precipitation. The minimum ambient air temperature for unfolding or unrolling the high-density polyethylene sheets was -10 C, and a minimum temperature of 0 C was required for seaming the high-density polyethylene sheets. Between shifts, geomembranes and geotextile were anchored with sandbags to prevent lifting by wind. Calculations were performed to determine the appropriate spacing of

sandbags on the geomembrane to resist lifting caused by 130 kilometer per hour winds (HNF 1997). All of the synthetic components contain UV light inhibitors and no impairment of performance is anticipated from the short-term UV light exposure during construction. Section 4.5.2.4 provides further detail on exposure prevention.

During the laying of the soil/bentonite layer and the overlying geomembrane, moisture content of the admixture was monitored and adjusted to ensure optimum compaction and to avoid development of cracks.

4.5.2.1.3 Static and Dynamic Loads and Stresses from the Maximum Quantity of Waste

When a LERF basin is full, liquid depth is approximately 6.4 meters. Static load on the primary liner is roughly 6,400 kilograms per square meter. Load on the secondary liner is slightly higher because of the weight of the gravel drainage layer. Assuming a density of 805 kilograms per square meter for the drainage gravel [conservative estimate based on specific gravity of 2.65 (Ambrose 1988)], the secondary high-density polyethylene liner carries approximately 7,200 kilograms per square meter when a basin is full.

Side slope liner stresses were calculated for each of the layers in the basin sidewalls and for the pipe trench on the northwest corner of each basin (HNF 1997). Results of these calculations indicate factors of safety against shear were 1.5 or greater for the primary geomembrane, geotextile, geonet, and secondary geomembrane.

Because the LERF is not located in an area of seismic concern, as identified in Appendix VI of 40 CFR 264 and WAC 173-303-282(6)(a)(I), discussion and calculation of potential seismic events are not required.

4.5.2.1.4 Stresses Resulting from Settlement, Subsidence, or Uplift

Uplift stresses from natural sources are expected to have negligible impact on the liner. Groundwater lies approximately 62 meters below the LERF, average annual precipitation is only 16 centimeters, and the average unsaturated permeability of the soils near the basin bottoms is high, ranging from about 5.5×10^4 centimeters per second to about 1 centimeter per second (Chen-Northern 1991b). Therefore, no hydrostatic uplift forces are expected to develop in the soil underneath the basins. In addition, the soil under the basins consists primarily of gravel and sand, and contains few or no organic constituents. Therefore, uplift caused by gas production from organic degradation is not anticipated.

Based on the design of the soil-bentonite liner, no structural uplift stresses are present within the lining system (Chen-Northern 1991b).

Regional subsidence is not anticipated because neither petroleum nor extractable economic minerals are present in the strata underlying the LERF basins, nor is karst (erosive limestone) topography present.

Dike soils and soil/bentonite layers were compacted thoroughly and proof-rolled during construction. Calculation of settlement potential showed that combined settlement for the foundation and soil/bentonite layer is expected to be about 2.7 centimeters. Settlement impact on the liner and basin stability is expected to be minimal (Chen-Northern 1991b).

4.5.2.1.5 Internal and External Pressure Gradients

Pressure gradients across the liner system from groundwater are anticipated to be negligible. The LERF is about 62 meters above the seasonal high water table, which prevents buildup of water pressure below the liner. The native gravel foundation materials of the LERF are relatively permeable and free draining. The 2 percent slope of the secondary liner prevents the pooling of liquids on top of the secondary liner. Finally, the fill rate of the basins is slow enough (average 190 liters per minute) that the load of the liquid waste on the primary liner is gradually and evenly distributed.

To prevent the buildup of gas between the liners, each basin is equipped with 21 vents in the primary geomembrane that allow the reduction of any excess gas pressure. Gas passing through these vents exit

through a single pipe that penetrates the anchor wall into a carbon adsorption filter. This filter extracts nearly all of the organic compounds, ensuring that emissions to the air from the basins are not toxic.

4.5.2.2 Liner System Location Relative to High-Water Table

The lowest point of each LERF basin is the northwest corner of the sump, where the typical subgrade elevation is 175 meters above mean sea level. Based on data collected from the groundwater monitoring wells at the LERF site, the seasonal high-water table is located approximately 62 meters or more below the lowest point of the basins. This substantial thickness of unsaturated strata beneath the LERF provides ample protection to the liner from hydrostatic pressure because of groundwater intrusion into the soil/bentonite layer. Further discussion of the unsaturated zone and site hydrogeology is provided in Addendum D.

4.5.2.3 Liner System Foundation

Foundation materials are primarily gravels and cobbles with some sand and silt. The native soils onsite are derived from unconsolidated Holocene sediments. These sediments are fluvial and glaciofluvial sands and gravels deposited during the most recent glacial and postglacial event. Grain-size distributions and shape analyses of the sediments indicate that deposition occurred in a high-energy environment (Chen-Northern 1990).

Analysis of five soil borings from the LERF site was conducted to characterize the natural foundation materials and to determine the suitability of onsite soils for construction of the impoundment dikes and determine optimal design factors. Well-graded gravel containing varying amounts of silt, sand, and cobbles comprises the layer in which the basins were excavated. This gravel layer extends to depths of 10 to 11 meters below land surface (Chen-Northern 1990). The basins are constructed directly on the subgrade. Excavated soils were screened to remove oversize cobbles (greater than 15 centimeters in the largest dimension) and used to construct the dikes.

Settlement potential of the foundation material and soil/bentonite layer was found to be low. The foundation is comprised of undisturbed native soils. The bottom of the basin excavation lies within the well-graded gravel layer, and is dense to very dense. Below the gravel is a layer of dense to very dense poorly graded and well-graded sand. Settlement was calculated for the gravel foundation soils and for the soil/bentonite layer, under the condition of hydrostatic loading from 6.4 meters of fluid depth. The combined settlement for the soils and the soil/bentonite layer is estimated to be about 2.7 centimeters. This amount of settlement is expected to have minimal impact on overall liner or basin stability (Chen-Northern 1991b). Settlement calculations are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

The load bearing capacity of the foundation material, based on the soil analysis discussed previously, is estimated at about 48,800 kilograms per square meter [maximum advisable presumptive bearing capacity (Hough 1969)]. Anticipated static and dynamic loading from a full basin is estimated to be less than 9,000 kilograms per square meter (Section 4.5.2.1.3), which provides an ample factor of safety.

When the basins are empty, excess hydrostatic pressure in the foundation materials under the liner system theoretically could result in uplift and damage. However, because the native soil forming the foundations is unsaturated and relatively permeable, and because the water table is located at a considerable depth beneath the basins, any infiltration of surface water at the edge of the basin is expected to travel predominantly downward and away from the basins, rather than collecting under the excavation itself. No gas is expected in the foundation because gas-generating organic materials are not present.

Subsidence of undisturbed foundation materials is generally the result of fluid extraction (water or petroleum), mining, or karst topography. Neither petroleum, mineral resources, nor karst are believed to be present in the sediments overlying the Columbia River basalts. Potential groundwater resources do exist below the LERF. Even if these sediments were to consolidate from fluid withdrawal, their depth most likely would produce a broad, gently sloping area of subsidence that would not cause significant

strains in the LERF liner system. Consequently, the potential for subsidence related failures are expected to be negligible.

Borings at the LERF site, and extensive additional borings in the 200 East Area, have not identified any significant quantities of soluble materials in the foundation soil or underlying sediments (Last et al. 1989). Consequently, the potential for sinkholes is considered negligible.

4.5.2.4 Liner System Exposure Prevention

Both primary and secondary geomembranes and the floating cover are stabilized with carbon black to prevent degradation from UV light. Furthermore, none of the liner layers experience long-term exposure to the elements. During construction, thin polyethylene sheeting was used to maintain optimum moisture content and provide protection from the wind for the soil/bentonite layer until the secondary geomembrane was laid in place. The secondary geomembrane was covered by the geonet and geotextile as soon as quality control testing was complete. Once the geotextile layer was completed, drainage material immediately was placed over the geotextile. The final (upper) geotextile layer was placed over the drainage gravel and immediately covered by the bentonite carpet liner. This was covered immediately, in turn, by the primary high-density polyethylene liner.

Both high-density polyethylene liners, geotextile layers, and geonet are anchored permanently to a concrete wall at the top of the basin berm. During construction, liners were held in place with many sandbags on both the basin bottoms and side slopes to prevent wind from lifting and damaging the materials. Calculations were performed to determine the amount of fluid needed in a basin to prevent wind lift damage to the primary geomembrane. Approximately 15 to 20 centimeters of solution are kept in each basin to minimize the potential for uplifting the primary liner (HNF 1997).

The entire lining system is covered by a very low-density polyethylene floating cover that is bolted to the concrete anchor wall. The floating cover prevents evaporation and intrusion from dust, precipitation, vegetation, animals, and birds. A patented tensioning system is employed to prevent wind from lifting the cover and automatically accommodate changes in liquid level in the basins. The cover tension mechanism consists of a cable running from the flexible geosynthetic cover over a pulley on the tension tower (located on the concrete anchor wall) to a dead man anchor. These anchors (blocks) simply hang from the cables on the exterior side of the tension towers. The anchor wall also provides for solid attachment of the liner layers and the cover, using a 6.4-millimeter batten and neoprene gasket to bolt the layers to the concrete wall, effectively sealing the basin from the intrusion of light, precipitation, and airborne dust (Figure 4.16).

The floating cover, made of very low-density polyethylene with UV light inhibitors, is not anticipated to experience unacceptable degradation during the service life of the LERF. The very low-density polyethylene material contains carbon black for UV light protection, anti-oxidants to prevent heat degradation, and seaming enhancers to improve its ability to be welded. A typical manufacturer's limited warranty for weathering of very low-density polyethylene products is 20 years (Poly America, undated). This provides a margin of safety for the anticipated medium-term use of the LERF for aqueous waste storage.

The upper 3.4 to 4.6 meters of the sidewall liner also could experience stresses in response to temperature changes. Accommodation of thermal influences for the LERF geosynthetic layers is affected by inclusion of sufficient slack as the liners were installed. Calculations demonstrate that approximately 67 centimeters of slack is required in the long basin bottom dimension, 46 centimeters across the basin, and 34 centimeters from the bottom of the basin to the top of the basin wall (HNF 1997).

Thermal stresses also are experienced by the floating cover. As with the geomembranes, sufficient slack was included in the design to accommodate thermal contraction and expansion.

4.5.2.4.1 Liner Repairs During Operations

Should repair of a basin liner be required while the basin is in operation, the basin contents will be transferred to the ETF or another available basin. After the liner around the leaking section is cleaned,

repairs to the geomembrane will be made by the application of a piece of high-density polyethylene sheeting, sufficient in size to extend approximately 8 to 15 centimeters beyond the damaged area, or as recommended by the vendor. A round or oval patch will be installed using the same type of equipment and criteria used for the initial field installations.

4.5.2.4.2 Control of Air Emissions

The floating covers limit evaporation of aqueous waste and releases of volatile organic compounds into the atmosphere. To accommodate volumetric changes in the air between the fluid in the basin and the cover, and to avoid problems related to 'sealing' the basins too tightly, each basin is equipped with a carbon filter breather vent system. Any air escaping from the basins must pass through this vent, consisting of a pipe that penetrates the anchor wall and extends into a carbon adsorption filter unit.

4.5.2.5 Liner Coverage

The liner system covers all of the ground surface that underlies the retention basins. The primary liner extends up the side slopes to a concrete anchor wall at the top of the dike encircling the entire basin (Figure 4.16).

4.5.3 Prevention of Overtopping

Overtopping prevention is accomplished through administrative controls and liquid-level instrumentation installed in each basin. The instrumentation includes local liquid-level indication as well as remote indication at the ETF. Before an aqueous waste is transferred into a basin, administrative controls are implemented to ensure overtopping will not occur during the transfer. The volume of feed to be transferred is compared to the available volume in the receiving basin. The transfer is not initiated unless there is sufficient volume available in the receiving basin or a cut-off level is established. The transfer into the basin would be stopped when this cut-off level is reached.

In the event of a 100-year, 24-hour storm event, precipitation would accumulate on the basin covers. Through the self-tensioning design of the basin covers and maintenance of adequate freeboard, all accumulated precipitation would be contained on the covers and none would flow over the dikes or anchor walls. The 100-year, 24-hour storm is expected to deliver 5.3 centimeters of rain or approximately 61 centimeters of snow. Cover specifications include the requirement that the covers be able to withstand the load from this amount of precipitation. Because the cover floats on the surface of the fluid in the basin, the fluid itself provides the primary support for the weight of the accumulated precipitation. Through the cover self-tensioning mechanism, there is ample 'give' to accommodate the overlying load without overstressing the anchor and attachment points.

Rainwater and snow evaporate readily from the cover, particularly in the arid Hanford Facility climate, where evaporation rates exceed precipitation rates for most months of the year. The black color of the cover further enhances evaporation. Thus, the floating cover prevents the intrusion of precipitation into the basin and provides for evaporation of accumulated rain or snow.

4.5.3.1 Freeboard

Under current operating conditions, 0.61 meter of freeboard is maintained at each LERF basin, which corresponds to an operating level of 6.8 meters, or 29.5 million liters.

4.5.3.2 Immediate Flow Shutoff

The mechanism for transferring aqueous waste is either through pump transfers with on/off switches or through gravity transfers with isolation valves. These methods provide positive ability to shut off transfers immediately in the event of overtopping. Overtopping a basin during a transfer is very unlikely because the low flow rate into the basin provides long response times. At a flow rate of 284 liters per minute, approximately 11 days would be required to fill a LERF basin from the 6.8-meter operating level (i.e., 0.61 meter of freeboard) to maximum capacity of 34 million liters (i.e., the 7.4-meter level).

4.5.3.3 Outflow Destination

Aqueous waste in the LERF is transferred routinely to ETF for treatment. However, should it be necessary to immediately empty a basin, the aqueous waste either would be transferred to the ETF for treatment or transferred to another basin (or basins), whichever is faster. If the waste is transferred to another LERF basin, the single pump for normal operation can be removed, and four submersible pumps can be installed using an emergency pump manifold. This portable piping and pumping system is capable of pumping 2,700 liters per minute. Not including set-up time, it would take approximately 7.6 days to pump the contents of a full basin at this pumping rate.

4.5.4 Structural Integrity of Dikes

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.4.1 Dike Design, Construction, and Maintenance

The dikes of the LERF are constructed of onsite native soils, generally consisting of cobbles and gravels. Well-graded mixtures were specified, with cobbles up to 15 centimeters in the largest dimension, but not constituting more than 20 percent of the volume of the fill. The dikes are designed with a 3:1 (3 units horizontal to 1 unit vertical) slope on the basin side, and 2.25:1 on the exterior side. The dikes are approximately 8.2 meters high from the bottom of the basin, and 3 meters above grade.

Calculations were performed to verify the structural integrity of the dikes (HNF 1997). The calculations demonstrate that the structural strength of the dikes is such that, without dependence on any lining system, the sides of the basins can withstand the pressure exerted by the maximum allowable quantity of fluid in the impoundment. The dikes have a factor of safety greater than 2.5 against failure by sliding.

4.5.4.2 Dike Stability and Protection

In the following paragraphs, various aspects of stability for the LERF dikes and the concrete anchor wall are presented, including slope failure, hydrostatic pressure, and protection from the environment.

Failure in Dike/Impoundment Cut Slopes. A slope stability analysis was performed to determine the factor of safety against slope failure. The computer program 'PCSTABL5' from Purdue University, using the modified Janbu Method, was employed to evaluate slope stability under both static and seismic loading cases. One hundred surfaces per run were generated and analyzed. The assumptions used were as follows (Chen-Northern 1991b):

- Weight of gravel: 2,160 kilograms per cubic meter
- Maximum dry density of gravel: 2,315 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for gravel: minimum 33 degrees
- Weight of soil/bentonite: 1,600 kilograms per cubic meter
- Mohr-Coulomb shear strength angle for soil/bentonite: minimum 30 degrees
- Slope: 3 horizontal: 1 vertical
- No fluid in impoundment (worst case for stability)
- Soils at in-place moisture (not saturated conditions)

Results of the static stability analysis showed that the dike slopes were stable with a minimum factor of safety of 1.77 (Chen-Northern 1991b).

The standard horizontal acceleration required in the *Hanford Plant Standards*, "Standard Architectural-Civil Design Criteria, Design Loads for Facilities" (DOE-RL 1988), for structures on the Hanford Site is 0.12 g. Adequate factors of safety for cut slopes in units of this type generally are considered 1.5 for static conditions and 1.1 for dynamic stability (Golder 1989). Results of the stability analysis showed that the LERF basin slopes were stable under horizontal accelerations of 0.10 and 0.15 g, with minimum factors of safety of 1.32 and 1.17, respectively (Chen-Northern 1991b). Printouts from the PCSTABL5 program are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application* (HNF 1997).

Hydrostatic Pressure. Failure of the dikes due to buildup of hydrostatic pressure, caused by failure of the leachate system or liners, is very unlikely. The liner system is constructed with two essentially impermeable layers consisting of a synthetic layer overlying a soil layer with low-hydraulic conductivity. It would require a catastrophic failure of both liners to cause hydrostatic pressures that could endanger dike integrity. Routine inspections of the leachate detection system, indicating quantities of leachate removed from the basins, provide an early warning of leakage or operational problems that could lead to excessive hydrostatic pressure. A significant precipitation event (e.g., a 100-year, 24-hour storm) will not create a hydrostatic problem because the interior sidewalls of the basins are covered completely by the liners. The covers can accommodate this volume of precipitation without overtopping the dike (Section 4.5.3), and the coarse nature of the dike and foundation materials on the exterior walls provides for rapid drainage of precipitation away from the basins.

Protection from Root Systems. Risk to structural integrity of the dikes because of penetrating root systems is minimal. Excavation and construction removed all vegetation on and around the impoundments, and native plants (such as sagebrush) grow very slowly. The large grain size of the cobbles and gravel used as dike construction material do not provide an advantageous germination medium for native plants. Should plants with extending roots become apparent on the dike walls, the plants will be controlled with appropriate herbicide application.

Protection from Burrowing Mammals. The cobble size materials that make up the dike construction material and the exposed nature of the dike sidewalls do not offer an advantageous habitat for burrowing mammals. Lack of vegetation on the LERF site discourages foraging. The risk to structural integrity of the dikes from burrowing mammals is therefore minimal. Periodic visual inspections of the dikes provide observations of any animals present. Should burrowing mammals be noted onsite, appropriate pest control methods such as trapping or application of rodenticides will be employed.

Protective Cover. Approximately 7.6 centimeters of crushed gravel serve as the cover of the exterior dike walls. This coarse material is inherently resistant to the effect of wind because of its large grain size. Total annual precipitation is low (16 centimeters) and a significant storm event (e.g., a 100-year, 24-hour storm) could result in about 5.3 centimeters of precipitation in a 24-hour period. The absorbent capacity of the soil exceeds this precipitation rate; therefore, the impact of wind and precipitation run-on to the exterior dike walls will be minimal.

4.5.5 Piping Systems

Aqueous waste from the 242-A Evaporator is transferred to the LERF using a pump located in the 242-A Evaporator and approximately 1,500 meters of pipe, consisting of a 3-inch carrier pipe within a 6-inch outer containment pipeline. Flow through the pump is controlled through a valve at flow rates from 150 to 300 liters per minute.

The pipeline exits the 242-A Evaporator below grade and remains below grade at a minimum 1.2-meter depth for freeze protection, until the pipeline emerges at the LERF catch basin, at the corner of each basin. All piping at the catch basin that is less than 1.2 meters below grade is wrapped with electric heat tracing tape and insulated for protection from freezing.

The transfer line from the 242-A Evaporator is centrifugally cast, fiberglass-reinforced epoxy thermoset resin pressure pipe fabricated to meet the requirements of ASME D2997 (ASME 1984). The 3-inch carrier piping is centered and supported within 6-inch containment piping. Pipe supports are fabricated of the same material as the pipe, and meet the strength requirements of ANSI B31.3 (ANSI 1987) for dead weight, thermal, and seismic loads.

A catch basin is provided at the northwest corner of each basin where piping extends from the basin to allow for basin-to-basin and basin-to-ETF liquid transfers. Drawing H-2-88766, sheets 1 through 4, provide schematic diagrams of the piping system at LERF. Drawing H-2-79604 provides details of the piping from the 242-A Evaporator to LERF.

4.5.5.1 Secondary Containment System for Piping

The 6-inch containment piping encases the 3-inch carrier pipe from the 242-A Evaporator to the LERF. All of the piping and fittings that are not directly over a catch basin or a basin liner are of this pipe-within-a-pipe construction. A catch basin is provided at the northwest corner of each basin where the inlet pipes, leachate risers, and transfer pipe risers emerge from the basin. The catch basin consists of a 20-centimeter-thick concrete pad at the top of the dike. The perimeter of the catch basin has a 20-centimeter-high curb, and the concrete is coated with a chemical resistant epoxy sealant. The concrete pad is sloped so that any leaks or spills from the piping or pipe connections will drain into the basin. The catch basin provides an access point for inspecting, servicing, and operating various systems such as transfer valving, leachate level instrumentation and leachate pump. Drawing H-2-79593 provides a schematic diagram of the catch basins.

4.5.5.2 Leak Detection System

Single-point electronic leak detection elements are installed along the transfer line at 305-meter intervals. The leak detection elements are located in the bottom of specially designed test risers. Each sensor element employs a conductivity sensor, which is connected to a cable leading back to the 242-A Evaporator control room. If a leak develops in the carrier pipe, fluid will travel down the exterior surface of the carrier pipe or the interior of the containment pipe. As moisture contacts a sensor unit, the alarm sounds in the ETF control room and the zone of the leak is indicated on the digital display. The pump located in the 242-A Evaporator is shut down, stopping the flow of aqueous waste through the transfer line. A low-volume air purge of the annulus between the carrier pipe and the containment pipe is provided to prevent condensation buildup and minimize false alarms by the leak detection elements.

The catch basins have conductivity leak detectors that alarm in the 242-A Evaporator control room. Leaks into the catch basins drain back to the basin through a 5.1-centimeter drain on the floor of the catch basin.

4.5.5.3 Certification

Although an integrity assessment is not required for piping associated with surface impoundments, an assessment of the transfer liner was performed, including a hydrostatic leak/pressure test at 10.5 kilograms per square centimeter gauge. A statement by an independent, qualified, registered professional engineer attesting to the integrity of the piping system is included in *Integrity Assessment Report for the 242-A Evaporator/LERF Waste Transfer Piping, Project W105* (WHC 1993), along with the results of the leak/pressure test.

4.5.6 Double Liner and Leak Detection, Collection, and Removal System

The double-liner system for LERF is discussed in Section 4.5.2. The leachate detection, collection, and removal system (Figures 4.18 and 4.19) was designed and constructed to remove leachate that might permeate the primary liner. System components for each basin include:

- 30.5-centimeter layer of drainage gravel below the primary liner at the bottom of the basin
- Geonet below the primary liner on the sidewalls to direct leachate to the gravel layer
- 3.0-meter by 1.8-meter by 0.30-meter-deep leachate collection sump consisting of a 25 millimeter high-density polyethylene flat stock, geotextile to trap large particles in the leachate, and 1.5-millimeter high-density polyethylene rub sheet set on the secondary liner
- 10-inch and 4-inch perforated leachate high-density polyethylene riser pipes from the leachate collection sump to the catch basin northwest of the basin
- Leachate collection sump level instrumentation installed in the 4-inch riser
- Level sensors, submersible leachate pump, and 1.5-inch fiberglass-reinforced epoxy thermoset resin pressure piping installed in the 10-inch riser

- Piping at the catch basin to route the leachate through 1.5-inch high-density polyethylene pipe back to the basins

The bottom of the basins has a two percent slope to allow gravity flow of leachate to the leachate collection sump. This exceeds the minimum of 1 percent slope required by WAC 173-303-650(j) for new surface impoundments. Material specifications for the leachate collection system are given in Section 4.5.2.1.1.

Calculations demonstrate that fluid from a small hole (2 millimeter) (EPA 1989, p. 122) at the furthest end of the basin, under a low head situation, would travel to the sump in less than 24 hours (HNF 1997). Additional calculations indicate the capacity of the pump to remove leachate is sufficient to allow time to readily identify a leak and activate emergency procedures (HNF 1997).

Automated controls maintain the fluid level in each leachate sump below 33 centimeters to prevent significant liquid backup into the drainage layer. The leachate pump is activated when the liquid level in the sump reaches about 28 centimeters, and is shut off when the sump liquid level reaches about 18 centimeters. This operation prevents the leachate pump from cycling with no fluid, which could damage the pump. Liquid level control is accomplished with conductivity probes that trigger relays selected specifically for application to submersible pumps and leachate fluids. A flowmeter/totalizer on the leachate return pipe measures fluid volumes pumped and pumping rate from the leachate collection sumps, and indicates volume and flow rate on local readouts. Other instrumentation provided is real-time continuous level monitoring with a readout at the catch basin. A sampling port is provided in the leachate piping system at the catch basin. Leak detection is provided through inspections of the leachate flow totalizer readings. For more information on inspections, refer to Chapter 6.0. For this application, continuous means uninterrupted except for brief periods of time for power failure, calibration, or equipment maintenance or repair. When continuous monitoring is not possible weekly basin level, leachate sump level, and flowmeter/totalizer readings will be obtained.

The stainless steel leachate pump is designed to deliver 110 liters per minute. The leachate pump returns draw liquid from the sump via 1.5-inch pipe and discharges into the basin through 1.5-inch high-density polyethylene pipe.

4.5.7 Construction Quality Assurance

The construction quality assurance plan and complete report of construction quality assurance inspection and testing results are provided in *242-A Evaporator Interim Retention Basin Construction Quality Assurance Plan* (KEH 1991). A general description of construction quality assurance procedures is outlined in the following paragraphs.

For excavation of the basins and construction of the dikes, regular inspections were conducted to ensure compliance with procedures and drawings, and compaction tests were performed on the dike soils.

For the soil/bentonite layer, test fills were first conducted in accordance with EPA guidance to demonstrate compaction procedures and to confirm compaction and permeability requirements can be met. The ratio of bentonite to soil and moisture content was monitored; lifts did not exceed 15 centimeters before compaction, and specific compaction procedures were followed. Laboratory and field tests of soil properties were performed for each lift and for the completed test fill. The same suite of tests was conducted for each lift during the laying of the soil/bentonite admixture in the basins.

Geotextiles and geomembranes were laid in accordance with detailed procedures and quality assurance programs provided by the manufacturers and installers. These included destructive and nondestructive tests on the geomembrane seams, and documentation of field test results and repairs.

4.5.8 Proposed Action Leakage Rate and Response Action Plan

An action leakage rate limit is established where action must be taken due to excessive leakage from the primary liner. The action leak rate is based on the maximum design flow rate the leak detection system can remove without the fluid head on the bottom liner exceeding 30 centimeters. The limiting factor in

the leachate removal rate is the hydraulic conductivity of the drainage gravel. An action leakage rate (also called the rapid or large leak rate) of 20,000 liters per hectare per day was calculated for each basin (WHC 1992b).

When it is determined that the action leakage rate has been exceeded, the response action plan will follow the actions in WAC 173-303-650(11)(b) and (c), which includes notification of Ecology in writing within 7 days, assessing possible causes of the leak, and determining whether waste receipt should be curtailed and/or the basin emptied.

4.5.9 Dike Structural Integrity Engineering Certification

The structural integrity of the dikes was certified attesting to the structural integrity of the dikes, signed by a qualified, registered professional engineer.

4.5.10 Management of Ignitable, Reactive, or Incompatible Wastes

Although ignitable or reactive aqueous waste might be received in small quantities at LERF, such aqueous waste is mixed with dilute solutions in the basins, removing the ignitable or reactive characteristics. For compatibility requirements with the LERF liner, refer to the waste analysis plan Chapter 3.0.

4.6 AIR EMISSIONS CONTROL

This section addresses the ETF requirements of Air Emission Standards for Process Vents, under 40 CFR 264, Subpart AA (incorporated by reference in WAC 173-303-690) and Subpart CC. The requirements of 40 CFR 264, Subpart BB (WAC 173-303-691) is not applicable because aqueous waste with 10 percent or greater organic concentration would not be acceptable for processing at the ETF.

4.6.1 Applicability of Subpart AA Standards

The ETF evaporator and thin film dryer perform operations that specifically require evaluation for applicability of WAC 173-303-690. Aqueous waste in these units routinely contains greater than 10 parts per million concentrations of organic compounds and are, therefore, subject to air emission requirements under WAC 173-303-690. Organic emissions from all affected process vents on the Hanford Facility must be less than 1.4 kilograms per hour and 2.8 megagrams per year, or control devices must be installed to reduce organic emissions by 95 percent.

The vessel off gas system provides a process vent system. This system provides a slight vacuum on the ETF process vessels and tanks (refer to Section 4.2.5.2). Two vessel vent header pipes combine and enter the vessel off gas system filter unit consisting of a demister, electric heater, prefilter, high-efficiency particulate air filters, activated carbon absorber, and two exhaust fans (one fan in service while the other is backup). The vessel off gas system filter unit is located in the high-efficiency particulate air filter room west of the process area. The vessel off gas system exhaust discharges into the larger building ventilation system, with the exhaust fans and stack located outside and immediately west of the ETF. The exhaust stack discharge point is 15.5 meters above ground level.

The annual average flow rate for the ETF stack (which is the combined vessel off gas and building exhaust flow rates) is 220 cubic meters per minute with a total annual flow of approximately 1.2 E+08 cubic meters. During waste processing, the airflow through just the vessel off gas system is about 23 standard cubic meters per minute.

Organic emissions occur during waste processing, which occurs less than 310 days each year (i.e., 85 percent operating efficiency). This operating efficiency represents the maximum annual operating time for the ETF, as shutdowns are required during the year for planned maintenance outages and for reconfiguring the ETF to accommodate different aqueous waste.

4.6.2 Process Vents - Demonstrating Compliance

This section outlines how the ETF complies with the requirements and includes a discussion of the basis for meeting the organic emissions limits, calculations demonstrating compliance, and conditions for reevaluation.

4.6.2.1 Basis for Meeting Limits/Reductions

The 242-A Evaporator and the 200 Area ETF are currently the only operating TSD units that contribute to the Hanford Facility volatile organic emissions under 40 CFR 264, Subpart AA. The combined release rate is currently well below the threshold of 1.4 kilograms per hour or 2,800 kilograms per year of volatile organic compounds. As a result, the ETF meets these standards without the use of air pollution control devices.

The amount of organic emissions could change as waste streams are changed, or TSD units are brought online or are deactivated. The organic air emissions summation will be re-evaluated periodically as condition warrants. Operations of the TSD units operating under 40 CFR 264, Subpart AA, will be controlled to maintain Hanford Facility emissions below the threshold limits or pollution control device(s) will be added, as necessary, to achieve the reduction standards specified under 40 CFR 264, Subpart AA.

4.6.2.2 Demonstrating Compliance

Calculations to determine organic emissions are performed using the following assumptions:

- Maximum flow rate from LERF to ETF is 568 liters per minute.
- Emissions of organics from tanks and vessels upstream of the UV/OX process are determined from flow and transfer rates given in *Clean Air Act Requirements, WAC 173-400, As-built Documentation, Project C-018H, 242-A Evaporator/PUREX Plant Process Condensate Treatment Facility* (Adtechs 1995).
- UV/OX reaction rate constants and residence times are used to determine the amount of organics, which are destroyed in the UV/OX process. These constants are given in *200 Area Effluent Treatment Facility Delisting Petition* (DOE/RL 1992).
- All organic compounds that are not destroyed in the UV/OX process are assumed to be emitted from the tanks and vessels into the vessel off gas system.
- No credit for removal of organic compounds in the vessel off gas system carbon absorber unit is taken. The activated carbon absorbers are used if required to reduce organic emissions.

The calculation to determine organic emissions consists of the following steps:

1. Determine the quantity of organics emitted from the tanks or vessels upstream of the UV/OX process, using transfer rate values
2. Determine the concentration of organics in the waste after the UV/OX process using UV/OX reaction rates and residence times. If the ETF is configured such that the UV/OX process is not used, a residence time of zero is used in the calculations (i.e., none of the organics are destroyed)
3. Assuming all the remaining organics are emitted, determine the rate which the organics are emitted using the feed flow rate and the concentrations of organics after the UV/OX process
4. The amount of organics emitted from the vessel off gas system is the sum of the amount calculated in steps 1 and 3.

The organic emission rates and quantity of organics emitted during processing are determined using these calculations and are included in the ETF operating record.

4.6.2.3 Reevaluating Compliance with Subpart AA Standards

Calculations to determine compliance with Subpart AA will be reviewed when any of the following conditions occur at the ETF:

- Changes in the maximum feed rate to the ETF (i.e., greater than the 568 liters per minute flow rate)
- Changes in the configuration or operation of the ETF that would modify the assumptions given in Section 4.6.2.2 (e.g., taking credit for the carbon absorbers as a control device)
- Annual operating time exceeds 310 days.

4.6.3 Applicability of Subpart CC Standards

The air emission standards of 40 CFR 264, Subpart CC apply to tank, surface impoundment, and container storage units that manage wastes with average volatile organic concentrations equal to or exceeding 500 parts per million by weight, based on the hazardous waste composition at the point of origination (61 FR 59972). However, TSD units that are used solely for management of mixed waste are exempt. Mixed waste is managed at the ETF and LERF and dangerous waste could be treated and stored at these TSD units.

TSD owner/operators are not required to determine the concentration of volatile organic compounds in a hazardous waste if the wastes are placed in waste management units that employ air emission controls that comply with the Subpart CC standards. Therefore, the approach to Subpart CC compliance at the ETF and LERF is to demonstrate that the ETF and LERF meet the Subpart CC control standards (40 CFR 264.1084 - 264.1086).

4.6.3.1 Demonstrating Compliance with Subpart CC for Tanks

Since the ETF tanks already have process vents regulated under 40 CFR 264, Subpart AA (WAC 173-303-690), they are exempt from Subpart CC [40 CFR 264.1080(b)(8)].

4.6.3.2 Demonstrating Compliance with Subpart CC for Containers

Container Level 1 and Level 2 standards are met at the ETF by managing all dangerous and/or mixed wastes in U.S. Department of Transportation containers [40 CFR 264.1086(f)]. Level 1 containers are those that store more than 0.1 cubic meters and less than or equal to 0.46 cubic meters. Level 2 containers are used to store more than 0.46 cubic meters of waste, which are in "light material service". Light material service is defined where a waste in the container has one or more organic constituents with a vapor pressure greater than 0.3 kilopascals at 20 C, and the total concentration of such constituents is greater than or equal to 20 percent by weight.

The monitoring requirements for Level 1 and Level 2 containers include a visual inspection when the container is received at the ETF and when the waste is initially placed in the container. Additionally, at least once every 12 months when stored onsite for 1 year or more, these containers must be inspected.

If compliant containers are not used at the ETF, alternate container management practices are used that comply with the Level 1 standards. Specifically, the Level 1 standards allow for a "container equipped with a cover and closure devices that form a continuous barrier over the container openings such that when the cover and closure devices are secured in the closed position there are no visible holes, gaps, or other open spaces into the interior of the container. The cover may be a separate cover installed on the container...or may be an integral part of the container structural design…" [40 CFR 264.1086(c)(1)(ii)]. An organic-vapor-suppressing barrier, such as foam, may also be used [40 CFR 264.1086(c)(1)(iii)]. Section 4.3 provides detail on container management practices at the ETF.

Container Level 3 standards apply when a container is used for the "treatment of a hazardous waste by a waste stabilization process" [40 CFR 264.1086(2)]. Because treatment in containers using the stabilization process is not provided at the ETF, these standards do not apply.

4.6.3.3 Demonstrating Compliance with Subpart CC for Surface Impoundments

The Subpart CC emission standards are met at LERF using a floating membrane cover that is constructed of very-low-density polyethylene that forms a continuous barrier over the entire surface area [40 CFR 264.1085(c)]. This membrane has both organic permeability properties equivalent to a high-density polyethylene cover and chemical/physical properties that maintain the material integrity for the intended service life of the material. The additional requirements for the floating cover at the LERF have been met (Section 4.5.2.4).

4.7 ENGINEERING DRAWINGS

4.7.1 Liquid Effluent Retention Facility

Drawings of the containment systems at the LERF are summarized in Table 4.1. Because the failure of these containment systems at LERF could lead to the release of dangerous waste into the environment, modifications that affect these containment systems will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.1. Liquid Effluent Retention Facility Containment System

LERF System	Drawing Number	Drawing Title
Bottom Liner	H-2-79590, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Top Liner	H-2-79591, Sheet 1	Civil Plan, Sections and Details; Cell Basin Bottom Liner
Catch Basin	H-2-79593, Sheet 1	Civil Plan, Section and Details; Catch Basin

The drawings identified in Table 4.2 illustrate the piping and instrumentation configuration within LERF, and of the transfer piping systems between the LERF and the 242-A Evaporator. These drawings are provided for general information and to demonstrate the adequacy of the design of the LERF as a surface impoundment.

Table 4.2. Liquid Effluent Retention Facility Piping and Instrumentation

LERF System	Drawing Number	Drawing Title
Transfer Piping to 242-A Evaporator	H-2-79604, Sheet 1	Piping Plot and Key Plans; 242-A Evaporator Condensate Stream
LERF Piping and Instrumentation	H-2-88766, Sheet 1	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 2	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 3	P&ID; LERF Basin and ETF Influent
	H-2-88766, Sheet 4	P&ID; LERF Basin and ETF Influent
Legend	H-2-89351, Sheet 1	Piping & Instrumentation Diagram - Legend

4.7.2 200 Area Effluent Treatment Facility

Drawings of the secondary containment systems for the ETF containers, and tanks and process units, and for the Load-In Tanks are summarized in Table 4.3. Because the failure of the secondary containment systems could lead to the release of dangerous waste into the environment, modifications, which affect the secondary containment systems, will be submitted to the Washington State Department of Ecology, as a Class 1, 2, or 3 Permit modification, as required by WAC 173-303-830.

Table 4.3. Effluent Treatment Facility and Load-In Station Secondary Containment Systems

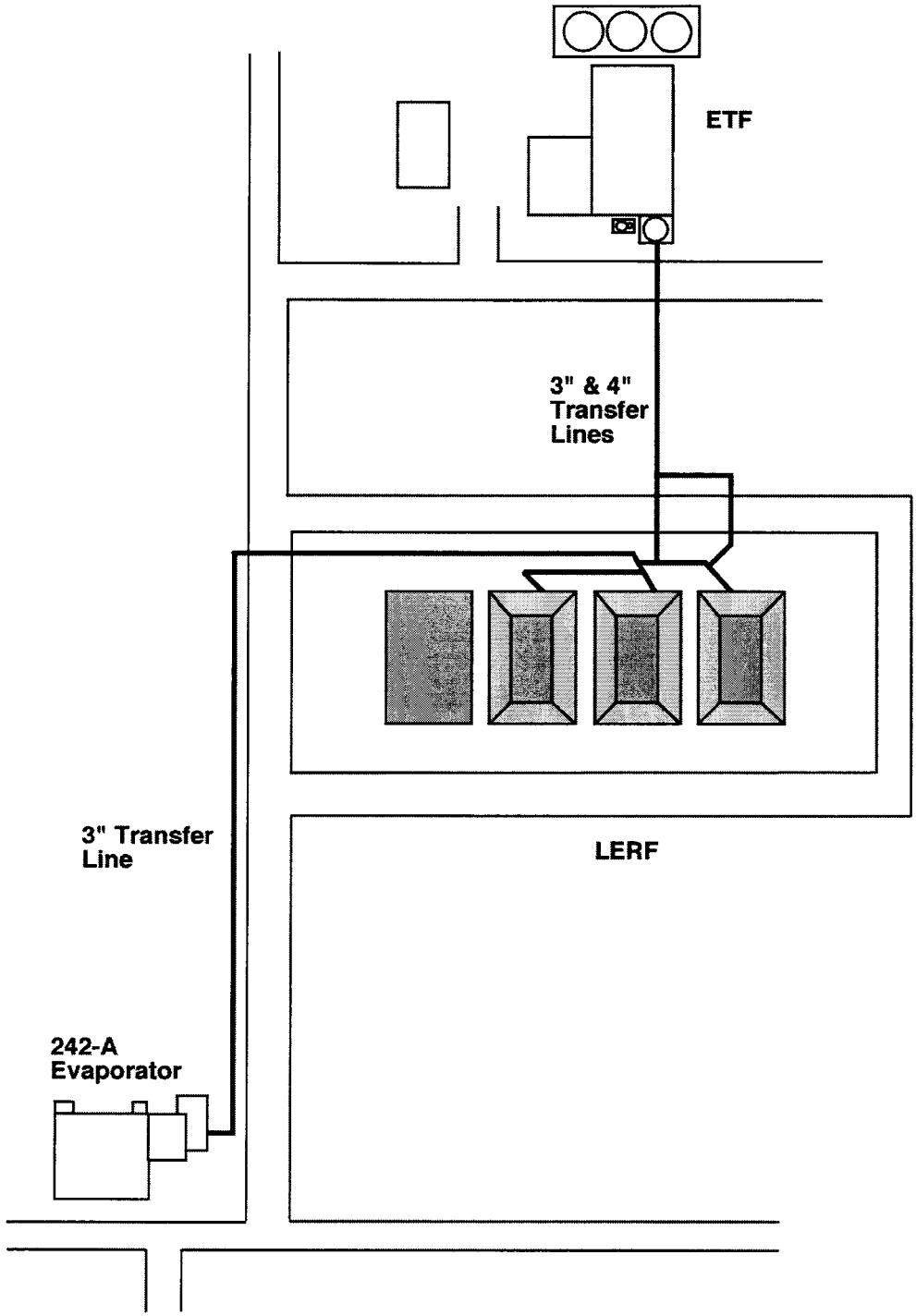
ETF Process Unit	Drawing Number	Drawing Title
Surge Tank, Process/ Container Storage Areas and Trenches - Foundation and Containment	H-2-89063, Sheet 1	Architectural/structural – Foundation and Grade Beam Plan
Sump Tank Containment	H-2-89065, Sheet 1	Architectural/structural – Foundation, Sections and Detail
Verification Tank Foundation and Containment	H-2-89068, Sheet 1	Architectural/structural – Verification Tank Foundation
Load-In Facility Foundation and Containment	H-2-817970, Sheet 1	Structural – ETF Truck Load-in Facility Plans and Sections
Load-In Facility Foundation and Containment	H-2-817970, Sheet 2	Structural – ETF Truck Load-in Facility Sections and Details

The drawings identified in Table 4.4 provide an illustration of the piping and instrumentation configuration for the major process units and tanks at the ETF, and the Load-In Tanks. Drawings of the transfer piping systems between the LERF and ETF, and between the Load-In Station and the ETF also are presented in this table. These drawings are provided for general information and to demonstrate the adequacy of the design of the tank systems.

Table 4.4. Major Process Units and Tanks at the Effluent Treatment Facility and Load-In Station

ETF Process Unit	Drawing Number	Drawing Title
Load-In Facility	H-2-817974, Sheet 1	P&ID – ETF Truck Load-In Facility
Load-In Facility	H-2-817974, Sheet 2	P&ID – ETF Truck Load-In Facility
Surge Tank	H-2-89337, Sheet 1	P&ID – Surge Tank System
UV/Oxidation	H-2-88976, Sheet 1	P&ID – UV Oxidizer Part 1
UV/Oxidation	H-2-89342, Sheet 1	P&ID – UV Oxidizer Part 2
Reverse Osmosis	H-2-88980, Sheet 1	P&ID – 1st RO Stage
Reverse Osmosis	H-2-88982, Sheet 1	P&ID – 2nd RO Stage
IX/Polishers	H-2-88983, Sheet 1	P&ID – Polisher
Verification Tanks	H-2-88985, Sheet 1	P&ID – Verification Tank System
ETF Evaporator	H-2-89335, Sheet 1	P&ID – Evaporator
Thin Film Dryer	H-2-88989, Sheet 1	P&ID – Thin Film Dryer
Transfer Piping from LERF to ETF	H-2-88768, Sheet 1	Piping Plan/Profile 4"– 60M-002-M17 and 3"-60M-001-M17
Transfer Piping from Load-In Facility to ETF	H-2-817969, Sheet 1	Civil – ETF Truck Load-In Facility Site Plan

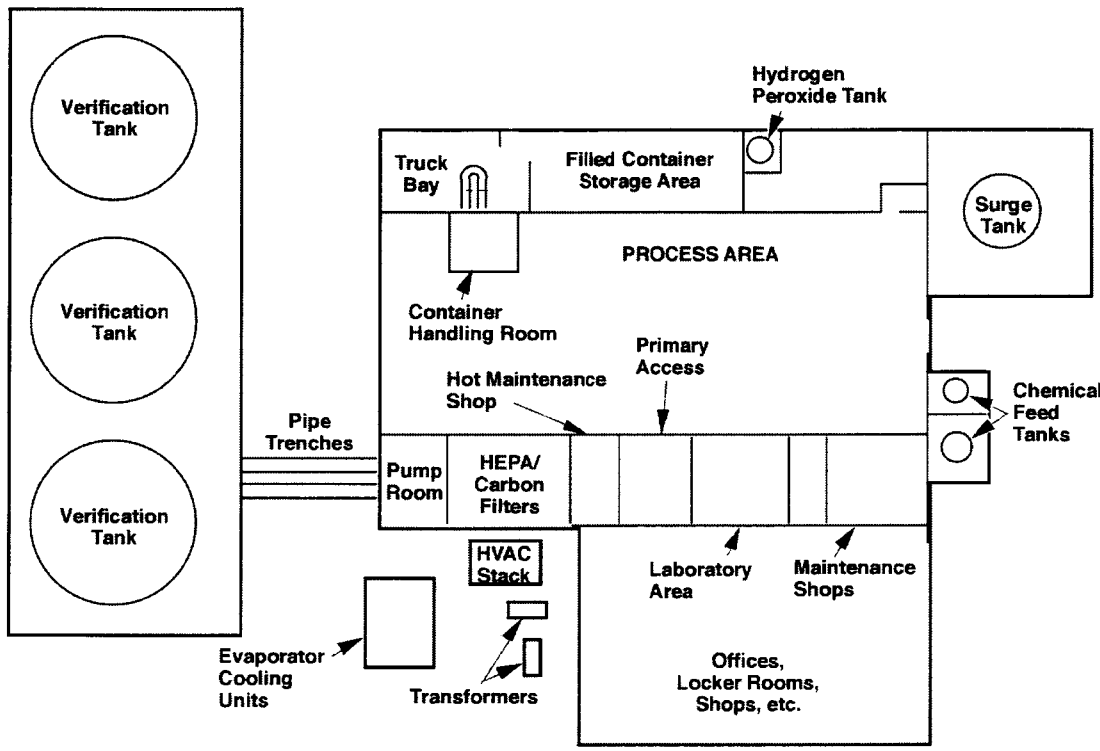
Figure 4.1. Liquid Effluent Retention Facility Layout



ETF = Effluent Treatment Facility
LERF = Liquid Effluent Retention Facility

M0704-3.5
4-21-07

Figure 4.2. Plan View of the 200 Area Effluent Treatment Facility



HEPA = High-efficiency particulate air
HVAC = Heating, ventilation, and air conditioning

M0704-3.6
4-24-07

Figure 4.3. 200 Area Effluent Treatment Facility Layout

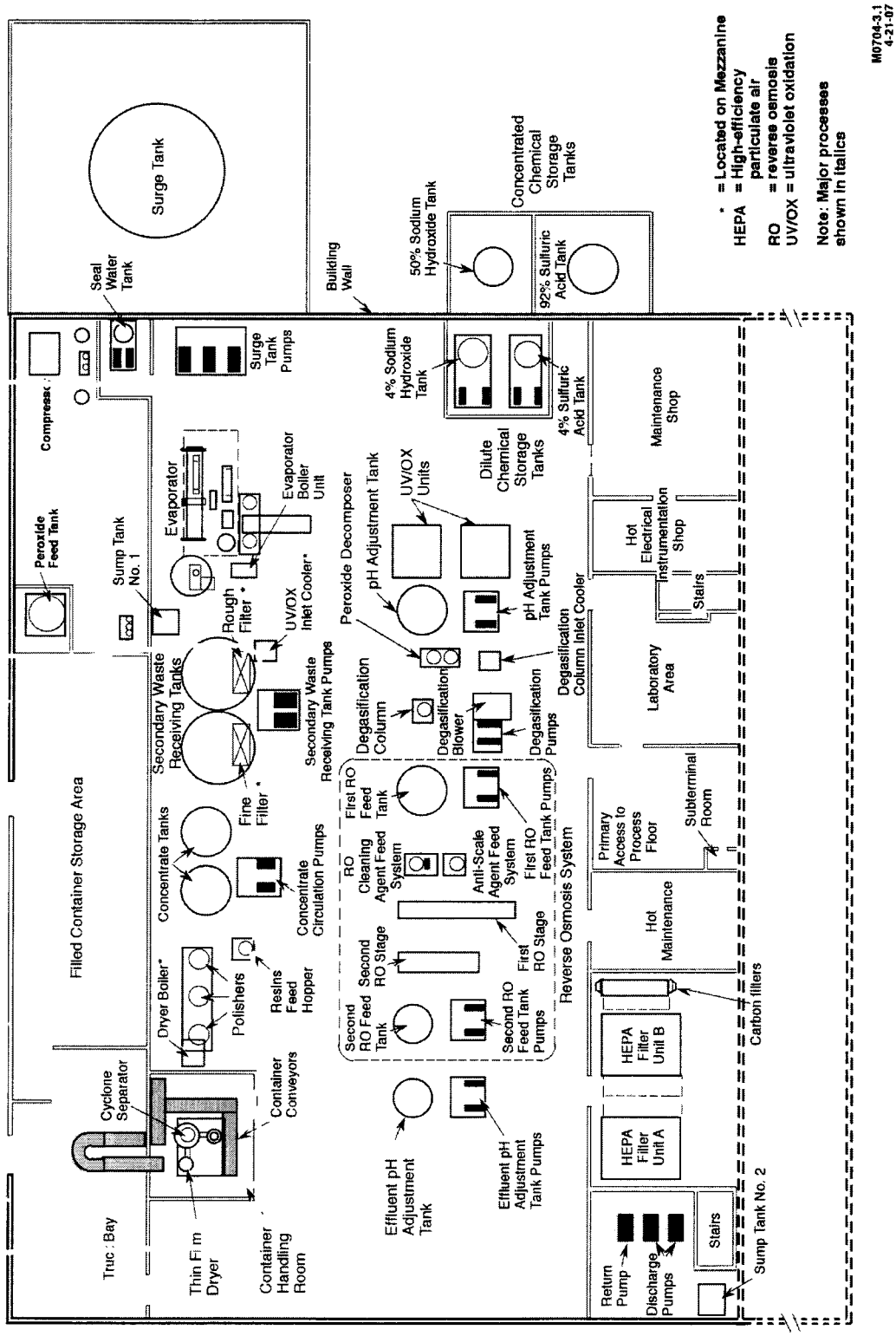
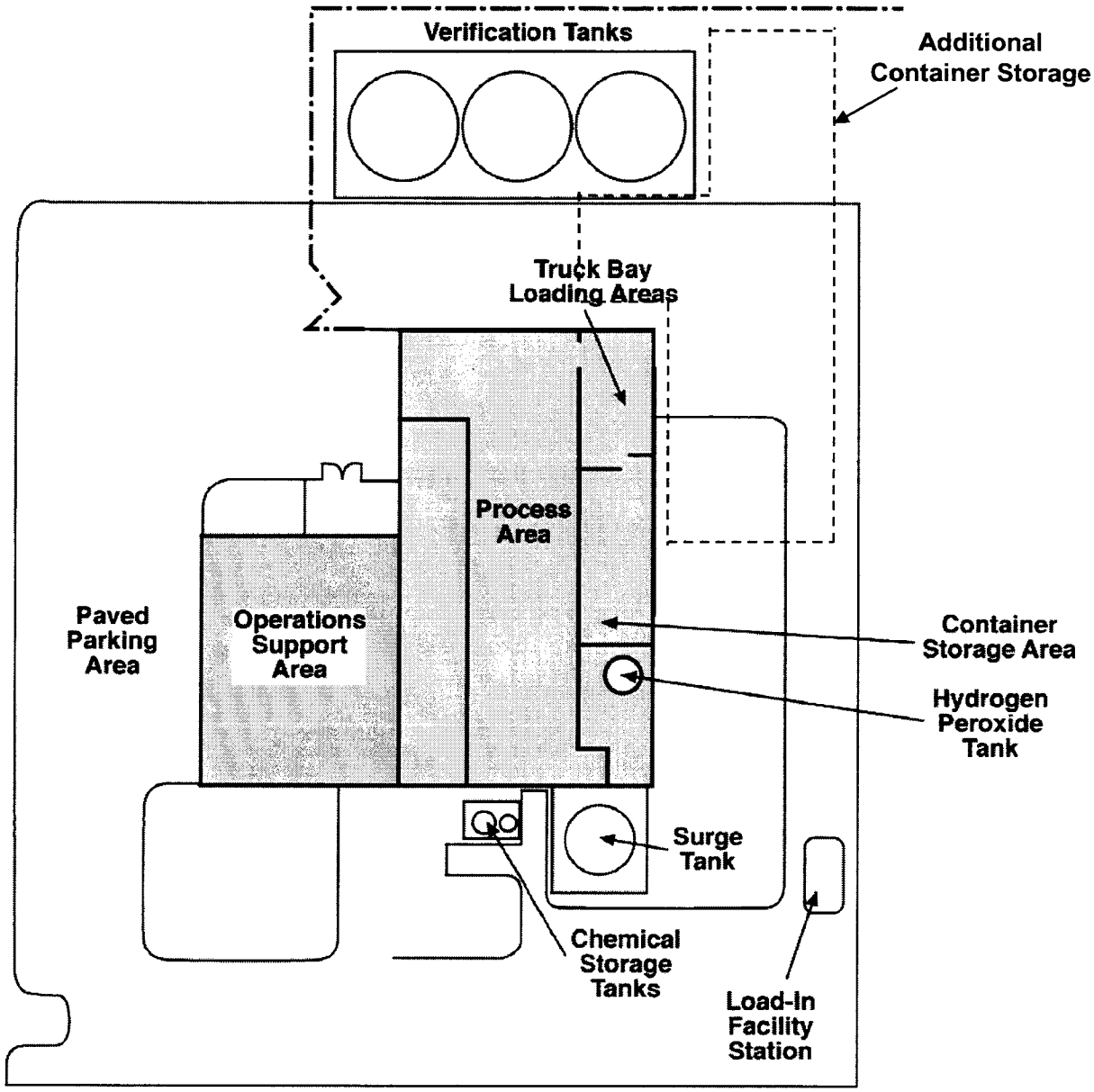
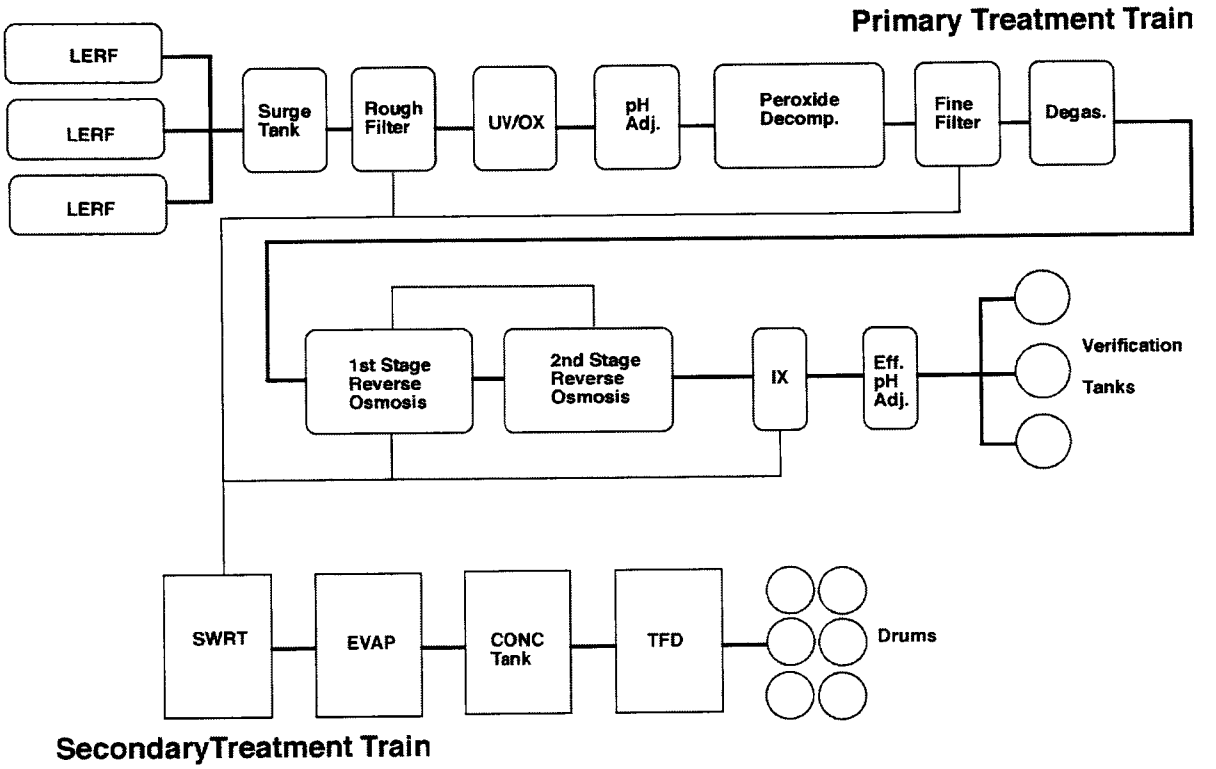


Figure 4.4. 200 Area Effluent Treatment Facility



M0704-3.4
4-21-07

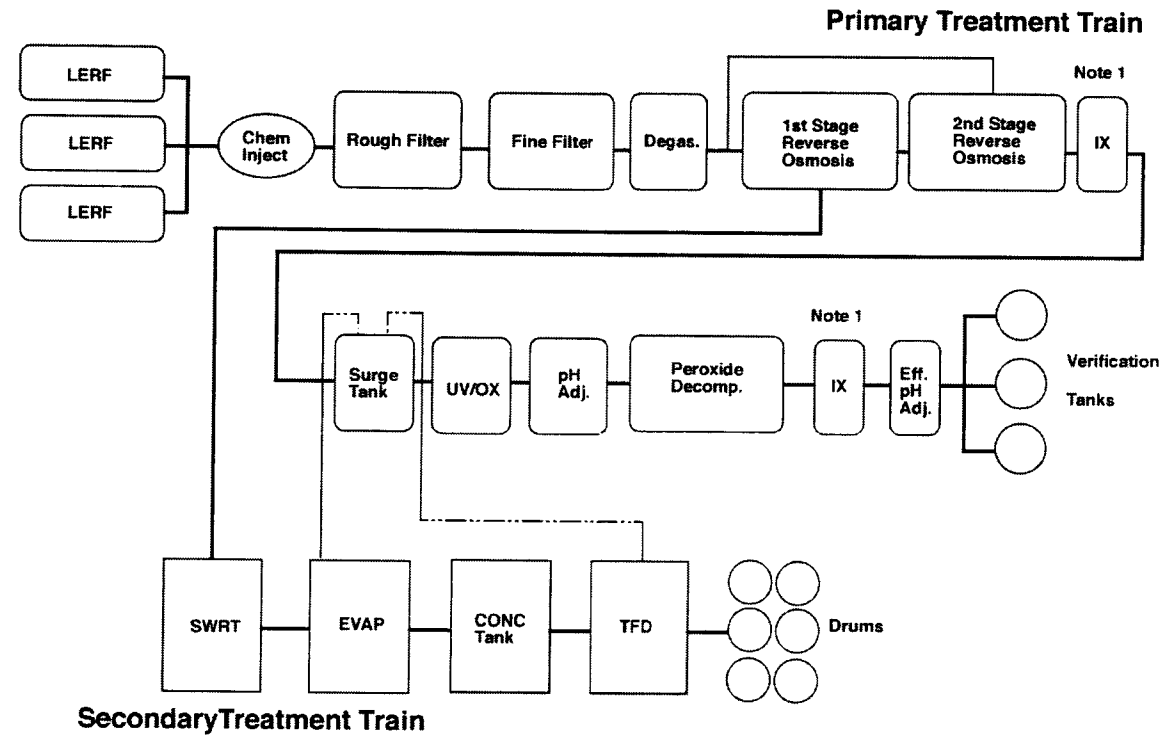
Figure 4.5. Example - 200 Area Effluent Treatment Facility Configuration 1



CONC Tank = Concentrate tank
Degas. = Degasification column
Eff. pH Adj. = Effluent pH adjustment tank
EVAP = Evaporator
IX = Ion Exchange
LERF = Liquid Effluent Retention Facility
pH Adj. = pH adjustment tank
SWRT = Secondary waste receiving tank
TFD = Thin film dryer
UV/OX = Ultraviolet Oxidation

M0704-3.8
4-21-07

Figure 4.6. Example - 200 Area Effluent Treatment Facility Configuration 2



Note1: IX can be in either location
CONC Tank = Concentrate tank
Degas. = Degasification column
Eff. pH Adj. = Effluent pH adjustment tank
Evap = Evaporator
IX = Ion exchange
pH Adj. = pH adjustment tank
SWRT = Secondary waste receiving tank
TFD = Thin film dryer
UV/OX = Ultraviolet Oxidation

M0704-3.2
4-21-07

Figure 4.7. Surge Tank

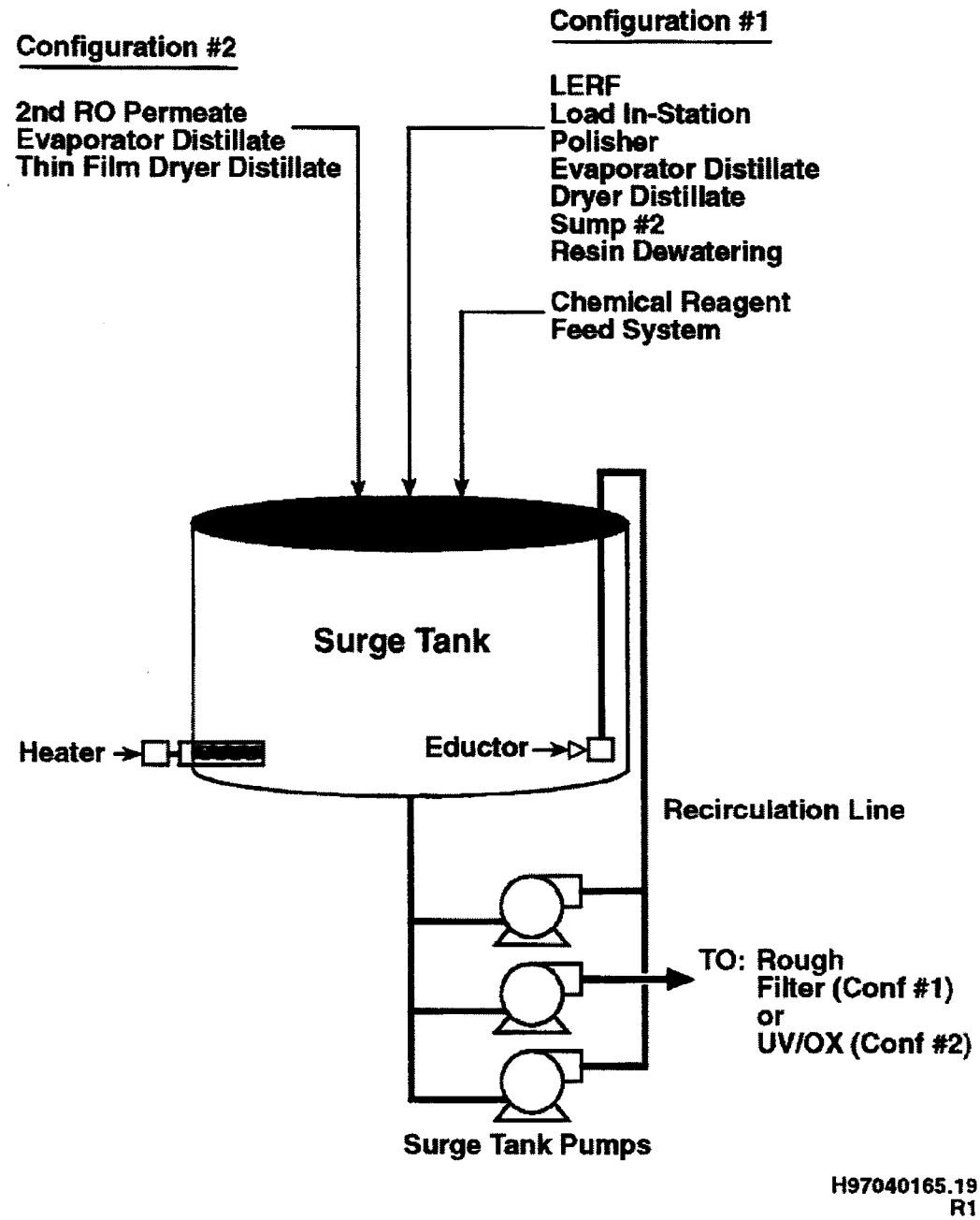
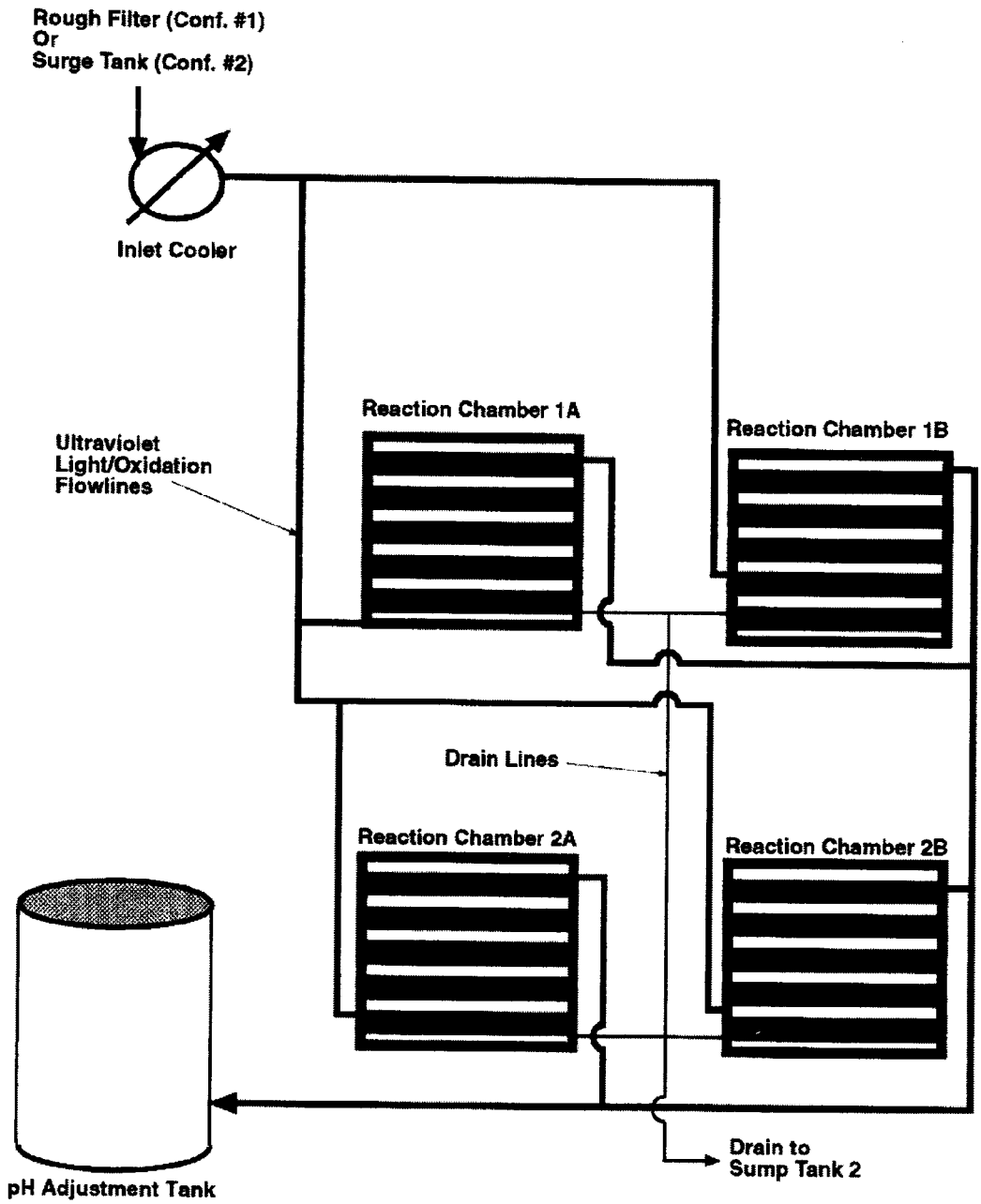


Figure 4.8. Ultraviolet Light/Oxidation Unit



H97040155.20

Figure 4.9. Reverse Osmosis Unit.

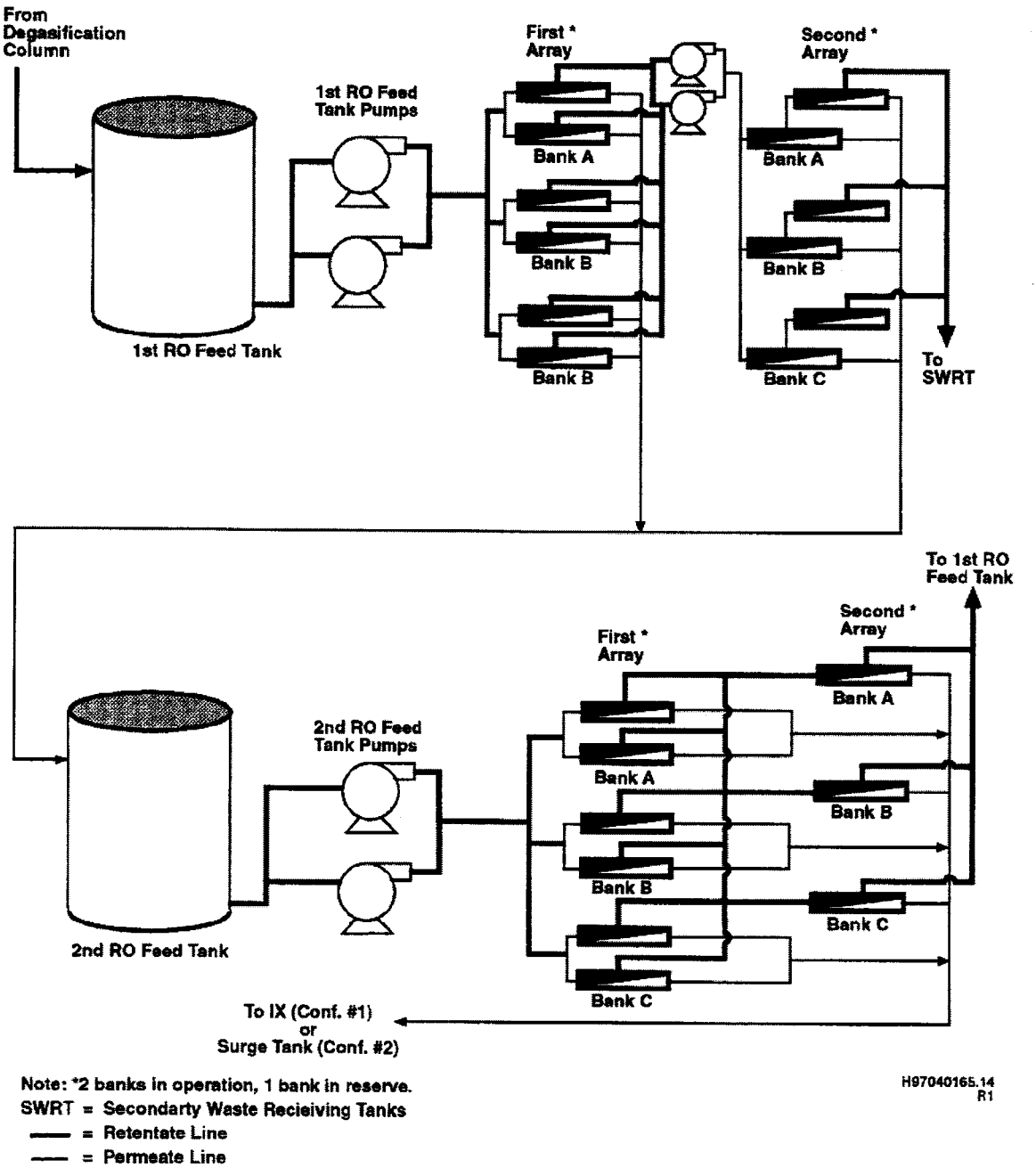
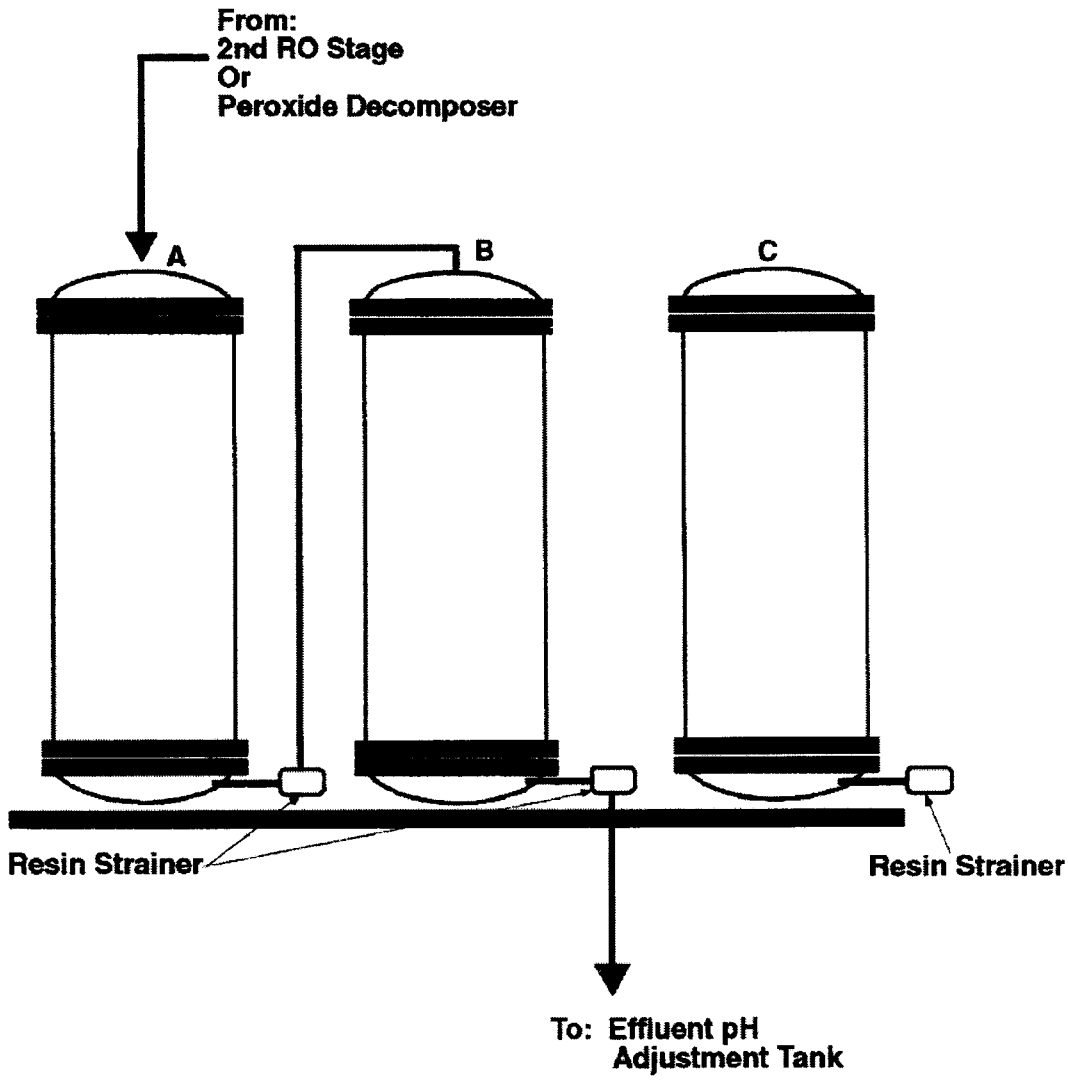


Figure 4.10. Ion Exchange Unit



NOTE: Example Configuration- Column A and B in Operation, Column C in Standby Mode

H97040165.18

Figure 4.11. Verification Tanks

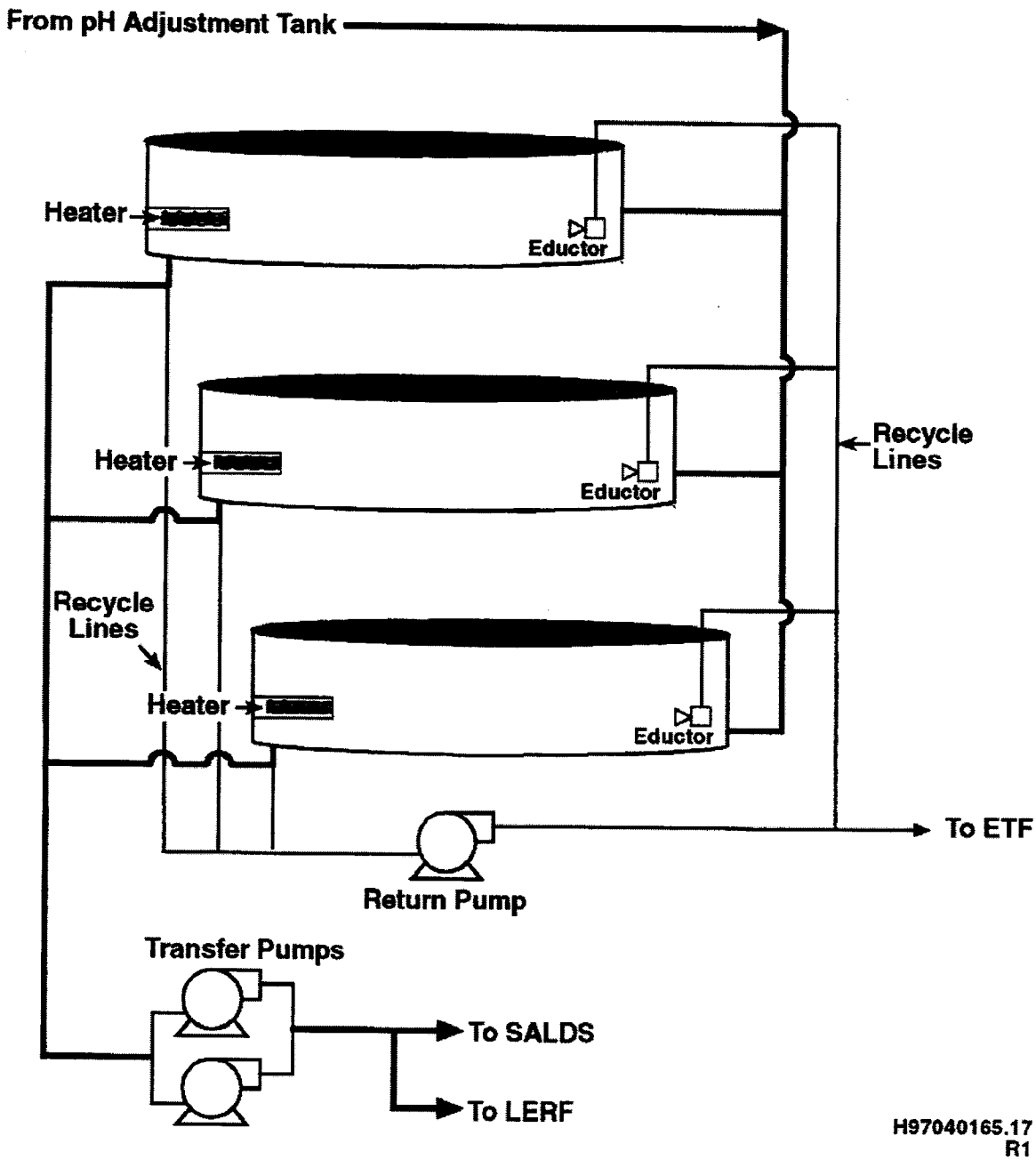


Figure 4.12. Effluent Treatment Facility Evaporator

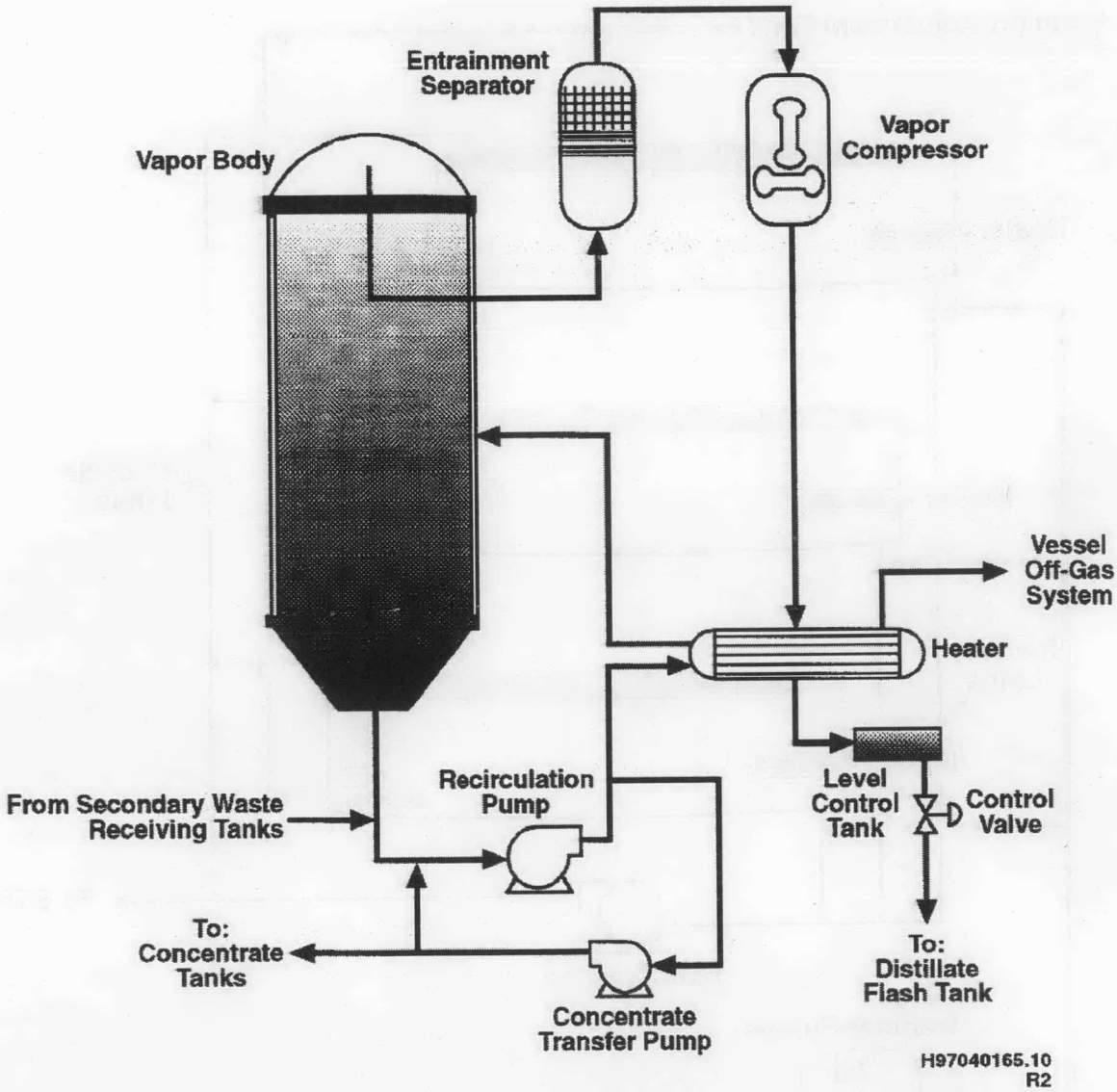


Figure 4.13. Thin Film Dryer

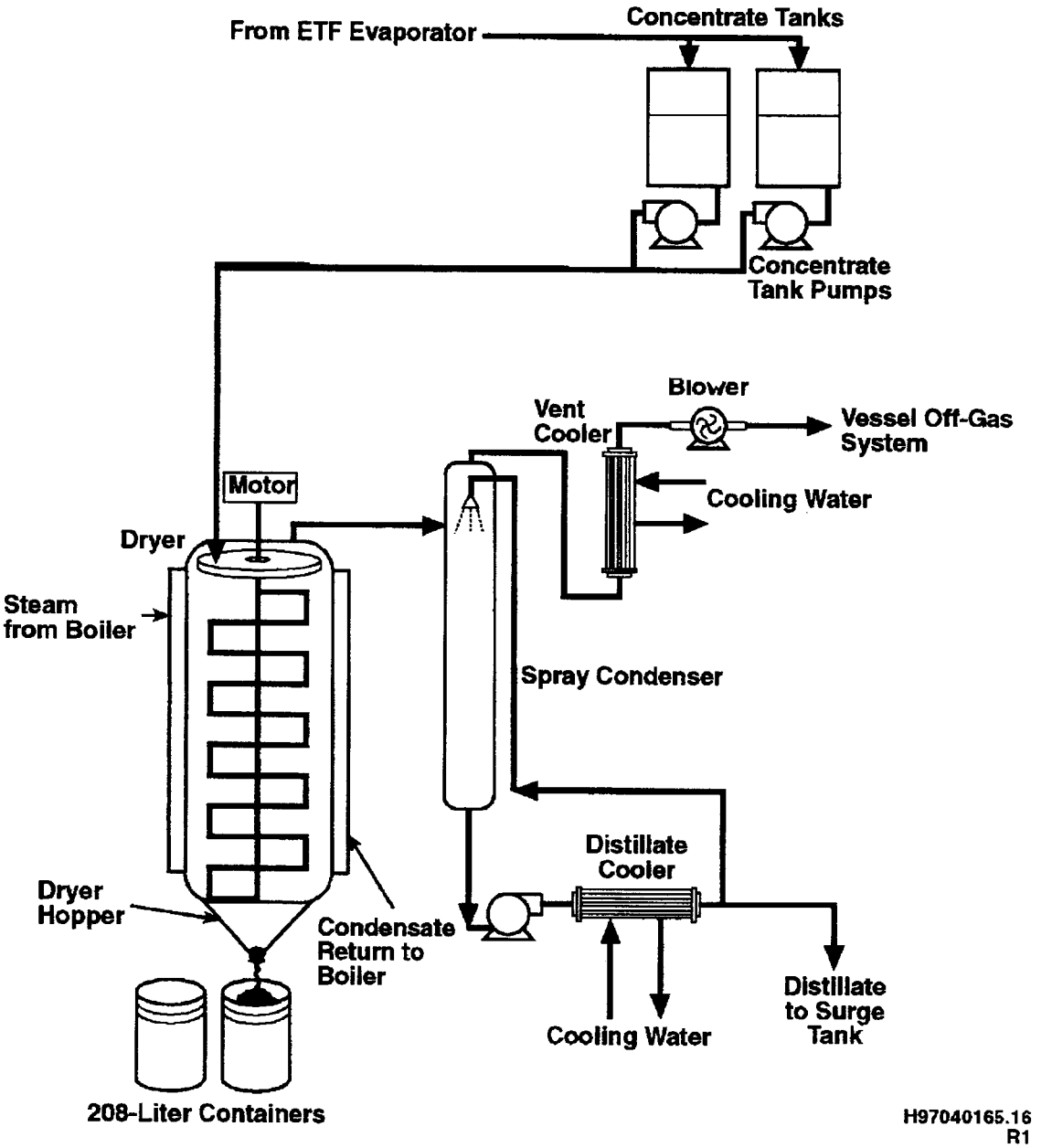
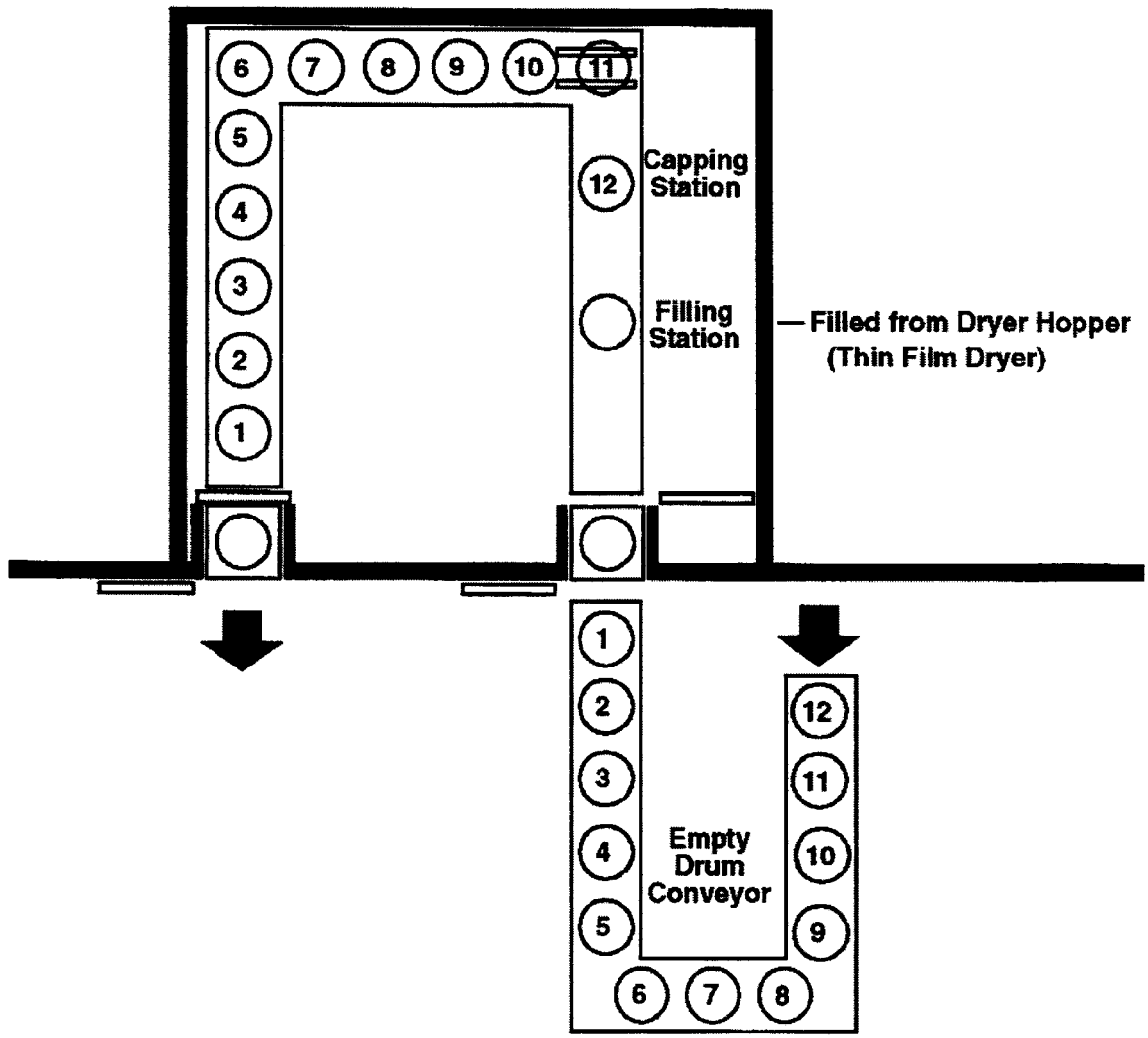


Figure 4.14. Container Handling System



H97040165.15
R1

Figure 4.15. Effluent Treatment Facility Sump Tanks

4.7.3

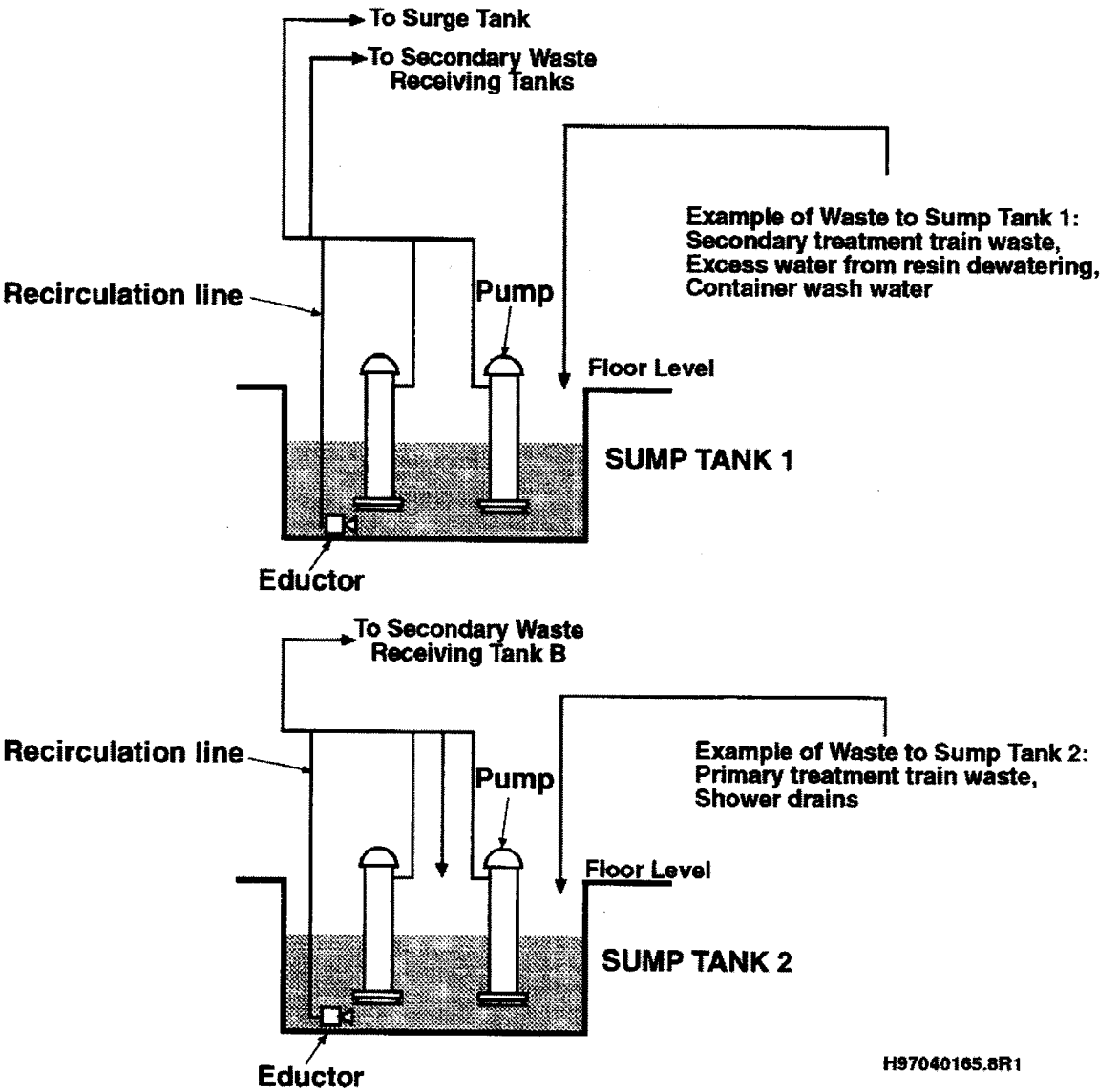


Figure 4.16. Liner Anchor Wall and Cover Tension System

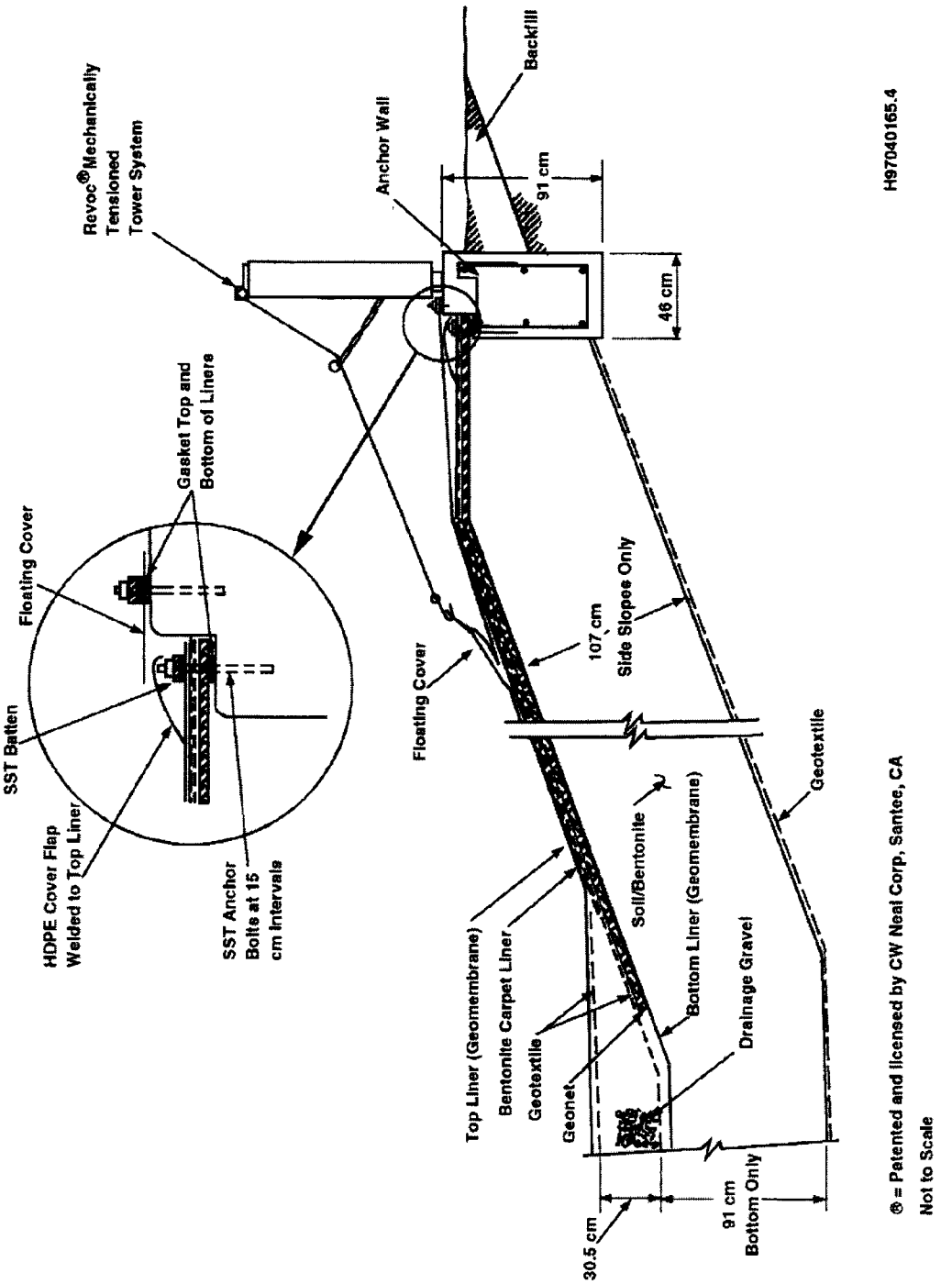


Figure 4.17. Liner System Schematic

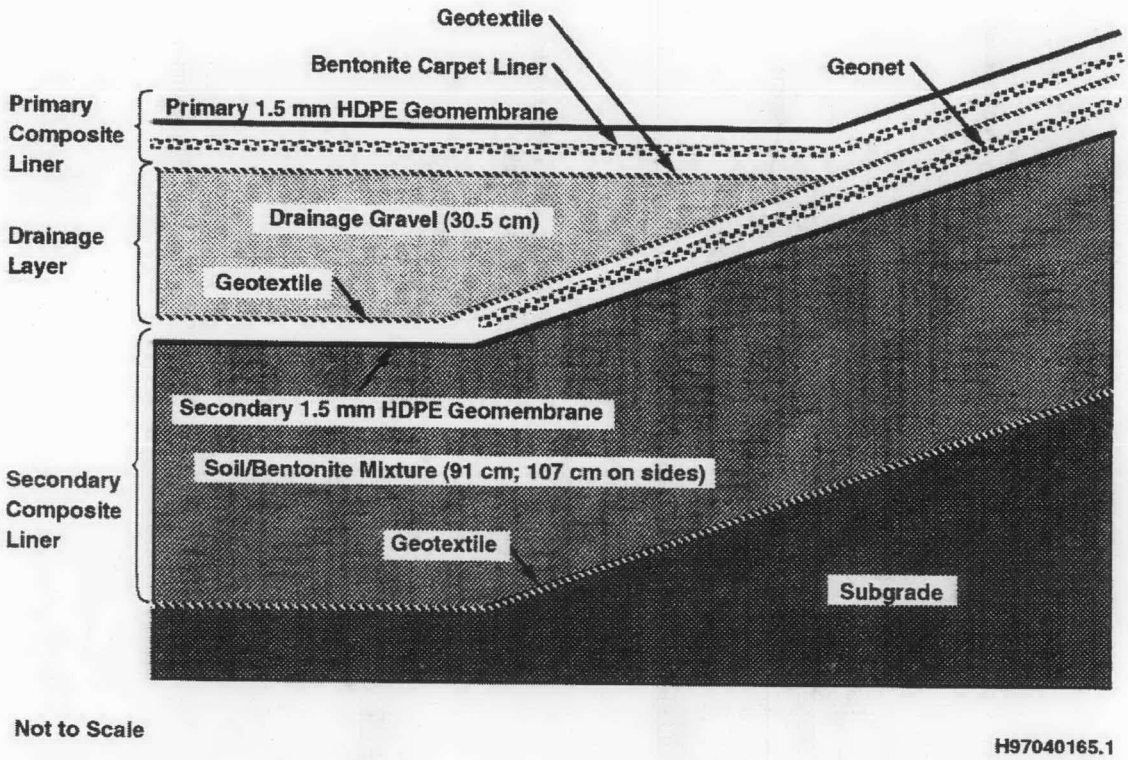


Figure 4.18. Detail of Leachate Collection Sump

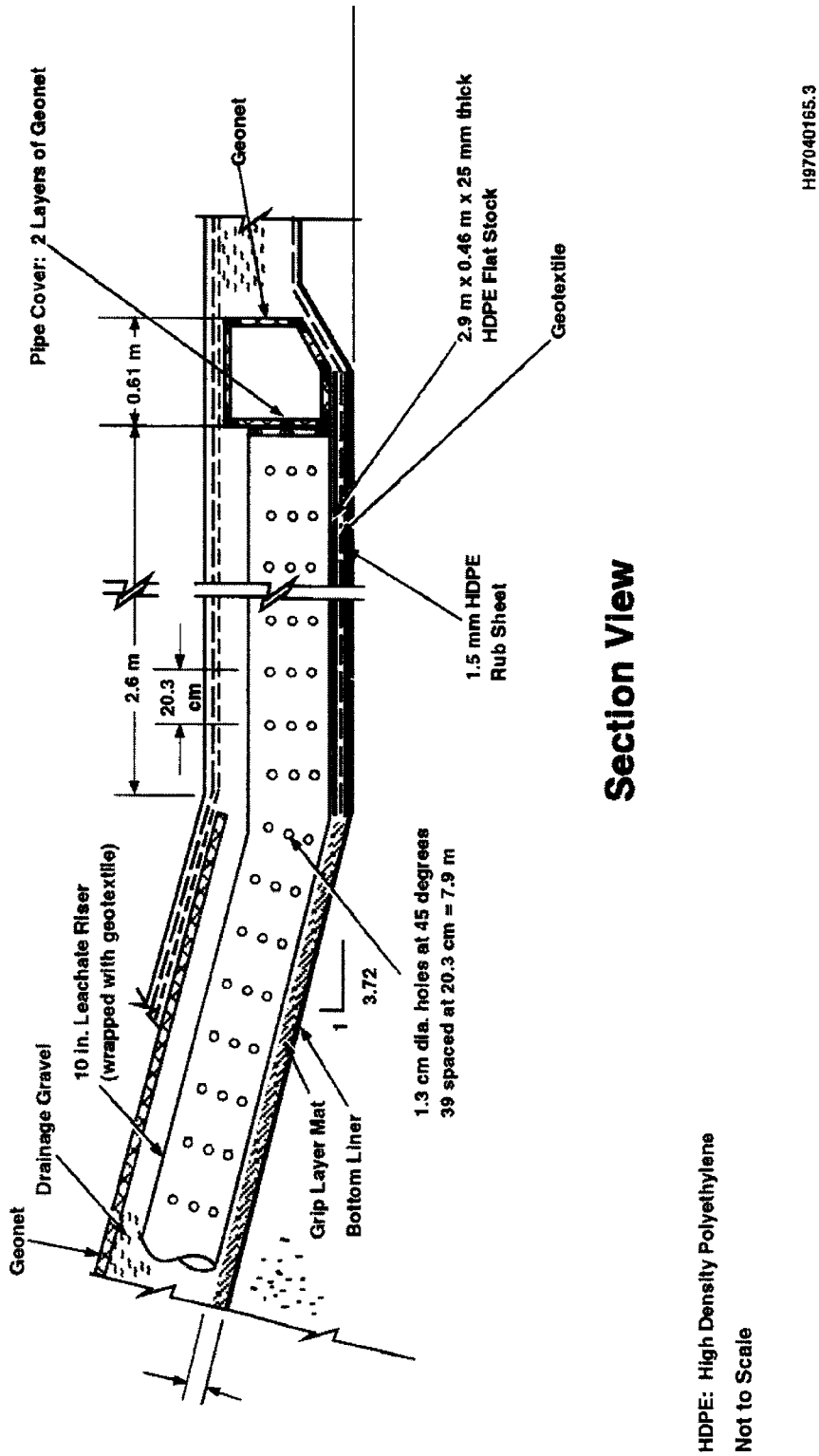


Table 4.5. 200 Area Effluent Treatment Facility Tank Systems Information

Tank Description	Material of Construction	Maximum Tank Capacity [1] liters	Inner diameter meters	Height meters	Shell Thickness [2] centimeters	Corrosion Protection [3]
Load-in tanks (2)	304 SS	37,900	3.6	4.7	0.64	Type 304 SS
Surge tank	304 SS	461,820	7.9	9.2	0.48	Type 304 SS
pH adjustment tank	304 SS	16,660	3.0	2.5	0.64	Type 304 SS
First RO feed tank	304 SS	20,440	3.0	3.2	0.64	Type 304 SS
Second RO feed tank	304 SS	7,600	Nonround tank 3.0 m x 1.5 m	1.5	0.48 w/rib stiffeners	Type 304 SS
Effluent pH adjustment tank	304 SS	14,390	2.4	3.6	0.64	Type 304 SS
Verification tanks (3)	Carbon steel with epoxy lining	2,763,340	18.3	11.4	0.79	epoxy coating
Secondary waste receiving tanks (2)	304 SS	75,700	4.3	5.7	0.64	Type 304 SS
Concentrate tanks (2)	316L SS	24,980	3.0	3.8	0.64	Type 316 SS
ETF evaporator (Vapor Body)	Alloy 625	20,800	2.4	6.8	variable	Alloy 625
Distillate flash tank	304 SS	950	Horizontal tank 0.76	Length 2.2	0.7	304 SS
Sump tank 1	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS
Sump tank 2	304 SS	4,160	1.5 x 1.5	3.4	3/16	304 SS

[1] The maximum operating volume of the tanks is identified. For the load-in tanks and the second RO feed tank, the maximum operating volume is also the operating capacity.
[2] The nominal thickness of ETF tanks is represented.
[3] Type 304 SS, 304L, 316 SS and alloy 625 provide corrosion protection.
304 SS = stainless steel type 304 or 304L.
316L SS = stainless steel type 316L.

Table 4.6. 200 Area Effluent Treatment Facility Additional Tank System Information

Tank Description	Liner Materials	Pressure Controls	Foundation Materials	Structural Support	Seams	Connections
Load-in tanks (2)	None	vent to atmosphere	concrete slab	SS skirt bolted to concrete	welded	flanged
Surge tank	None	pressure indicator/vacuum breaker valve	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
First RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Second RO feed tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel frame	welded	flanged
Effluent pH adjustment tank	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Verification tanks (3)	Epoxy	pressure indicator/filtered vent to atmosphere	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged
Secondary waste receiving tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
Concentrate tanks (2)	None	pressure indicator/vent to VOG	concrete slab	carbon steel skirt	welded	flanged
ETF evaporator (vapor body)	None	pressure indicator/vapor vent - to DFT/VOG	concrete slab	carbon steel frame	welded	flanged
Distillate flash tank	None	vent to VOG	concrete slab	carbon steel I-beam and cradle	welded	flanged
Sump tank 1	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged
Sump tank 2	None	vent to VOG	concrete containment	reinforced concrete containment basin	welded	flanged

DFT = distillate flash tank
VOG = vessel off gas system

Table 4.7. Ancillary Equipment and Material Data

System	Ancillary Equipment	Number	Material
Load-in tanks	Load-in/transfer pumps (2)	P-103A/-103B	316 SS
	Load-in filters (3)	59A-FL-001/-002/-003	304 SS
Surge tank	Surge tank pumps (3)	2025E-60A-P-1A/-1B/-1C	304 SS
Rough filter	Rough filter	2025E-60B-FL-1	304 SS
UV/OX	UV oxidation inlet cooler	2025E-60B-E-1	316 SS
	UV oxidizers (4)	2025E-60D-UV-1A/-1B/-2A/-2B	316 SS
pH adjustment	pH adjustment pumps (2)	2025E-60C-P-1A/-1B	304 SS
Peroxide decomposer	H_2O_2 decomposers (2)	2025E-60D-CO-1A/-1B	CS with epoxy coating
Fine filter	Fine filter	2025E-60B-FL-2	304 SS
Degasification	Degasification column inlet cooler	2025E-60E-E-1	316 SS
	Degasification column	2025E-60E-CO-1	FRP
	Degasification pumps (2)	2025E-60E-P-1A/-1B	316 SS
RO	Feed/booster pumps (6)	2025E-60F-P-1A/-1B/-2A/-2B/-3A/-3B	304 SS
	Reverse osmosis arrays (21)	2025E-60F-RO-01 through -21	Membranes: polyamide Outer piping: 304 SS
IX/Polishers	Polishers (3)	2025E-60G-IX-1A/-1B-1C	CS with epoxy coating
	Resins strainers (3)	2025E-60G-S-1A/-1B/-1C	304 SS
Effluent pH adjustment	Recirculation/transfer pumps (2)	2025E-60C-P-2A/-2B	304 SS/PVC
Verification tanks	Return pump	2025E-60H-P-1	304 SS
	Transfer pumps (2)	2025E-60H-P-2A/-2B	
Secondary waste receiving tanks	Secondary waste feed pumps (2)	2025E-60I-P-1A/-1B	304 SS
ETF evaporator system	Feed/distillate heat exchanger	2025E-60I-E-02	Tubes: 316 SS Shell: 304 SS
	Heater (reboiler)	2025E-60I-E-01	Tubes: alloy 625 Shell: 304 SS
	Recirculation pump	2025E-60I-P-02	316 SS
	Concentrate transfer pump	2025E-60I-P-04	316 SS
	Entrainment separator	2025E-60I-DE-01	Top section: 316 SS Bottom section: alloy 625
	Vapor compressor (incl. silencers)	2025E-60I-C-01	304 SS
	Silencer drain pump	2025E-60I-P-06	316 SS
	Level control tank	2025E-60I-TK-5	304 SS
	Distillate flash tank pump	2025E-60I-P-03	316 SS
Concentrate tanks	Concentrate circulation pumps (2)	2025E-60J-P-1A/-1B	316 SS
Thin film dryer	Concentrate feed pump	2025E-60J-P-2	316 SS
	Thin film dryer	2025E-60J-D-1	Interior surfaces: alloy 625 Rotor and blades: 316 SS
	Powder hopper	2025E-60J-H-1	316 SS
	Spray condenser	2025E-60J-DE-01	316 SS
	Distillate condenser	2025E-60J-CND-01	Tubes: 304 SS Shell: CS
	Dryer distillate pump	2025E-60J-P-3	316 SS
Resin dewatering	Dewatering pump	2025E-80E-P-1	

Table 4.8. Concrete and Masonry Coatings

Coating	Minimum wet film thickness (mil)	Percentage of film forming solids per volume (%)	Minimum dry film thickness (mil)
Concrete and masonry			
Prime: Amercoat-187*	4.5	22.0	1.0
Second: Amercoat-33	6.4	23.46	1.5
Finish: Amercoat-33	6.4	23.46	1.5
Or			
Prime: Amercoat-385	5-6	66	3-4
Topcoat: Amercoat-450HS	3-4	66	2-2.5
High traffic, container storage area			
Filler: Ameron Nu-Klad 114A**	--	100	--
Prime: Amercoat-105A	2-3	100	2-3
Topcoat: Amercoat-120	20-30	100	20-30

* Amercoat is a trademark of Ameron, Incorporation.
**Nu-Klad is a trademark of Ameron, Incorporation.

Table 4.9. Geomembrane Material Specifications

Property	Value
Specific gravity	0.932 to 0.950
Melt flow index	1.0 g/10 min., maximum
Thickness (thickness of flow marks shall not exceed 200% of the nominal liner thickness)	60 mil 310% (1.5 mm 3 10%)
Carbon black content	1.8 to 3%, bottom liner 2 to 3% top liner
Tensile properties (each direction)	
• Tensile strength at yield	21.5 kgf/cm width, minimum
• Tensile strength at break	32.2 kgf/cm width, minimum
• Elongation at yield	10%, minimum
• Elongation at break	500%, minimum
Tear resistance	13.6 kgf, minimum
Puncture resistance	31.3 kgf, minimum
Low temperature/brittleness	-400 C, maximum
Dimensional (%change each direction)	32%, maximum
Environmental stress crack	750 h, minimum
Water absorption	0.1 maximum and weight change
Hydrostatic resistance	316,000 kgf/m^2
Oxidation induction time (200 C/l atm. O_2)	90 minutes

Reference: Construction Specifications (KEH 1990b). Format uses NSF 54 table for high-density polyethylene as a guide (NSF 1985). However, RCRA values for dimensional stability and environmental stress crack have been added.

%	=	percent	max	=	maximum
g	=	gram	kgf	=	kilograms force
min	=	minute	m	=	meters
h	=	hour	mm	=	millimeters

Table 4.10. Drainage Gravel Specifications

Property	Value
Sieve size	
25 millimeters	100 wt% passing
19 millimeters	80 – 100 wt% passing
9.5 millimeters	10 – 40 wt% passing
4.75 millimeters	0 – 4 wt% passing
Permeability	0.1 cm/sec, minimum

Reference: Sieve size is from WSDOT M41-10-88, Section 9.03.1(3)C for Grading No. 5 (WSDOT 1988). Permeability requirement is from WAC 173-303-650(2)(j) for new surface impoundments.

This page intentionally left blank.

D. GROUNDWATER MONITORING PLAN, LIQUID EFFLUENT RETENTION FACILITY D.1

D.1 INTRODUCTION D.1
D.1.1 History of Groundwater Monitoring at the Liquid Effluent Retention Facility D.1
D.1.2 Facility Description D.1
D.1.3 Physical Structure D.1
D.1.4 Operational History D.2
D.1.5 Waste Characteristics D.2

D.2 HYDROGEOLOGY AND GROUNDWATER-CHEMISTRY D.2
D.2.1 Geology D.2
D.2.1.1 Hanford Formation D.3
D.2.1.2 Ringold Formation D.3
D.2.1.3 Elephant Mountain Member D.3
D.2.2 Groundwater Hydrology D.3
D.2.2.1 Aquifer Properties D.4
D.2.2.2 Flow Dynamics D.5
D.2.3 Groundwater Chemistry D.6
D.2.4 Well Completions and Conditions D.6

D.3 GROUNDWATER-MONITORING PROGRAM D.7
D.3.1 Objectives of Dangerous Waste Groundwater Monitoring D.7
D.3.2 Dangerous Constituents D.8
D.3.3 Concentration Limits D.8
D.3.4 Groundwater Monitoring System and Point of Compliance D.8
D.3.5 Compliance Period D.8
D.3.6 Sampling and Analysis D.8
D.3.6.1 Monitoring Parameters D.9
D.3.6.2 Sampling Frequency D.9
D.3.6.3 Sampling Procedures D.9
D.3.6.4 Sample Chain-of-Custody D.10
D.3.7 Decontamination of Drilling and Sampling Equipment D.10
D.3.8 Quality Objectives and Criteria D.11
D.3.9 Analytical Procedures D.11
D.3.9.1 Quality Control D.11
D.3.10 Data Management D.12
D.3.10.1 Loading Data D.12
D.3.10.2 Data Review, Verification, Validation, and Usability D.12
D.3.10.3 Data Review Corrective Actions D.13
D.3.11 Statistical Analysis of Groundwater Monitoring Data D.13
D.3.12 Reporting and Recordkeeping D.15
D.3.13 Evaluation and Notification D.15

D.4 COMPLIANCE-MONITORING PROGRAM D.16

D.5 CORRECTIVE-ACTION PROGRAM D.16

D.6 REFERENCES D.30

Figures

Figure D.1 LERF Location Map Showing Revised Unconfined Aquifer Thickness D.23

Tables

Table D.1 Pertinent Information for Monitoring Wells in LERF D.17

Table D.2 Groundwater Flow Characterization Results Based on Trend Surface Analysis or Three-Point Solution of Well Water Level Measurements in LERF and Surrounding Area[a] D.17

Table D.3 Dangerous Constituents for Groundwater Monitoring Based on Comparisons to Basin 42, 43, and 44 Chemistry D.18

Table D.4 Dangerous Constituents and Indicators to be Analyzed as Indicators of Groundwater Contamination at the LERF Basins D.18

D. GROUNDWATER MONITORING PLAN, LIQUID EFFLUENT RETENTION FACILITY

This document describes a groundwater monitoring program for the Liquid Effluent Retention Facility (LERF). The LERF is a regulated unit under the *Hazardous Waste Management Act* [*Revised Code of Washington* (RCW) 70.105] and is subject to groundwater monitoring requirements pursuant to *Washington Administrative Code* [(WAC) 173-303-645].

D.1 INTRODUCTION

This plan describes the LERF groundwater monitoring program, including the monitoring network, constituent list, sampling schedule, sampling and analysis protocols, and data evaluation and reporting methods for LERF groundwater monitoring. Four monitoring wells at LERF (299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79) establish a monitoring network compliant with the requirements of the Permit (WAC 173-303-645).

D.1.1 History of Groundwater Monitoring at the Liquid Effluent Retention Facility

A groundwater monitoring program was established at LERF in 1990 before final construction of the regulated unit. Samples were collected quarterly from four monitoring wells (one upgradient and three down-gradient from the LERF), and evaluation of indicator parameters began before waste was transferred to the basins. Analytes listed in 40 *Code of Federal Regulations* (CFR) 264, Appendix IX; groundwater quality parameters; and several site-specific constituents were analyzed the first year of sample collection. Total organic carbon, total organic halides, pH, and specific conductivity (indicator parameters) were also analyzed during the first year; upgradient/downgradient comparison values were calculated for these parameters based on requirements of 40 CFR 265 Subpart F- Groundwater Monitoring. Detection monitoring continued on a semi-annual schedule. Two wells, 299-E26-9 and 299-E35-2, could no longer yield representative samples of groundwater in 1999 and 2001, respectively, due to declining water levels. These wells went dry in 2002 and 2005. Inter-well statistical evaluation of LERF groundwater monitoring data has not been performed since 2001. Sampling continued at former down-gradient well 299-E26-10 and former upgradient well 299-E26-11. Wells 299-E26-77 and 299-E26-79 were drilled and construction was completed in 2008 (*Borehole Summary Report for the Installation of RCRA Wells, FY 2008* [Sexton 2008]). These wells are located west and south of LERF, respectively, and were sampled concurrently with existing wells beginning in January 2009.
A groundwater evaluation was conducted during and subsequent to installation of the new wells, and the results indicate that the four wells form an adequate monitoring network capable of yielding representative samples of the uppermost hydrostratigraphic unit laterally continuous under the LERF basins (*Liquid Effluent Retention Facility Characterization Report* [Smoot 2009]).

D.1.2 Facility Description

This section provides an overview of the physical structures, operational history, and waste characteristics for the LERF. Additional details are provided in Chapter 3.0, Waste Analysis and Chapter 4.0, Process Information.

D.1.3 Physical Structure

The LERF is located in the central portion of the Hanford Site on the eastern boundary of the 200 East Area (Figure D.1). Construction of the LERF was completed in 1991. The LERF consists of three dangerous waste management units classified as a surface impoundment: Basins 42, 43, and 44.

The LERF is a 15.8-hectare (39-acre) site with three 2.9 x 10^7-liter (7.7-million-gallon) capacity basins. The basins are arranged side by side with 18.2-meter (60-feet) separation between each basin. The dimensions of each basin (cell) are 100.5 by 82.2 meters (330 by 270 feet), with a maximum fluid depth of 6.7 meters (22 feet). The side slopes of the basin have a slope ratio of 3:1.

The primary liner for each basin is a 60-mil, high-density polyethylene (HDPE) geomembrane laid directly over a manufactured geotextile/bentonite carpet layer. The secondary liner is also a 60-mil HDPE geomembrane laid directly on 0.9 meters (36 inches) of a soil/bentonite mixture. The liners are

separated by a synthetic drainage geonet laid on the sides of the basins, with 0.3 meters (12 inch) of drainage gravel at the bottom. The sides slope to a sump, which is pumped when the liquid level reaches approximately 28 centimeters (11 inches) and shuts off when it drops to 18 centimeters (7 inches).

D.1.4 Operational History

The LERF was constructed to manage 242-A evaporator process condensate. Since the completion of the 200 Area Effluent Treatment Facility (ETF), the LERF stores liquid wastes for operations at the ETF and related activities. The LERF basins have also been identified to provide storage capacity for other Hanford Site projects involving contaminated waste streams.

The first 242-A evaporator waste reduction campaign, and transfer of wastewater to LERF, began in April 1994. Future waste streams will be identified for management in LERF as cleanup activities at Hanford progress.

D.1.5 Waste Characteristics

The ETF was designed to treat a variety of aqueous wastes containing both chemical and radiological contaminants. They include, but are not limited to, the following Hanford wastes: 242-A evaporator process condensate; contaminated groundwater from pump-and-treat remediation activities; laboratory aqueous waste from unused samples and sample analyses; and leachate from landfills, such as Trenches 31 and 34 in 218-W-5 burial ground, and the Environmental Restoration Disposal Facility. Waste characteristics acceptable for management at LERF and the 200 Area ETF are defined by the requirements of Chapter 3.0, Waste Analysis Plan.

Influent samples from the ETF and the 242-A Evaporator effluent, and basin samples provide information on the types and concentrations of dangerous constituents in the wastes. These data are maintained in the Hanford Facility Operating Record, LERF and 200 Area ETF file, and in the Hanford Environmental Information System (HEIS) database and were reviewed to evaluate and select dangerous constituents, as well as indicator parameters for groundwater monitoring at LERF. If the waste acceptance criteria for the LERF basins are modified, the LERF Groundwater Monitoring Plan will be evaluated and if necessary, a permit modification will be requested.

D.2 HYDROGEOLOGY AND GROUNDWATER-CHEMISTRY

This section describes the geology, hydrogeology, and groundwater chemistry beneath the LERF area.

D.2.1 Geology

The geology near the LERF consists of Columbia River Basalt overlain by a series of sedimentary units of the Ringold Formation and Hanford formation. This discussion is primarily based on information from *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports* (Delaney et al. 1991); *Site Characterization Report for the Liquid Effluent Retention Facility* (Sweeney et al. 1994); *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington* (Williams et al. 2000); and on the results from the groundwater evaluation performed in 2008 and 2009 (Smoot 2009). The terrain surrounding the LERF is flat to slightly undulating, and the average elevation is approximately 195 meters (640 feet) above mean sea level (msl). The LERF lies in the Pasco Basin, between the axis of the Umtanum-Gable Mountain anticlinal ridge and the axis of the Cold Creek syncline.

The stratigraphy beneath the LERF is interpreted from the four boreholes drilled to construct the original groundwater monitoring network, in addition to the two new wells constructed in 2008. Correlations were also made with data from nearby sites. The thickness of the sediments near the LERF basins is about 61 meters (200 feet). Three principal stratigraphic units present near the LERF are the Hanford formation, the Ringold Formation, and the Elephant Mountain Member of the Saddle Mountains Basalt.

D.2.1.1 Hanford Formation

The Hanford formation in the vicinity of the LERF ranges from approximately 59 to 61 meters (193 to 200 feet) thick and consists predominantly of a loose, sandy, pebble-cobble gravel; and a gravelly sand, with occasional layers of sand and/or muddy sand. The Hanford formation is subdivided into an upper gravel sequence (Hug), a sandy sequence (Hs), and a lower gravel sequence (Hlg) in some areas. The sandy sequence is present locally, and where it is missing, the single sequence of gravel-dominated facies exists, designated as undifferentiated (Hun) on the cross-sections.

The LERF is located along the southern flank of a major west-northwest/east-southeast trending cataclysmic flood channel. Because of multiple flood events and the turbulence and extremely high-energy associated with these floods, it is difficult to correlate individual strata within flood sequences. In outcrops of the Hanford formation elsewhere in the Pasco Basin, for example, it is common to see changes from gravel-dominated sediments to sand- and silt-dominated sediments over a distance of a few tens of meters.

D.2.1.2 Ringold Formation

The Ringold Formation represents ancient fluvial and lacustrine deposits associated with the ancestral Columbia River and the formation exhibits consolidation and weathering. Isolated, erosional remnants of the Ringold Formation may exist locally between the Hanford formation and the basalt beneath the LERF. The *200 East Groundwater Aggregate Area Management Study Report* (U.S. DOE 1993) reported approximately 2.74 meters (9 feet) of the Ringold Lower Mud Unit in well 299-E26-11 and mapped the Lower Mud Unit extending to this location from the east. This also has been interpreted as a possible saprolite (residual mud) resulting from weathering of the Elephant Mountain Member flow top. Thin (few meters or less) pockets of Ringold Formation also occur to the south near well 299-E25-9.

D.2.1.3 Elephant Mountain Member

The nature and extent of the Elephant Mountain Member basalt is better understood as the result of characterization performed in 2008 near the LERF basins. This is one of the youngest members of the Saddle Mountains Basalt and is the uppermost basalt in this area. In the immediate vicinity of the LERF basins, the basalt surface consists of a ridge on approximately the same trend as Gable Mountain and Rattlesnake Mountain. This portion of basalt appears to be fractured, vesicular, and permeable, suggesting that it is basalt flow top. The Elephant Mountain Member basalt was encountered in all six wells drilled near the LERF. The Elephant Mountain Member basalt dips to the south with a gradient of approximately 2×10^{-2}.

The Elephant Mountain Member flow top is composed of basalt rubble, reddish-brown weathered basalt, broken or cracked basalt, and vesicular basalt. Results of drilling and sampling of wells 299-E26-77 and 299-E26-79 in 2008 indicate the presence of permeable basalt in the lower portion of the unconfined aquifer. The thickness of the flow top ranges from 2 meters (6.5 feet) at well 299-E26-77 (west of the LERF) to 3.2 meters (10.5 feet) at well 299-E26-79 (south of the LERF), and 1.5 meters (5 feet) at well 299-E26-11 (east of LERF).

The interior of the Elephant Mountain Member is intact. Observations of drilling at wells 299-E26-77 and 299-E26-79, where drilling slowed dramatically approximately 5.5 to 6.1 meters (18 to 20 feet) below the first encounter of basalt, indicated the presence of competent basalt colonnade or entablature. This observation is confirmed regionally in other wells, including 699-47-42 and 299-E26-8.

D.2.2 Groundwater Hydrology

The vadose zone beneath the LERF is in the Hanford formation and portions of the Elephant Mountain Member basalt above the water table, as well as potentially some of the Ringold Formation near well 299-E26-11. There are no perched water table conditions observed near the LERF basins. The uppermost aquifer directly beneath the LERF consists of thin aquifer(s) in the Hanford formation, and Elephant Mountain Member flow top. The aquifer in the Hanford formation is unconfined; however, recent analysis of water-level data for barometric pressure responses indicates that the aquifer near well

299-E26-11 is semi-confined. Well 299-E26-11 is still considered capable of yielding representative samples from the same hydro-stratigraphic unit as the other three wells associated with the LERF groundwater monitoring program.

Well construction details are discussed in Section D.2.4. New wells 299-E26-77 and 299-E26-79 were drilled into and completed in the Elephant Mountain Member flow top. The wells produce 22.7 to 30.3 liters per minute (6 to 8 gallons per minute), which is sufficient for geochemical sampling, and the flow top is sufficiently permeable for adequate hydraulic connection with the overlying sediments.

Basalt flow top fracturing, brecciation, and/or weathering provide localized zones of higher permeability. Where these conditions exist and are in hydraulic communication with overlying saturated sediments, the basalt flow top is part of the overlying unconfined aquifer system. Based on evaluations of drill cuttings, drilling rates, and water production noted during drilling wells 299-E26-77 and 299-E26-79, the Elephant Mountain Member flow top functions as a component of the unconfined aquifer and forms a laterally continuous aquifer beneath the LERF.

The uppermost aquifer increases in thickness to the south (Figure D.1) due to the south-dipping structure of the Elephant Mountain Member. The flow interior of the Elephant Mountain Member represents the lower boundary of the uppermost aquifer. This was verified by observations of drilling at wells 299-E26-77 and 299-E26-79, as discussed in Section D.2.1.3. The revised aquifer thickness map reflecting results of drilling and sampling in 2008 is shown in Figure D.1.

D.2.2.1 Aquifer Properties

Transmissivity values determined from early tests conducted in the LERF wells were reported in Sweeney et. al. (1994). Values ranged from 11 to 230 meters^2 per day (118 to 2,476 feet^2 per day) for well 299-E26-9 (now dry), resulting in equivalent hydraulic conductivity of approximately 6 to 120 meters per day (20 to 394 feet per day), assuming an aquifer thickness of 2 meters (6.6 feet). The transmissivity value for both wells 299-E26-11 and 299-E35-2 (now dry) was 6 meters^2 per day (64.6 feet^2 per day). Data were not obtained for well 299-E26-10 during these early testing activities.

Hydrologic tests were conducted in 2003 at wells 299-E26-10 and 299-E26-11. An analysis of the results of slug tests indicates that hydraulic conductivity at well 299-E26-10 ranged from 35 to 55 meters per day (115 to 180 feet per day); and well 299-E26-11 had a hydraulic conductivity of approximately 5 to 7 meters per day (16 to 23 feet per day). A constant-rate discharge test conducted in well 299-E26-10 resulted in a hydraulic conductivity value of approximately 36 meters per day (118 feet per day) and a specific yield of 0.13. No hydraulic boundaries or response characteristics indicative of detachment or perched-water conditions were exhibited during the performance of the constant-rate pumping test. These results suggest that the saturated sediments of the Hanford formation at this location are part of the larger, site wide unconfined aquifer system. Detailed discussions pertaining to these tests are contained in *Results of Detailed Hydrologic Characterization Tests – Fiscal Year 2003* (Spane and Newcomer 2004).

Hydrologic tests were conducted in the two new wells and in well 299-E26-11. Water-level drawdown was also measured during well development. Slug testing was performed in November 2008, and the results of the tests were analyzed.

In well 299-E26-77, a total of 1,442 liters (381 gallons) were pumped during development, at a maximum rate of 22 liters per minute (5.8 gallons per minute), for a total of 59 minutes. Drawdown, measured using an electronic water meter, ranged from 0.9 to 1.1 meters (2.9 to 3.5 feet) at the maximum rate of 22 liters per minute (5.8 gallons per minute). Slug test results indicated hydraulic conductivity approximately several tens of meters per day (e.g. 10 – 30 m/day).

In well 299-E26-79, a total of 1,271.9 liters (336 gallons) were pumped over a period of 42 minutes at a continuous flow rate of 30.2 liters per minute (8 gallons per minute). Drawdown, measured using a pressure transducer and data logger, ranged from 0.2 to 0.5 meters (0.8 to 1.6 feet). Slug test results again indicated hydraulic conductivity approximately several tens of meters per day (e.g. 10 – 30 m/day).

Slug test results for well 299-E26-11 indicated a hydraulic conductivity value of approximately 10 meters per day (33 feet per day), which is somewhat lower than the tests performed in the new wells. This value is within the same range of the results previously reported for this well (5 to 7 meters per day [16 to 23 feet per day]).

The hydraulic characteristics of all four monitoring wells do not vary widely (total range from 5 to 55 meters per day [16 to 180 feet per day]) and indicate similar hydraulic conductivity beneath the LERF.

D.2.2.2 Flow Dynamics

Regional groundwater flow was initially from west to east but was impacted by groundwater mounding resulting from wastewater discharges; these impacts continue to the present to a smaller degree. The water table elevation for wells in 200 East Area for March 2008 is shown in Figure D.1.

Groundwater flow conditions were re-evaluated after installation of the two new wells. A preliminary evaluation of water levels in the uppermost aquifer (Hanford formation and/or Elephant Mountain Member flow top) was conducted using static water levels measured at the four LERF wells during the first and second quarters of fiscal year 2009. The results of the evaluation are presented in Smoot (2009) and are summarized in Table D.2, as well as the results of trend-surface analyses conducted and documented by Spane and Newcomer (2004). The evaluation included gyroscope surveys in the completed wells to determine the deviation of the holes from vertical. The water level in a deviated borehole would appear to be deeper than it actually is because it is measured at an angle to vertical. In addition, the wells have been surveyed at the highest precision practical and tied into the local surveying network to minimize error in the surface elevation.

To determine the hydraulic gradient at the LERF, three-point computations were made using recent water-level measurements collected from the three down-gradient wells: 299-E26-10, 299-E26-77, and 299-E26-79. Well 299-E26-11 has a higher water-level elevation compared to the other three wells (McDonald 2007, *Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells*). Therefore, calculations with water levels from well 299-E26-11 result in a westerly flow direction.

Well bore deviation surveys and highly accurate (within 2 mm) casing elevation surveys were performed on the down-gradient wells to minimize errors in water-level measurements. The results indicated the difference between the measured depth to water and the true vertical depth to water, which allowed the water-level measurements to be corrected for deviations of the well bores from vertical. For well 299-E26-10, the difference between the measured and true depth to water was 1.2 centimeters (0.5 inches). The difference was larger for the two new wells: 26 centimeters (10.2 inches) for well 299-E26-77, and 46.9 centimeters (18.5 inches) for well 299-E26-79.

Water-level measurements were collected during November 2008 and in February and March 2009. The measurements from November contained an outlier, so the gradient computation was only performed on the February and March measurements. The results for February indicated a direction of 254 degrees azimuth (west-southwest) and a magnitude of 9.7×10^{-5} meter per meter. The flow direction calculated from the February measurements confirms previous results from Spane and Newcomer (2004) that groundwater flow is toward the west-southwest. The results for March were 177 degrees azimuth (south) at a magnitude of 2.1×10^{-4} meter per meter. The difference between these results reflects the uncertainty remaining in the measurements, which may be partly due to barometric pressure fluctuations. Monthly measurements and annual evaluation will continue according to the requirements of this plan to reduce uncertainty in the measurements and resulting flow direction calculations.

An analysis was performed in wells 299-E26-10 and 299-E26-11 to assess barometric pressure effects on well water-level elevation measurements (*Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells, Hanford Site* [McDonald 2007]). Pressure transducers were installed in the wells from April to July 2007 to measure well water-level elevations (other wells used in the trend-surface analysis were dry or were not accessible). Hourly well water-level elevations were

measured and recorded, and hourly barometric pressure data for 200 East Area was obtained from the Pacific Northwest National Laboratory meteorological station.

The multiple regression method in *Identifying and Removing Barometric Pressure Effects in Confined and Unconfined Aquifers* [Rasmussen and Crawford 1997]) was used to analyze the well water-level responses to barometric pressure fluctuations. The water-level response characteristics indicated that the aquifer is unconfined at well 299-E26-10 and leaky confined at well 299-E26-11. This suggests that a low hydraulic conductivity layer may be causing locally confined conditions in the aquifer as dewatering occurs.

Assuming a hydraulic conductivity of 30 meters per day (98.4 feet per day), a gradient of 10^{-4} (west end of the basins), and an effective porosity of 0.1, groundwater travel time would be approximately 10 meters per year (33 feet per year) in the vicinity of the LERF basins. Factoring in well 299-E26-11, the gradient is closer to 10^{-3} and the travel time is approximately 100 meters per year (328 feet per year).

D.2.3 Groundwater Chemistry

Groundwater chemistry in the uppermost aquifer beneath the LERF was affected by several years of diluted liquid waste discharge to the 216-B-3 Pond System, which ceased in 1997.

Groundwater samples were collected at the new LERF wells during drilling in 2008 and during sampling of all four LERF wells in January 2009. Water quality parameters in the January 2009 samples from wells 299-E26-11 and 299-E26-79 show a clear correlation demonstrated by relatively low levels of the major cations and anions and a sodium-carbonate-type signature; the similarity suggests substantial hydraulic communication. Water quality parameters for the January 2009 samples at the other two wells (299-E26-10 and 299-E26-77) show the same basic signature as the first two wells, with the addition of calcium and sulfate. These results are documented in the groundwater evaluation report/Liquid Effluent Retention Facility Characterization Report (Smoot 2009). These parameters are collected to evaluate hydrogeologic conditions and are not related to specific waste constituents.

Water quality parameters for the four wells show similarities. The identified disparity (i.e., higher calcium sulfate content in the two westernmost down-gradient wells) may be explained by the presence of a regional sulfate plume (*Hanford Site Groundwater Monitoring for Fiscal Year 2008* [U.S. DOE 2009]) originating to northwest of the LERF site. Thus, available chemistry data support the conclusion that the four wells are completed in the same aquifer. Water quality parameters will continue to be collected semiannually for purposes of further evaluating the conclusion reached via the aquifer characterization study - that the four wells yield representative samples of the uppermost hydrostratigraphic unit that is continuous under the LERF Basins. See Table D.5.

D.2.4 Well Completions and Conditions

The basic well information is summarized in Table D.1 and in Figures D.2 through D.5. All four wells extend beyond 61 meters (200 feet) in depth. Although the new wells extend 5.5 to 6.1 meters (18 to 20 feet) into the Elephant Mountain basalt, the screened intervals in all four wells intercept the unconfined aquifer.

The initial LERF groundwater monitoring wells were installed in 1990 and included three down-gradient wells on the west end of the facility boundary and one upgradient well at the east end of the facility. This configuration was based on the east-to-west groundwater flow direction, caused by the recharge mound created by years of liquid effluent disposal to B Pond. Wells 299-E26-9, 299-E26-10, and 299-E35-2 were originally installed as down-gradient wells and well 299-E26-11 as an upgradient well. Wells 299-E26-77 and 299-E26-79 were installed in 2008. Well 299-E26-77 is adjacent to the location of well 299-E26-9, and well 299-E26-79 is south of LERF between Basins 42 and 43 (Figure D.1). Well 299-E26-10 (Figure D.2) has a 4.5-meter (15-feet) screen, screening the wells across the entire aquifer column. The well screen in 299-E26-10 penetrates approximately 0.5 meters (1.8 feet) into the basalt. Well 299-E26-11 (Figure D.3) was completed with a 1.5-meter (5-feet)-long channel-pack screen placed

completely within the basalt flow top and includes a sand pack that extends 1.3 meters (4.4 feet) above the screen top.

Well 299-E26-77 encountered groundwater at approximately 63.4 meters (208 feet) below ground surface and was drilled to a total depth of 71 meters (232.8 ft) below ground surface (Figure D.4). The well is constructed with 7.6 meters (25 feet) total length of screen installed across approximately 1.4 meters (4.6 feet) of sediments and 6.2 meters (21.4 feet) of basalt flow top. Well 299-E26-79-encountered groundwater at 61.5 meters (201.7 feet) below ground surface and was drilled to a total depth of 68.5 meters (224.8 feet) below ground surface (Figure D.5). The well is constructed with 7.6 meters (25 feet) total length of screen installed across approximately 3.7 meters (12 feet) of sediments and 3.9 meters (13 feet) of basalt flow top. The screens are 10-centimeters (4-inches) in diameter, 20-slot, stainless-steel wire-wrap. Both wells have a 1-meter (3-foot) blank sump below the screens. The casing from the top of the screen to land surface is 10-cenimeter (4-inch)-diameter stainless steel.

The longevity of the operable monitoring lifetime for the remaining LERF wells is an ongoing concern as water levels continue to decline. Well 299-E26-10 is projected to provide samples until approximately 2019, while well 299-E26-11 is projected to provide samples beyond 2024. This assumes that the wells can be sampled until the water reaches a minimum sampling depth of 0.5 meters (1.6 feet) above the bottom of the well and a constant, linear decline in the water table. Wells 299-E26-77 and 299-E26-79 are not expected to go dry based on the current rates of water-level decline, the maximum extent of decline, and the available screened interval. Water-level trends will continue to be evaluated.

D.3 GROUNDWATER-MONITORING PROGRAM

Groundwater monitoring at LERF consists of wells 299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79 and is compliant with the requirements of WAC 173-303-645(8)(a). More specifically, this network is capable of yielding ground water samples from the uppermost aquifer that:

- Represent the quality of background water that has not been affected by leakage from a regulated unit;
- Represent the quality of ground water passing the point of compliance.
- Allow for the detection of contamination when dangerous waste or dangerous constituents have migrated from the waste management area to the uppermost aquifer.

Characterization conducted in 2008 and 2009 indicates that the characteristics of the hydrostratigraphic units underlying the LERF basins constitute an aquifer unit that is continuous beneath the LERF basins and is capable of yielding representative groundwater samples.

Since the close proximity of the three LERF basins to one another prevents separate groundwater monitoring networks for each of the three basins, the waste management area is described by an imaginary line encompassing the three LERF basins, as provided for in WAC 173-303-645(6)(b).

D.3.1 Objectives of Dangerous Waste Groundwater Monitoring

A groundwater monitoring program, in accordance with the requirements of WAC 173-303-645, is designed to determine whether there is statistically significant evidence of contamination in the uppermost aquifer attributable to the LERF basins. The statistical approach at LERF uses intra-well statistical comparisons of groundwater quality changes.

The action leakage rate has not been exceeded during operations, and results of the LERF groundwater monitoring program to date suggest that the LERF basins have not impacted groundwater quality beneath the site. The monitoring results for wells 299-E26-10 and 299-E26-11, and recent results from new wells 299-E26-77 and 299-E26-79, have not indicated dangerous constituents above background levels, with the exception of carbon tetrachloride. This constituent was reported at 2.3 μg/liter in well 299-E26-77 and at 2.4 μg/liter in well 299-E26-79 however, these analyses are suspect due to possible instrument contamination. Additional carbon tetrachloride sample results will be necessary to determine whether this constituent is actually present in groundwater; if it is not (which is the current assumption), a detection

monitoring program in accordance with WAC 173-303-645(9) is appropriate for the site to provide compliance with the requirements of WAC 173-303-645.

D.3.2 Dangerous Constituents

A list of dangerous and/or mixed aqueous waste that can be accepted in LERF is defined by the requirements of Chapter 3.0, Waste Analysis Plan.

Dangerous constituents and suitable indicator parameters that provide a reliable indication of the presence of dangerous constituents in groundwater for purposes of groundwater monitoring were selected based on the target parameter constituents from Chapter 3.0, Waste Analysis Plan, and results of LERF basin water samples collected between July 1999 and August 2009. Several target parameters in the Waste Analysis Plan occur in the LERF basin data and were evaluated relative to the dangerous constituents (groundwater monitoring list in Chemical Test Methods for designating Dangerous Waste, Appendix 5, as provided in WAC 173-303-110(7). Dangerous constituents measured as part of routine liquid sampling in the LERF basins were included as chemical parameters. Next, constituents that have a primary drinking water standard and that exceeded one-half of the maximum contamination levels in any sample were included, regardless of whether they are dangerous constituents. Ammonia was included because it degrades to nitrate in the environment.

The dangerous constituents for groundwater monitoring and evaluation are shown in Table D.3. These were further evaluated to identify the groundwater monitoring indicator parameters (based on the dangerous constituents), which are provided in Section D.3.6.1.

D.3.3 Concentration Limits

A series of events that triggers the shift from detection monitoring to compliance monitoring is prescribed in WAC 173-303-645. If there is statistically significant evidence of contamination, as required in WAC 173-303-645(9)(f), groundwater protection standards and concentration limits will subsequently be established in accordance with WAC 173-303-645(9)(g)(iv)(D). Section D.3.13, Evaluation and Notification, provides the process and schedule for actions, notification, and permit modification, if necessary.

If a tolerance limit or control chart limit is exceeded at a statistically significant level, additional measurements shall be conducted to verify that a detection event has occurred. If the detection of a dangerous constituent is verified, as discussed in Section D.3.13, compliance monitoring will be implemented in accordance with WAC 173-303-645(10).

D.3.4 Groundwater Monitoring System and Point of Compliance

The groundwater monitoring system for the LERF will consist of four wells. Wells 299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79 will be monitored in accordance with the requirements provided in this monitoring plan. The point of compliance for the LERF groundwater monitoring plan will be represented by the vertical surface between the four monitoring wells that extends down into the uppermost aquifer underlying the waste management area, based on WAC 173-303-645(6)(a). The waste management area is described by an imaginary line encompassing the three LERF basins, as provided for in WAC 173-303-645(6)(b).

D.3.5 Compliance Period

Any compliance period will be established by the Washington State Department of Ecology (Ecology) in accordance with WAC 173-303-645 (7) if the Permittee is required to establish a compliance monitoring program pursuant to WAC 173-303-645 (10).

D.3.6 Sampling and Analysis

This section describes the sampling and analysis program for the three LERF regulated units (Basins 42, 43, and 44) that are the waste management area, including monitoring parameters, analytical methods, monitoring frequency, and sampling protocols.

D.3.6.1 Monitoring Parameters

Monitoring parameters include the indicator parameters and geochemical parameters.

As identified in section D.3.2, arsenic (Basins 42, 43, and 44), n-nitrosodimethylamine (NDMA) (primarily Basin 42), carbon tetrachloride (Basin 43), and total organic halogen are the indicator parameters and dangerous constituents that provide a reliable indication of the presence of dangerous constituents in groundwater, subject to statistical evaluation to fulfill requirements of the groundwater monitoring plan. Table D.4 provides the constituents to be analyzed and the frequency of sampling. These were derived from evaluating the dangerous constituents provided in Section D.3.2, and as discussed below.

Nitrate was initially proposed because ammonia/ammonium is present in large quantities in the waste stream and degrades to nitrate in the environment through nitrification. However, there are numerous nitrate sources near the LERF basins, and groundwater chemistry results indicate high concentrations and recent changes in nitrate. Thus, changes in nitrate concentration alone will not be a reliable indicator of LERF performance, and will not be monitored as an indicator parameter.

Arsenic is proposed because it has been detected in the basin effluent in all three of the LERF basins. It is persistent and relatively mobile in the environment, and it has a low detection level with current analytical methods. Therefore, arsenic will be monitored as a dangerous constituent that provides an indication of groundwater contamination.

Analysis of the effluent streams into the LERF basins indicates that organic constituents are present in Basins 42 and 43; however, detectable quantities of organic constituents are not observed in Basin 44. N-nitrosodimethylamine (NDMA) is found in the effluent in LERF Basin 42, and may be relatively mobile in Hanford soils; however, biodegradation may remove NDMA under aerobic conditions. NDMA has a low detection level using currently available analytical methods. Therefore, NDMA will be monitored as a dangerous constituent that provides an indication of groundwater contamination.

Other organic constituents in the Basin 42 effluent consist primarily of alcohols and ketones, with lesser amounts of ethers, phenols, and phthalates. In general, most of these constituents degrade readily and have half-lives in the environment in the order of hours to a few days.

Halogenated hydrocarbons are present in Basin 43. Carbon tetrachloride is observed in the Basin 43 leachate at several times the drinking water standard. These relatively small concentrations will likely be degraded in the environment, but the generally aerobic condition in the Hanford vadose zone is likely to inhibit dehalogenation. Carbon tetrachloride and total organic halogen therefore, are proposed as indicators of halogenated organic contamination.

D.3.6.2 Sampling Frequency

Samples will be collected quarterly for two years from wells 299-E26-10, 299-E26-11, 299-E26-77, and 299-E26-79 to establish background conditions for dangerous constituents identified in section D.3.6.1for the statistical evaluation (presented in Section D.3.13). After background data are obtained, the Permittee will continue to collect samples quarterly and to evaluate the data in accordance with the statistical methods.

Samples will be collected for analysis of major anions, cations, and alkalinity semiannually to evaluate groundwater geochemistry.

D.3.6.3 Sampling Procedures

Groundwater sampling procedures, sample collection documentation, sample preservation and shipment, and chain-of-custody requirements are described below. The Permittees will develop, maintain, and conduct work according to procedures consistent with, and no less stringent than, those described to be conducted. The Permittees will maintain current copies of these procedures in the Hanford Facility Operating Record, LERF and 200 Area ETF file, as required by Permit Condition II.I.1.

Samplers fill out groundwater sample report forms as they purge and sample each well. Field personnel measure water levels in each well before sampling and then purge stagnant water from the well. Field personnel also record time of sampling which allows correlation with barometric pressure measurements at the Hanford Meteorological Station. Water levels are typically measured with laminated-steel electrical sounding tapes with a precision of 2 mm. Procedures require sample collection after three casing volumes of water have been purged from the well and after field parameters (pH, temperature, specific conductance, and turbidity) have stabilized. Field parameters are measured in a flow-through chamber. Both filtered and unfiltered samples are collected for metals analyses. Filtering is performed in the field with 0.45-micron, in-line, disposable filters to ensure that results represent dissolved metals and do not include particulates. Dissolved trace metals analysis (from filtered samples) will be used for statistical analyses of trace metal arsenic.

Sample preservation techniques will follow generally accepted practices (e.g. U.S. Environmental Protection Agency [EPA]-approved guidelines such as *Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods* [SW-846], Table 11-1, or equivalent) and will be documented in sample authorization forms generated by the Sample and Data Management organization. Preservatives are added to collection bottles before use in the field. A chemical preservative label is affixed to the sample container listing the specific preservative. The preservative's brand name, lot number, concentration, and date opened are recorded.

D.3.6.4 Sample Chain-of-Custody

Groundwater samplers use chain-of-custody forms to document the integrity of groundwater samples from the time of collection through data reporting. The forms are generated during scheduling and are managed through a documented procedure. Required information recorded on the forms includes the following:

- Sampler's name
- Method of shipment and destination
- Collection date and time
- Sample identification numbers
- Analysis methods
- Preservation methods

Samples are labeled and sealed with evidence tape, wrapped with bubble wrap, and placed in a U.S. Department of Transportation-approved container with ice, as appropriate. The packaging parameters for samples are determined by associated hazards. Samples for offsite laboratories are shipped according to U.S. Department of Transportation regulations. A chain-of-custody form accompanies all samples.

When samples are transferred from one custodian to another (e.g., from sampler to shipper, or from shipper to analytical laboratory), the receiving custodian inspects the form and the samples, noting any deficiencies. Each transfer of custody is documented by the printed names and signatures of the custodian relinquishing the samples and the custodian receiving the samples, as well as the time and date of transfer. Commercial shippers do not sign chain-of-custody forms, but the forms are signed by the receiving laboratory, and sample integrity is verified by inspecting the bottle seals.

D.3.7 Decontamination of Drilling and Sampling Equipment

The following information is included relative to well drilling equipment if new wells are installed at LERF for this Permit. Well drilling equipment is decontaminated using high temperature and pressure washing. The equipment then is rinsed with clean water.

Equipment for collecting soil samples during drilling for later chemical analysis is decontaminated. Equipment is washed with phosphate-free detergent, rinsed three times with de-ionized water, rinsed once with nitric acid (glass or stainless-steel equipment only), rinsed three more times with de-ionized water, and then finally rinsed with hexane. After heat drying, equipment is wrapped in unused aluminum foil

and sealed with tape until needed. The tape shall not come into contact with the equipment to avoid any contamination from the materials in the tape.

Monitoring wells for the LERF shall be equipped with dedicated sampling pumps. Sample pumps are placed at approximately mid-depth within the screen interval. Water-level measuring tapes are cleaned with potable or deionized water and a clean towel. Sample manifolds used at the well head require decontamination as follows: wash with a phosphate-free detergent, rinse three times in high-purity water, rinse in a 1 M solution of nitric acid, rinse three more times in high-purity water, then rinse in hexane, and finally dry in drying chamber. These are done in accordance with established procedures.

D.3.8 Quality Objectives and Criteria

The quality control program is designed to assess and enhance the reliability and validity of groundwater data, and to document whether the resulting data are of the quantity and quality necessary for the intended decision-making purpose. In groundwater detection monitoring, the primary decision-making purpose is to determine whether a statistically significant increase in a dangerous constituent concentration is observed in groundwater down-gradient from the permitted site. Consequently, data quality is monitored by evaluating the results of quality control samples, conducting audits, validating groundwater data, and comparing these results to data quality requirements established in this groundwater monitoring plan. Accuracy, precision, and detection are the primary parameters used to assess data quality. Data for these parameters are obtained from two categories of quality control samples: (1) those that provide checks on field and laboratory activities (field quality control), and (2) those that monitor laboratory performance (laboratory quality control). Table D.6 summarizes the types of samples in each category and the sample frequencies and characteristics evaluated.

D.3.9 Analytical Procedures

Instruments for field measurements (e.g., pH, specific conductance, temperature, and turbidity) are verified using standard solutions before use. These include, for pH, 4, 7, and 10 buffer/standard solutions; for specific conductance, 445 uS/cm and 1413 uS/cm solutions; and for turbidity, Gelex standards 0-10, 0-100, and 0-1000 NTU. Instruments are operated in accordance with the manufacturer's instructions. Each instrument is assigned a unique number that is tracked via field and verification documentation.

Laboratory analytical methods are specified in Table D.7, and reflected in contracts with the laboratories and are standard methods from SW-846 (1986, as revised), *Methods for Chemical Analysis of Water and Wastes* (U.S. EPA 1979, as revised), or *Standard Methods for the Examination of Water and Wastewater, 20th Edition* (APHA/AWWA/WEF 1998, as revised). Analytes, analytical methods, and required maximum practical quantitation limits are shown in Table D.7.

D.3.9.1 Quality Control

Quality control data are evaluated based on acceptance criteria for each quality control sample type, as summarized by constituent in Table D.8. These criteria limits are intended to provide confidence that the analytical and field methods are in control and provide reliable data. For field and method blanks, the acceptance limit is two times the instrument detection limit (metals) or method detection limit (other chemical parameters), except for common laboratory contaminants acetone, methylene chloride, 2-butanone, and phthalate esters where the limit is five times the method detection limit. Groundwater samples that are associated (i.e., collected on the same date and analyzed by the same method) with out-of-limit field blanks shall be flagged with a "Q" in the HEIS database to indicate a potential problem, and then recorded in the Hanford Facility Operating Record, LERF and 200 Area ETF file pursuant to Permit Condition III.3.D.1.b.

Field duplicates must agree within 20% (as measured by relative percent difference) to be acceptable. Only those field duplicates with at least one result greater than five times the appropriate detection limit shall be evaluated. In the case where one result is a non-detect, the detection limit is used to calculate the

relative percent difference. Unacceptable field duplicate results are flagged with a "Q" in the database and recorded in the Hanford Facility Operating Record, LERF and 200 Area ETF file.

The acceptance criteria for laboratory duplicates, matrix spikes, matrix spike duplicates, surrogates, and laboratory control samples are defined in Table D.8 and are in accordance with EPA SW-846. The acceptance criteria for the associated parameter data shall be analyzed and recorded in accordance with Section D.3.10.2.

Table D.9 lists the acceptable accuracy for the double-blind standards for carbon tetrachloride and total organic halides. These samples are prepared by spiking Hanford background well water (currently, wells 699-19-88 and 699-49-100C) with known concentrations of constituents of interest. Spiking concentrations range from the detection limit to the upper limit of concentration determined in groundwater on the Hanford Site. Investigations shall be conducted for double-blind standards that are outside of acceptance limits in accordance with Section D.3.10.2. The results from these standards shall be used to determine acceptability of the associated parameter data. Recommended holding times depend on the analytical method, as specified in EPA SW-846 or (U.S. EPA 1979). The holding times shall be specified in laboratory contracts pursuant to permit requirements. Data associated with exceeded holding times are flagged with an "H" in the HEIS database and noted in the Hanford Facility Operating Record, LERF and 200 Area ETF file. Data exceeding holding times shall be maintained but potentially may not be used in statistical analyses, in accordance with Section D.3.10.2.

Additional quality control measures include laboratory audits and participation in nationally based performance evaluation studies. Audit results are used to improve performance. Summaries of audit results and performance evaluation studies shall be incorporated into the Hanford Facility Operating Record, LERF and 200 Area ETF file as appropriate to substantiate data quality objectives and data acceptance criteria.

D.3.10 Data Management

This section describes data management practices.

D.3.10.1 Loading Data

The contract laboratories report analytical results electronically and in hardcopy. The electronic results shall be loaded into the HEIS database as they are received from the laboratories. The appropriate sections of the Hanford Environmental Information System shall be incorporated by reference into the Hanford Facility Operating Record, LERF and 200 Area ETF file to satisfy Permit Condition III.3D.1.b. Field data (e.g., specific conductance, pH, temperature, turbidity, and depth to water) are recorded on field records. Data management staff enters these into the HEIS database manually through data-entry screens and verify each value against the hardcopy. An electronic field data collection system may be implemented soon, which would replace the manual field data collection and the manual data entry process when it is implemented.

Data not available electronically may also include well logbooks, borehole videos, geologic descriptions, field screening data, or other information.

D.3.10.2 Data Review, Verification, Validation, and Usability

The final data review shall determine whether data meet the criteria specified below. The work activities shall follow documented procedures and processes for data validation and verification, as summarized below. Validation of groundwater data involves assessing whether the data collected and measured truly reflect aquifer conditions. Verification involves assessing data accuracy, completeness, consistency, availability, and internal control practices to determine overall reliability of the data collected. Other data quality objectives that shall be met include the proper chain-of-custody, sample handling, use of proper analytical techniques for each constituent, and the quality and acceptability of the laboratory analyses conducted.

Groundwater monitoring staff performs checks on laboratory electronic data files for formatting, allowed values, data flagging (qualifiers), and completeness. Hardcopy results are verified to check for (1) completeness, (2) notes on condition of samples upon receipt by the laboratory, (3) notes on problems that arose during the analysis of the samples, and (4) correct reporting of results. If data are incomplete or deficient, staff will work with the laboratory to correct the problem discovered during the analysis.

The data validation process provides the requirements and guidance for validating groundwater data that are routinely collected. Validation is a systematic process of reviewing verified data against a set of criteria (listed in Table D.8) to determine whether the data are acceptable for their intended use.

Results of laboratory and field QC evaluations, double-blind sample results, laboratory performance evaluation samples, and holding-time criteria are considered when determining data usability. Staff review the data to identify whether observed changes reflect changes in groundwater quality or potential data errors, and they may request data reviews of laboratory, field, or water-level data for usability purposes. The laboratory may be requested to check calculations or reanalyze the sample, or the well may be resampled. Results of the data reviews are used to flag the data appropriately in the HEIS database (e.g., "R" for reject, "Y" for suspect, or "G" for good) and/or to add comments.

Upon final data acceptance, both the raw data and the accepted/validated data shall be incorporated into the Hanford Facility Operating Record, LERF and 200 Area ETF file.

D.3.10.3 Data Review Corrective Actions

The responses to data quality defects are identified through the verification/validation process. Corrective actions are shown in Table D.8.

D.3.11 Statistical Analysis of Groundwater Monitoring Data

Groundwater monitoring constituents have been identified for the LERF basins and are listed in Table D.3. The dangerous constituents and indicator parameters used to indicate the presence of contamination (WAC 173-303-645(9)(a)) and subject to statistical evaluation are listed in Table D.4 and include arsenic, n-nitrosodimethylamine, carbon tetrachloride, and total organic halides.

To establish background conditions, eight samples will be collected during the first two years (quarterly sampling frequency) in accordance with the Permit. Once the baseline has been established, the sample collection and analysis will continue on a quarterly basis.

The statistical method for comparing baseline (background) groundwater quality with compliance-point groundwater quality is the combined Shewhart/CUSUM control chart provided for by WAC 173-303-645(8)(h)(iv) and recommended by EPA as a core strategy for detection monitoring in Unified Guidance *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities*, (U.S. EPA, 2009). Applying this intra-well statistical procedure will enable monitoring in the existing wells based on the following justification:

The methods can be used when no upgradient well is available or the upgradient well is suspect (such as at LERF); when an upgradient well exists but there is a high degree of spatial variability in groundwater chemistry among wells; or there is considerable uncertainty in groundwater flow direction as is the condition at LERF.
The methods may be applied to each well individually while maintaining the desired site wide false-positive and false-negative error rates (this method is effective). Spatial variations that may adversely affect the analysis of variance procedure do not play a role under these methods. (Note: Elimination of spatial variability decreases the uncertainty in measured concentrations, making intra-well comparisons more sensitive to a real release (*Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs* [ASTM 1998].)

The statistical method uses a combined Shewhart-CUSUM control chart approach, first referenced in *Combined Shewhart-CUSUM Control Chart for Improved Quality Control in Clinical Chemistry* (Westgard et al. 1977) and further developed in *Combined Shewhart-CUSUM Quality Control Schemes*

(Lucas 1982). This method is an EPA recommended core strategy for detection monitoring, as provided and described in *Unified Guidance Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (US EPA 2009).. The power of the control chart method is enhanced by the combined Shewhart and CUSUM procedures. The Shewhart procedure is sensitive to sudden shifts, and the CUSUM procedure is sensitive to gradual changes in the mean concentrations. A combined Shewhart and CUSUM procedure, therefore, is well designed to detect both types of changes.

The method is a sequential testing procedure to test for an upward shift in the mean concentration of a constituent of interest. The Shewhart portion of the test checks for any sudden upward shift in groundwater quality parameters based on a single observation, while the CUSUM checks for any gradually increasing trend in the groundwater monitoring parameters. The combined Shewhart–CUSUM method can be implemented following a baseline of eight or more independent samples for a given well (US EPA 2009; ASTM 1998). The method assumes that the groundwater background data and future observations will be independent and normally distributed in accordance with WAC 173-303-645(8)(g)(i). The most important assumption is that the data are independent. The aquifer properties and flow rates suggest that quarterly sampling will assure independent samples are collected. The assumption of normality can usually be met by log transforming the data or by other Box-Cox transformations.

The combined Shewhart-CUSUM procedure can be implemented as follows: Let x'_i be a series of independent baseline observations i = 1.... b (b = 8). Let x_i be a series of future monitoring measurements i = 1, 2, 3.... Then, using the baseline data, the following steps are applied:

First, determine if the x'_i can be assumed to follow a normal distribution with mean μ and standard deviation σ using the Shapiro-Wilk test for normality (US EPA 2009). If not, transform the x'_i using the appropriate Box-Cox transformation and work with the transformed data.

Next, use the baseline measurements to compute the estimates:

$$\bar{x}' = \sum_{i=1}^{b} x_i'/\mathrm{b} \text{ for } \mu \text{ and } s' = \sqrt{\sum_{i=1}^{b} (x_i' - \bar{x}')^2 /(b-1)} \text{ for } \sigma.$$

Determine the upper Shewhart control limit (SCL) for the procedure by calculating $SCL = \bar{x}' + z_s s'$, where z_s is a percentile from the standard normal distribution used to set the false-negative, and false-positive values of the SCL. The value of z_s that is most often suggested for groundwater use is 4.5 by Lucas, 1982, and (ASTM 1998). The EPA Unified Guidance uses a value of 5 in its example (US EPA 2009), but does not provide specific recommendations. The value 4.5 is more conservative than 5. Other values may also be used, depending on the sampling scheme and whether verification sampling is used to modify the false-positive and false-negative error rates. If less than 15% of the background measurements are non-detects, the non-detects will be replaced with half the MDL and the s' calculated as usual. If more than 15% of the background measurements are non-detect, a Kaplan-Meier, robust regression on order (ROS), or Cohen's method (US EPA 2009) will be implemented to estimate the mean and standard deviation of the background samples. If all eight background samples are non-detect, the laboratory Reporting Limit (RL) will be used as the SCL in the Shewhart test.

Determine the upper CUSUM control limit (CCL), with $CCL = z_c$. The value of z_c suggested by Lucas, 1982) is $z_c = 5$. This value can also be adjusted to reach desired false-negative and false-positive error rates. In practice setting $z_c = z_s = 4.5$ results in a single limit with no compromise in leak detection capabilities (ASTM 1998, US EPA 2009).

Determine the amount of increased shift in the mean of the water quality parameter of interest to detect an upward trend. This value is referenced as "k" and is usually measured in σ units of the water quality parameter. Starks (1988) suggests a value of k = 1, if there are less than 12 baseline observations, and a

value of k = 0.75 if there are 12 or more baseline observations. The Unified Guidance (US EPA 2009) also cites these values.

Using the monitoring data after the baseline has been established:

Compute the CUSUM statistic as $S_i = \max\{0, (x_i - \bar{x}')/s' - k + S_{i-1}\}$ as each new monitoring measurement, x_i becomes available, where i = 1,2,3,..., max{a, b} is the maximum of a and b, and $S_0 = 0$.

As each new monitoring measurement becomes available, compute the Shewhart and CUSUM tests. A verification sampling will be conducted if either $x_i \geq$ SCL or $S_i \geq$ CCL. A well is declared to be out of control only if the verification result also exceeds the SCL or the CCL. If both $x_i <$ SCL and $S_i <$ CCL, then continue monitoring.

As monitoring continues and the process is shown to be in control, (i.e., there is no statistically significant evidence of facility impact to groundwater) the baseline mean and standard deviation should be updated periodically (e.g., every 1 or 2 years) to incorporate the new data (US EPA 2009). This reduces uncertainty in the background, and helps adjust for groundwater influences from outside sources. This updating process should continue for the lifetime of the monitoring program.

If an exceedance occurs, resampling will be undertaken to verify or refute the original exceedance. The analytical result from the resample is substituted into the above formulas in place of the original value obtained, and the CUSUM statistic is updated. (Note: In the above combined test, the Shewhart portion of the test will quickly detect extremely large deviations from the baseline period. The CUSUM portion of the combined test is sequential. Thus, a small shift in the mean concentration over the baseline period will slowly aggregate in the CUSUM statistic and eventually cause the test to exceed the CCL.)

If resampling does not confirm the exceedance of the control limit, and *if the exceedance can be shown to be a measurement in error or a confirmed outlier, it should be excluded from the revised background. Otherwise, any disconfirmed exceedances (including any resamples that exceed the background limit but are disconfirmed by other resamples) should probably be included when updating the background. The reason is that background limits designed to incorporate retesting are computed as low as possible to ensure adequate statistical power* (US EPA 2009).

D.3.12 Reporting and Recordkeeping

Reporting of monitoring evaluations for LERF will be carried out through the annual dangerous waste (RCRA) groundwater monitoring report.

Pertinent information for groundwater monitoring and electronic files for groundwater data shall be maintained in the Hanford Facility Operating Record, LERF and 200 Area ETF file required by Permit Condition II.I.1. Records may be stored in either electronic or hardcopy format.

The Hanford Facility Operating Record, LERF and 200 Area ETF file will also include, consistent with Permit Condition III.3.D.1.b, the following:

- Groundwater sample reports
- Chain-of-custody forms
- Sample receipt records.

D.3.13 Evaluation and Notification

Groundwater flow rate and direction in the uppermost aquifer will be evaluated and reported annually. Groundwater chemistry data collected under this permit will be reviewed semi-annually to determine if there is statistically significant evidence of contamination (in accordance with WAC 173-303-645[9][f]) using the statistical method provided in Section D.3.11. The results of the statistical evaluation and associated information will be submitted to Ecology annually, beginning after the second full year of sampling and analysis under this groundwater monitoring program (WAC 173-303-645(9)(c)).

If statistically significant evidence of contamination is determined for one or more of the dangerous constituents or indicator parameters, at any monitoring well at the compliance point, the owner or operator may resample within one month and repeat the analysis for the detected compounds in accordance with WAC 173-303-645(9)(g)(ii). The resample data will be compared with the control limit. If resampling confirms statistically significant evidence of contamination, the following will be performed in accordance with WAC 173-303-645(9)(g):

- Notify Ecology in writing within 7 days of the finding, indicating which chemical parameters have shown statistically significant evidence of contamination.
- Sample the groundwater in all monitoring wells and determine if constituents included in *Chemical testing Methods for Designating Dangerous Waste*, Appendix 5 are present, and if so, in what concentration. For any of these compounds detected, the owner or operator may resample within one month of receiving the results and repeat the analysis for those compounds detected. If the constituents are detected in the second analysis, they will form the basis for compliance monitoring.
- If dangerous constituent(s) are detected, submit an application for a Permit modification to Ecology within 90 days to establish a compliance monitoring program in accordance with WAC 173-303-645(9)(g)(iv).
- If dangerous constituents are not detected, continue to monitor in accordance with the detection monitoring program.

In the case that a source other than the LERF caused the contamination or the detection is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in groundwater (as allowed by WAC 173-303-645[9][g][vi]), the following will apply:

- Notify Ecology in writing within 7 days of the finding (i.e., exceedance) and indicate the intent to make a demonstration to this effect.
- Submit a report to Ecology within 90 days. The report should demonstrate that a source other than the regulated unit caused the contamination, or that the contamination resulted from an error in sampling, analysis, evaluation, or natural variation in groundwater chemistry.
- Continue monitoring in accordance with the detection monitoring program.

If it is determined, in accordance with WAC 173-303-645(9)(h), that the detection monitoring program no longer satisfies the requirements of WAC 173-303-645(9), submit an application to Ecology for a Permit modification within 90 days to make any appropriate changes to the program.

D.4 COMPLIANCE-MONITORING PROGRAM

Reserved.

D.5 CORRECTIVE-ACTION PROGRAM

Reserved.

Table D.1 Pertinent Information for Monitoring Wells in LERF

Well	Top of Casing Elevation (m), MSL (NAVD88)	Well Water Level Record Period	Saturated Well Screen Section Elevation (m), MSL (NAVD88)	Comments
299-E26-10	184.42	10/90 – 5/09	122.37 - 120.69 (1.7)	Top of basalt, approximately 121.2 m MSL
299-E26-11	183.88	10/90 - 5/09	123.32 - 120.25 (3.1)	Top of basalt, approximately 122.6 m MSL
299-E26-77	184.771	8/08 – 5/09	123.54 - 115.99 (7.5)	Screened in permeable basalt
299-E26-79	183.114	8/08 – 5/09	123.60 - 115.98 (7.6)	Screened in permeable basalt

MSL = mean sea level
NAVD88 = North American Vertical Datum of 1988

Table D.2 Groundwater Flow Characterization Results Based on Trend Surface Analysis or Three-Point Solution of Well Water Level Measurements in LERF and Surrounding Area[a]

Date	Maximum Observed Well Water-Level Elevation Difference (m)	Flow Direction, (0° = N; 90° = E)	Hydraulic Gradient (m/m)	Comments
6/10/97	1.308	266°	1.04×10^{-3}	
6/8/98	1.222	264°	9.81×10^{-4}	
3/8 - 9/99	1.186	257°	9.67×10^{-4}	
3/22 - 23/00	1.173	269°	9.09×10^{-4}	
3/13 - 14/01	1.096	270°	8.71×10^{-4}	
3/19/02	1.110	264°	9.04×10^{-4}	Well 299-E34-3 measured on 5/1/02
3/19/03	1.068	273°	8.75×10^{-4}	Well 299-E26-9 dry; no measurement available
2/09	NA	254	9.57 x 10-5	
3/09	NA	177	2.1 x 10-4	
Average Values (Standard Deviation)	1.166 (±0.083)	266° (±5.2°)	9.35×10^{-4} ($\pm 6.3 \times 10^{-5}$)	

(a) The well network for 6/10/97 and 3/19/03 included 299-E26-9, 299-E26-10, 299-E26-11, 299-E27-10, 299-E34-3, 299-E34-7, and 299-E35-2. The well network for 2/09 and 3/09 included wells 299-E26-10, 299-E26-77, and 299-E26-79.

NA = not applicable

Table D.3 Dangerous Constituents for Groundwater Monitoring Based on Comparisons to Basin 42, 43, and 44 Chemistry

Chemical Constituent	Range of Basin 42, 43, and 44 Water Analysis Results
Acetone	Non-detect (1 - 20)[a] to 5,900 µg/L
Ammonia/ammonium (as nitrogen)	48 to 769 mg/L
Antimony	0.5 to 32 µg/L
Arsenic	0.53 to 8.9 µg/L
Barium	1 to 108 µg/L
Bis(2-ethylhexyl) phthalate (DEHP)	12 to 230 µg/L
Carbon tetrachloride	13 to 490 µg/L
Chloroform	2 to 7.6 µg/L
Chloromethane	1.5 µg/L (one measurement)
Chromium	0.4 to 95.9 µg/L
Copper	0.86 to 818 µg/L
Cresol (o, p, m)	Non-detect (0.59 - 1) to 49 µg/L
Lead	Non-detect (0.05 - 0.1) to 94.6 µg/L
Mercury	Non-detect (0.04 – 0.05) to 1.22 µg/L
Nickel	Non-detect (4 – 8) to 22.2 µg/L
Nitrate (as nitrogen)	342 µg/L to 4,780 µg/L
Nitrite (as nitrogen)	68 µg/L to 2,820 µg/L
N-nitrosodimethylamine	12 µg/L to 2,760 µg/L
Selenium	Non-detect (0.3 – 0.4) to 5.5 µg/L
Silver	2.3 µg/L to 33 µg/L
Zinc	Non-detect (2 – 12) to 79.9 µg/L
[a] Method detection limits varied over the time in which these analyses were performed.	

Table D.4 Dangerous Constituents and Indicators to be Analyzed as Indicators of Groundwater Contamination at the LERF Basins

Constituent	Sample Frequency	Comment
• Arsenic • N-nitrosodimethylamine • Carbon tetrachloride • Total organic halides	Samples collected quarterly for two years to establish background. Samples collected quarterly for ongoing statistical evaluations after background is established.	Subject to statistical evaluation, based on the standard sampling plan outlined in WAC 173-303-645(8)(g)(i) and WAC 173-303-645(8)(g)(ii).

Table D.5 Constituents to be Analyzed for Geochemical Evaluation of Groundwater

Constituent	Sample Frequency	Comment
• Major anions • Major cations • Alkalinity	Semiannually	Aid geochemical evaluation

1 **Table D.6 Quality Control Samples**

Sample Type	Primary Characteristics Evaluated	Frequency
Field Quality Control		
Full trip blank	Contamination from containers or transportation	One per 20 well trips
Field transfer blank	Airborne contamination from the sampling site	One each day volatile organic compound samples are collected
Equipment blank	Contamination from non-dedicated sampling equipment	As needed[a]
Duplicate samples	Reproducibility	One per 20 well trips
Laboratory Quality Control		
Method blank	Laboratory contamination	One per batch
Laboratory duplicates	Laboratory reproducibility	[b]
Matrix spike	Matrix effects and laboratory accuracy	[b]
Matrix spike duplicate	Laboratory reproducibility and accuracy	[b]
Surrogates	Recovery/yield	[b]
Laboratory control sample	Method accuracy	One per batch

a. For portable Grundfos pumps, equipment blanks are collected 1 per 10 well trips. Whenever a new type of non-dedicated equipment is used, an equipment blank is collected every time sampling occurs until it can be shown that less frequent collection of equipment blanks is adequate to monitor the decontamination procedure for the non-dedicated equipment.

b. As defined in the laboratory contract or quality assurance plan and/or analysis procedures.

2
3

Table D.7 Preservation Techniques, Analytical Methods Used, and Current Required Quantitation Limits for Chemical Constituents

Constituent	Collection & Preservation[a,b]	Analysis Methods[c]	Method Quantitation Limit (µg/L)[d]
Metals			
Arsenic	P, HNO_3 to pH<2	SW-846[e] Method 6010,or EPA/600 Method 200.8	4
Barium			5
Calcium			1,000
Sodium			500
Potassium			4,000
Magnesium			750
Anions by Ion Chromatography			
Nitrate	P, none	EPA/600 Method 300.0[f]	250
Sulfate			500
Chloride			200
Nitrite			250
Volatile Organics			
Carbon tetrachloride	G, no headspace	SW-846 8260	2
Semi Volatile Organics			
N-nitrosodimethylamine	G, no headspace	SW-846 8270D	10
Total Organic Halides			
Total Organic Halides	G, no headspace	SW-846 9020	20
Alkalinity			
Alkalinity	G/P, none	EPA Standard Method[g] 2320 EPA/600 Method 310.1 EPA/600 Method 310.2	5,000

a. P = plastic; G = glass.
b. All samples will be cooled to 4°C upon collection.
c. Constituents grouped together are analyzed by the same method, unless otherwise indicated.
d. Detection limit units, except where indicated.
e. SW-846, Methods for Evaluation of Solid Waste: Physical/Chemical Methods. EPA/600/4-84-017).
f. Analytical method adapted from Method 300.0, Test Methods for Determination of Inorganic Anions in Water by Ion Chromatography (EPA-600/4-84-017).
g. Standard Methods for the Examination of Water and Wastewater (AWWA/APHA 1998).

EPA = U.S. Environmental Protection Agency
N/A = not applicable

Table D.8 Field and Laboratory Quality Control Elements and Acceptance Criteria

Constituent[a]	QC Element	Acceptance Criteria	Corrective Action
General Chemical Parameters			
Alkalinity	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	<20% RPD[c]	Data reviewed[d]
	MS[e]	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	<20% RPD[f]	Flagged with "Q"
Anions			
Anions by IC	MB	<MDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	DUP	<20% RPD[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	<20% RPD[f]	Flagged with "Q"
Metals			
Arsenic Barium ICP metals	MB	<CRDL	Flagged with "C"
	LCS	80-120% recovery[c]	Data reviewed[d]
	MS	75-125% recovery[c]	Flagged with "N"
	MSD	<20% RPD[c]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	<20% RPD[f]	Flagged with "Q"
Volatile Organic Compounds			
Carbon tetrachloride	MB	<MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB, FXR	<2 times MDL	Flagged with "Q"
	Field duplicate	<20% RPD[f]	Flagged with "Q"
Semivolatile Organic Compounds			
N-nitrosodimethylamine	MB	<2 times MDL	Flagged with "B"
	LCS	Statistically derived[g]	Data reviewed
	MS	Statistically derived[g]	Flagged with "N"
	MSD	Statistically derived[g]	Data reviewed[d]
	SUR	Statistically derived[g]	Data reviewed[d]
	EB, FTB	<2 times MDL	Flagged with "Q"
	Field duplicate	<20% RPD[f]	Flagged with "Q"

a. Refer to Table D.7 for specific analytical methods.
c. Laboratory-determined, statistically derived control limits may also be used. Such limits are reported with the data.
d. After review, corrective actions are determined on a case-by-case basis. Corrective actions may include a laboratory recheck or flagging the data as suspect ("Y" flag) or rejected ("R" flag).
e. Applies to total organic carbon and total organic halides only.
f. Applies only in cases where one or both results are greater than 5 times the detection limit.
g. Determined by the laboratory based on historical data. Control limits are reported with the data.

Data flags:
B, C = possible laboratory contamination (analyte was detected in the associated method blank)
N = result may be biased (associated matrix spike result was outside the acceptance limits)
Q = problem with associated field QC sample (blank and/or duplicate results were out of limits)

Table D.8 Field and Laboratory Quality Control Elements and Acceptance Criteria

Abbreviations:

CRDL = contract-required detection limit
DUP = laboratory matrix duplicate
EB = equipment blank
FTB = full trip blank
FXR = field transfer blank
GC = gas chromatography
ICP = inductively coupled plasma
ICP/MS = inductively coupled plasma/mass spectrometry
LCS = laboratory control sample
MB = method blank
MDA = minimum detectable activity
MDL = method detection limit
MS = matrix spike
MSD = matrix spike duplicate
PCB = polychlorinated biphenyl
RPD = relative percent difference
SUR = surrogate

Table D.9 Blind-Standard Constituents and Schedule

Constituents	Frequency	Accuracy (%)[a]	Precision (% RSD)[a]
Carbon tetrachloride	Quarterly	±25%	<25%
Total organic halides[b]	Quarterly	±25%	<25%

If the results are less than 5 times the required detection limit, then the criterion is that the difference of the results of the replicates is less than the required detection limit.

Two sets of spikes for total organic halides will be used. The spiking compound for one set should be 2,4,5-trichlorophenol. The spiking compound for the second set should include the constituents used for the volatile organic compounds sample (carbon tetrachloride).

RSD = relative standard deviation

Figure D.1 LERF Location Map Showing Revised Unconfined Aquifer Thickness

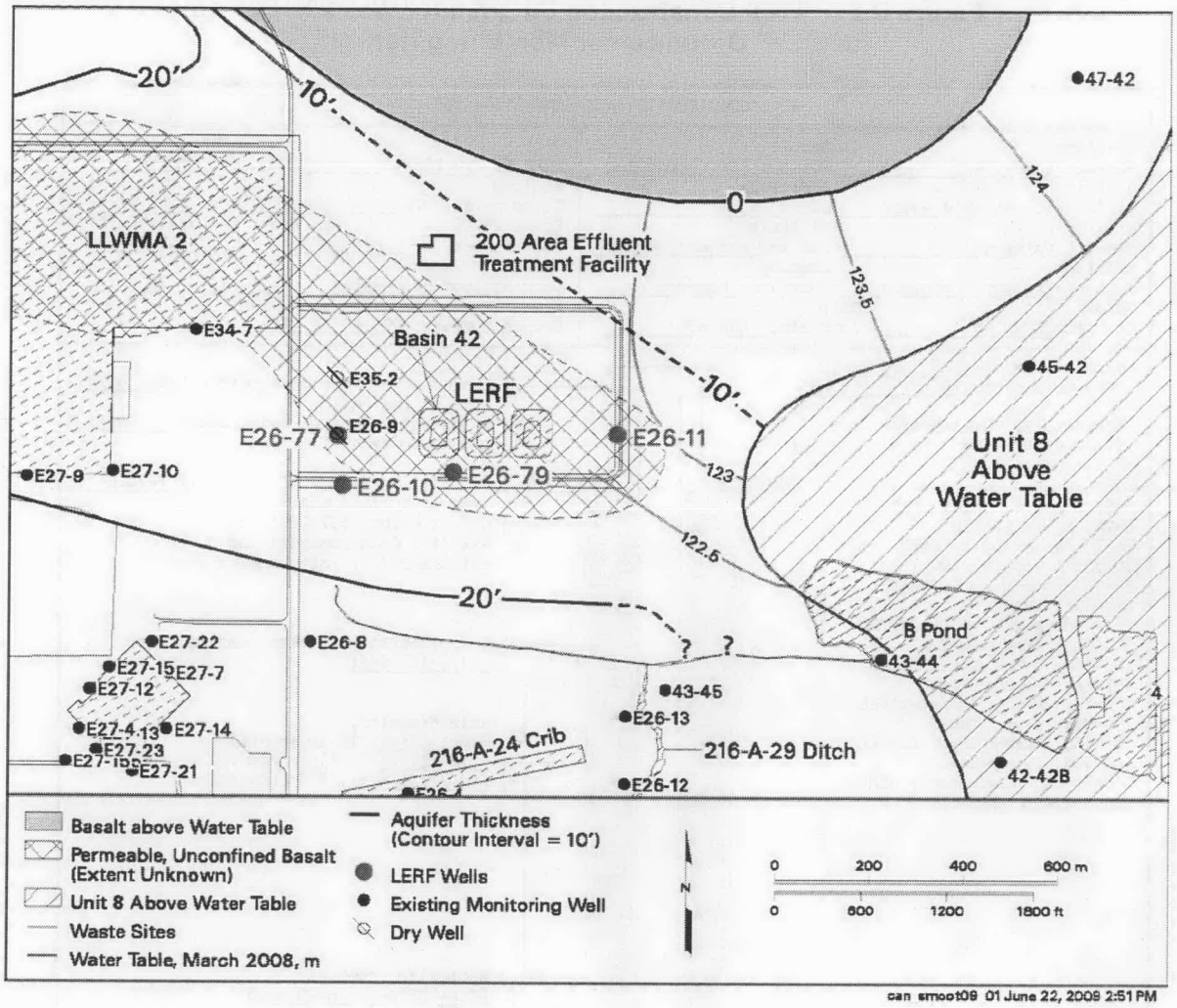


Figure D.2 Well Construction Diagram for Well 299-E26-10 in LERF Groundwater Monitoring Network

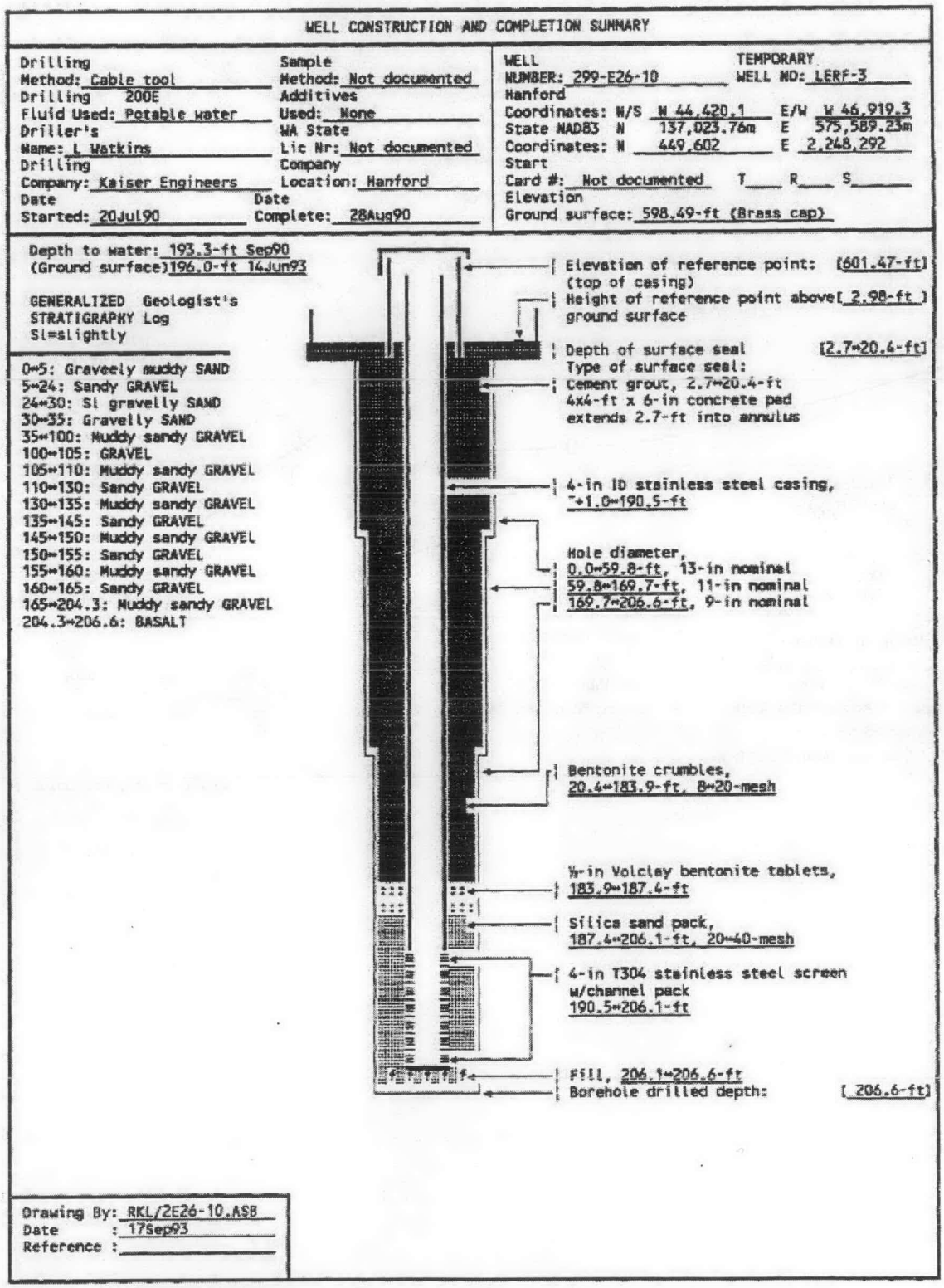


Figure D.3 Well Construction Diagram for Well 299-E26-1 in LERF Groundwater Monitoring Network

WELL CONSTRUCTION AND COMPLETION SUMMARY

Drilling Method: Cable tool
Drilling Fluid Used: Potable water 200E
Driller's Name: L Watkins
Drilling Company: Kaiser Engineers
Date Started: 21Jun90

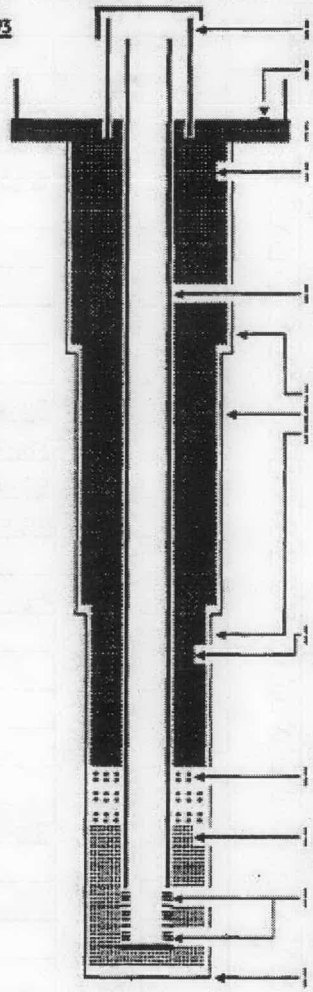
Sample Drive barrel Method: Hard tool
Additives Used: None
WA State Lic Nr: Not documented
Company Location: Hanford
Date Complete: 20Aug90

WELL NUMBER: 299-E26-11
TEMPORARY WELL NO: LF-4
Hanford Coordinates: N/S N 44,779.2 E/W W 44,979.2
State NAD83 N 137,134.88m E 576,180.17m
Coordinates: N 449,966 E 2,250,231
Start Card #: Not documented T___ R___ S___
Elevation Ground surface: 596.72-ft (Brass cap)

Depth to water: 189.9-ft Aug90
(Ground surface)191.3-ft 14Jun93

GENERALIZED STRATIGRAPHY Log
Geologist's Log
Sl=slightly

0-24: Sandy GRAVEL
24-40: GRAVEL
40-53: Sandy GRAVEL
53-54: Muddy SAND
54-55: Gravelly SAND
55-60: Gravelly SAND
60-65: Sandy GRAVEL
65-70: Muddy sandy GRAVEL
70-80: Sandy GRAVEL
80-85: Muddy sandy GRAVEL
85-90: Sandy GRAVEL
90-100: Muddy sandy GRAVEL
100-105: Sandy GRAVEL
105-110: GRAVEL
110-135: Sandy GRAVEL
135-140: GRAVEL
140-145: Sandy GRAVEL
145-155: GRAVEL
155-160: Muddy sandy GRAVEL
160-165: Sandy GRAVEL
165-193: Muddy sandy GRAVEL
193-198: Sl gravelly sandy MUD
198-206.2: BASALT



Elevation of reference point: [599.68-ft] (top of casing)
Height of reference point above ground surface [2.96-ft]
Depth of surface seal [3.0-15.8-ft]
Type of surface seal: Cement grout 3.0-15.8-ft, 4x4-ft x 6-in concrete pad extending 3.0-ft into annulus
4-in ID stainless steel casing, ~+1.0-200.2-ft
Hole diameter,
0.0-61.5-ft, 13-in nominal
61.5-166.6-ft, 11-in nominal
166.7-206.2-ft, 9-in nominal
Bentonite crumbles, 15.8-188.0-ft, 8-20-mesh
¾-in bentonite hole plug, 188-195.9-ft
Silica sand pack,
195.9-197.0-ft, 40-60-mesh
197.0-206.0-ft, 20-40-mesh
4-in T304, stainless steel screen w/channel pack 200.2-205.8-ft
Borehole drilled depth: [206.2-ft]

Drawing By: RKL/2E26-11.ASB
Date : 17Sep93
Reference :

Figure D.4 Well Summary Sheet for Well 299-E26-77 in LERF Groundwater Monitoring Network

WELL SUMMARY SHEET

Start Date: 08/17/2008
Finish Date: 09/05/2008
Page 1 of 2

Well ID: C16455
Well Name: 299-E26-77
Location: Inside fence, LERF 200 E
Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton
Date: 9/08/08
Reviewed By: L. D. Walker
Date: 10/13/08
Signature:
Signature:

CONSTRUCTION DATA

Description:

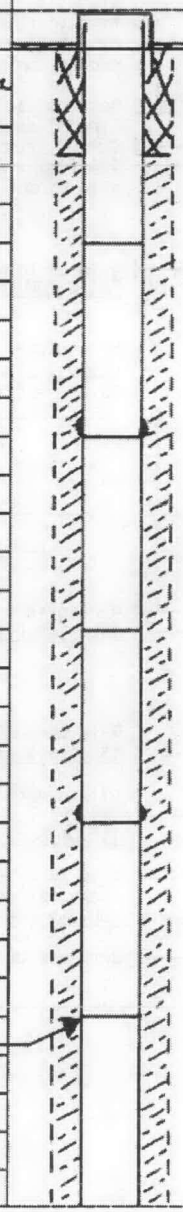
6" x 4' x 4' concrete pad
6" stainless steel protective monument:

4" ID Sch. 10 stainless steel casing: 1.96 ft ags to 200.85 ft bgs
4" stainless steel wire wrap screen, 0.020": 200.85 to 225.6 ft bgs
4" Sch. 10 stainless steel sump: 225.6 to 228.6 ft bgs

Portland cement grout: 0 to 11.05 ft bgs
Bentonite granules: 11.05 to 189.0 ft bgs
Bentonite pellets: 189.0 to 194.6 ft bgs
10-20 silica sand: 194.6 to 232.8 ft bgs

casing joint

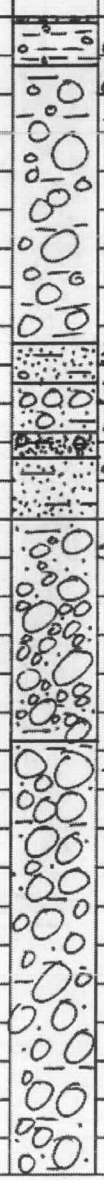
Diagram:



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 0, 20, 40, 60, 80, 100

Graphic Log:



Lithologic Description:

0-0.5: gravel drill pad
0.5-5: gravelly Silt (gM)
5-34: silty Gravel (mG)
34-38: gravelly silty Sand (gmS)
38-43: silty sandy Gravel (msG)
43-45.5: gravelly Sand (gS)
45.5-52: silty Sand (mS)
52-75: silty sandy Gravel (msG)
75-123: sandy silty Gravel (smG)

A-6003-643 (03/03)

Well Summary Sheet for Well 299-E26-77 in LERF Groundwater Monitoring Network (cont.)

WELL SUMMARY SHEET

Start Date: 08/12/2008
Finish Date: 02/05/2008
Page 2 of 2

Well ID: C6455	Well Name: 299-E26-77
Location: Inside fence, LERF, 200E	Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton — Date: 9/08/08	Reviewed By: L.J. Walker — Date: 10/13/08
Signature:	Signature:

CONSTRUCTION DATA

Description	Diagram
centralizer	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
120		123-124: Sand (S)
		124-126: gravelly Silt (gM)
		126-159: silty Gravel (mG)
140		
160		159-205.5: silty sandy Gravel (msG)
180		
200		DTW = 201.9 ft bgs on 08/27/2008
		205.5-233: basalt
220		TD = 232.8' bgs on 08/26/2008
		All depths recorded in feet "below ground surface" (bgs)

A-6003-643 (03/03)

Figure D.5 Well Summary Sheet for Well 299-E26-79 in LERF Groundwater Monitoring Network

WELL SUMMARY SHEET

Start Date: 09/09/2008
Finish Date: 10/02/2008
Page 1 of 2

Well ID: C.6826	Well Name: 299-E26-79
Location: Inside fence, LERF, 200E	Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton — Date: 10/6/08	Reviewed By: L.D. Walker — Date: 10/13/08
Signature: [signature]	Signature: [signature]

CONSTRUCTION DATA

Description	Diagram
6" x 4' x 4' concrete pad	
6" stainless steel protective monument: 3.0' bgs to 3.1' ags	
4" stainless steel Sch. 10 casing: 2.3 ft ags to 195.2 ft bgs	
4" stainless steel wire wrap screen, 0.020": 195.2 to 220.2' bgs	
4" stainless steel Sch. 10 sump: 220.2 to 223.2 ft bgs	
Portland cement grout: 0 to 10.3 ft bgs	
Bentonite granules: 10.3 to 183.0 ft bgs	
Bentonite pellets: 183.0 to 187.8 ft bgs	
10-20 silica sand: 187.8 to 224.76 ft bgs	
Casing joint	

GEOLOGIC/HYDROLOGIC DATA

Depth in Feet	Graphic Log	Lithologic Description
0		0-1: gravel drill pad
		1-27: sandy silty Gravel (sm G)
20		27-27.5: sandy Silt (sM)
		27.5-29: silty Gravel (m G)
		29-32: sandy Silt (sM)
		32-54: silty Sand (m S)
40		
		54-79: silty sandy Gravel (msG)
60		
80		79-119: sandy silty Gravel (sm G)
100		

A-6003-643 (03/03)

Well Summary Sheet for Well 299-E26-79
in LERF Groundwater Monitoring Network (cont.)

WELL SUMMARY SHEET

Start Date: 09/09/2008
Finish Date: 10/02/2008
Page 2 of 2

Well ID: C6826
Well Name: 299-E26-79
Location: Inside fence, LERF 200E
Project: M-24 RCRA Wells (LERF)
Prepared By: S. Sexton
Date: 10/6/08
Reviewed By: L. D. Walker
Date: 10/13/08
Signature:
Signature:

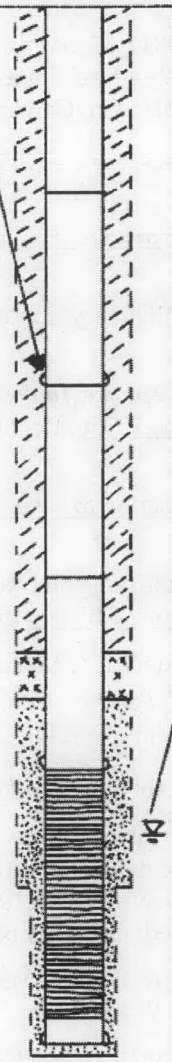
CONSTRUCTION DATA

Description

Centralizer

All temporary casing removed from borehole

Diagram



GEOLOGIC/HYDROLOGIC DATA

Depth in Feet: 120, 140, 160, 180, 200, 220

Graphic Log

Lithologic Description

119-135: silty sandy Gravel (ms/G)
135-152: Gravel (G)
152-200: silty sandy Gravel
DTW = 201.7 ft bgs on 09/22/2008
200-203: sandy Gravel (sG)
203-206: gravelly Sand (gS)
206-207: modified clay
207-224.76: basalt
TD = 224.76 ft bgs on 09/23/2008

All depths recorded in feet "below ground surface" (bgs)

A-6003-643 (03/03)

D.6 REFERENCES

40 CFR 141. "National Primary Drinking Water Regulations", "Radionuclides; Proposed Rule". U.S. Environmental Protection Agency, *Code of Federal Regulations*.

40 CFR 264, Appendix IX. "Ground-Water Monitoring List". U.S. Environmental Protection Agency, *Code of Federal Regulations*.

APHA/AWWA/WEF. (1998). *Standard Methods for the Examination of Water and Wastewater, 20th Edition*, as revised, American Public Health Association, American Water Works Association, and Water Environment Federation, Washington, D.C., ISBN: 0875530478.

ASTM. (1998). *Standard Guide for Developing Appropriate Statistical Approaches for Ground-Water Detection Monitoring Programs*. ASTM D 6312-98, American Society for Testing and Materials, West Conshohocken, Pennsylvania.

Delaney, C. D., K. A. Lindsey, and S. P. Reidel. (1991). *Geology and Hydrology of the Hanford Site: A Standardized Text for Use in Westinghouse Hanford Company Documents and Reports*. WHC-SD-EN-TI-003, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

Gibbons, R. D. (1994). *Statistical Methods for Groundwater Monitoring*. John Wiley & Sons, New York.

Gilbert, R. O. (1987). *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York.

Lucas, J. M. (1982). "Combined Shewhart-CUSUM Quality Control Schemes". In *Journal of Quality Technology*, 14:(2)51-59.

McDonald, J. P. (2007). *Water-Level Barometric Response Analysis for the Liquid Effluent Retention Facility Monitoring Wells, Hanford Site*. SGW-35756, Rev. 0, Fluor Hanford, Richland, Washington.

Montgomery, D. C., and E. A. Peck. (1982). *Introduction to Linear Regression Analysis.*, John Wiley & Sons, New York.

Rasmussen, T. C., and L. A. Crawford. (1997). "Identifying and Removing Barometric Pressure Effects in Confined and Unconfined Aquifers". In *Ground Water*, 35: 502-511.

RCW 70.105. "Public Health and Safety", "Hazardous Waste Management". Washington State Department of Ecology, *Revised Code of Washington*.

Resource Conservation and Recovery Act of 1976, 42 U.S.C.6901, et seq.

Sen, P. K. (1968). "Estimates of the Regression Coefficient Based on Kendall's Tau". In *Journal of the American Statistical Association* 63:1379-1389.

Sexton, S. M. (2008). Borehole Summary Report for the Installation of RCRA Wells 299-E26-77 (C6455), 299-E26-79 (C6826), 299-E25-236 (C6542), and 199-N-165 (C6693), FY 2008. SGW-39344, Rev. 0, CH2M Hill Plateau Remediation Company, Richland, Washington.

Smoot, J. L. (2009). *Liquid Effluent Retention Facility Characterization Report*. SGW-41072, CH2M Hill Plateau Remediation Company, Richland, Washington.

Spane, F. A., and Newcomer, D. R. (2004). *Results of Detailed Hydrologic Characterization Tests - Fiscal Year 2003*. PNNL-14804, Pacific Northwest National Laboratory, Richland, Washington.

Starks TH. (1988). *Evaluation of Control Chart Methodologies for RCRA Waste Sites*, (EPA/600/4-88/040), U.S. Environmental Protection Agency Office of Research and Development, Las Vegas, Nevada.

SW-846. (1986). *Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods*, 3rd Edition, as amended. U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Washington, D.C.

Sweeney, M. D., K. A. Lindsey, J. S. Schmid, and J. V. Borghese. (1994). *Site Characterization Report for the Liquid Effluent Retention Facility*. WHC-SD-EN-EV-024, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

U.S. DOE. (1993). *200 East Groundwater Aggregate Area Management Study Report*. DOE/RL-92-19, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

U.S. DOE. (2009). *Hanford Site Groundwater monitoring for Fiscal Year 2008*. DOE/RL-2008-66, Rev. 0, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

U.S. EPA. (1979). *Methods for Chemical Analysis of Water and Wastes*. EPA-600/4-79-020, as revised, U.S. Environmental Protection Agency, Washington, D.C.

U.S. EPA. (2009), *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Unified Guidance*. EPA 530-R-09-007, U.S. Environmental Protection Agency, Washington, D.C.

Westgard, J. O., T. Groth, T. Aronson, and C. De Verdier. (1977). "Combined Shewhart-CUSUM Control Chart for Improved Quality Control in Clinical Chemistry". In *Clinical Chemistry*, 28(10):1881-1887.

Williams, B. A., B. N. Bjornstad, R. Schalla, and W. D. Webber. (2000). *Revised Hydrogeology for the Suprabasalt Aquifer System, 200-East Area and Vicinity, Hanford Site, Washington*. PNNL-12261, Pacific Northwest National Laboratory, Richland, Washington.

This page intentionally left blank.