

AR TARGET SHEET

The following document was too large to scan as one unit, therefore, it has been broken down into sections.

EDMC#: 0062811

SECTION: 8 OF 15

DOCUMENT #: WA7890008967 Rev 8

TITLE: Hanford Facility RCRA
Permit, Dangerous Waste
Portion, Rev 008, 9/04

ATTACHMENT 34
Liquid Effluent Retention Facility and
200 Area Effluent Treatment Facility

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1 **Contents**

2 1.0 PART A DANGEROUS WASTE PERMIT Att 34.1-i
3 Liquid Effluent Retention Facility
4 200 Area Effluent Treatment Facility

1 **1.0 PART A, FORM 3, DANGEROUS WASTE PERMIT**

2 The following is a chronology of the regulatory history of the Liquid Effluent Retention Facility (LERF)
3 and 200 Area Effluent Treatment Facility (ETF).

4 **LERF:**

- 5 • On February 26, 1990, the original Hanford Facility Dangerous Waste Part A Permit Application
6 (Part A), Form 3, Revision 0, was submitted to the Washington State Department of Ecology
7 (Ecology).
- 8 • On June 26, 1991, the Part A, Form 3, Revision 1, added nonspecific source Dangerous Waste
9 Number F005 to corresponded with the dangerous waste numbers from the Double-Shell Tank (DST)
10 System and 242-A Evaporator.
- 11 • On May 17, 1993, the Part A, Form 3, Revision 2, added nonspecific source Dangerous Waste
12 Numbers F001, F002, and F004 to corresponded with the dangerous waste numbers from the DST
13 System and 242-A Evaporator.
- 14 • On November 4, 1994, the Part A, Form 3, Revision 3, added nonspecific source Dangerous Waste
15 Number F003 to correspond with the dangerous waste numbers from the DST System and
16 242-A Evaporator.
- 17 • On February 9, 1996, the Part A, Form 3, Revision 4, added treatment capability (for treatment of
18 dilute aqueous waste streams from other Hanford Facility generators) pursuant to treatment surface
19 impoundment exemption located in Title 40 Code of Federal Regulations Part 268.4
- 20 • On October 1, 1996, the Part A, Form 3, Revision 5, supported the transition of this treatment,
21 storage, and/or disposal (TSD) unit to the new Project Hanford Management Contractor.
- 22 • On May 22, 1998, the Part A, Form 3, Revision 6, was submitted to increase the waste management
23 capacity from 24,605,000 liters per basin to 29,500,000 liters per basin.

24 **ETF:**

- 25 • On June 26, 1991, the original Hanford Facility Dangerous Waste Part A, Form 3, Revision 0, was
26 submitted to Ecology.
- 27 • On August 25, 1993, the Part A, Form 3, Revision 1, added three 2,536,000-liter verification tanks for
28 greater-than-90 day storage and a greater-than-90 day container storage area. Also added six new
29 dangerous waste numbers to reflect the waste that could be stored in the verification tanks and 32 new
30 dangerous waste numbers that could be stored in the container storage area.
- 31 • On October 1, 1996, the Part A, Form 3, Revision 2, was revised to support the transition of this
32 TSD unit to the new Project Hanford Management Contractor. Also added Dangerous Waste Number
33 F039 (multi-source leachate). Dangerous Waste Number F039 was added to support Low-Level
34 Burial Grounds efforts to treat, store, and/or dispose of multi-source leachate from the mixed waste
35 trenches and from other potential sources of leachate.
- 36 • On May, 22, 1998, the Part A, Form 3, Revision 3, was submitted to add treatment of waste in
37 containers as a new process. This process was added to address sludge which accumulates in the
38 bottoms of the ETF process tanks. This waste is periodically removed and placed into containers.
39 The waste is solidified by decanting the supernate from the container and the remainder of the waste
40 is then allowed to evaporate or absorbents are added as necessary to address remaining liquids.
41 Following treatment, this waste is either stored at the ETF or transferred to another TSD unit..

FORM 3	DANGEROUS WASTE PERMIT APPLICATION	I. EPA/State I.D. No.												
		<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:2.5%;">W</td><td style="width:2.5%;">A</td><td style="width:2.5%;">7</td><td style="width:2.5%;">8</td><td style="width:2.5%;">9</td><td style="width:2.5%;">0</td><td style="width:2.5%;">0</td><td style="width:2.5%;">0</td><td style="width:2.5%;">8</td><td style="width:2.5%;">9</td><td style="width:2.5%;">6</td><td style="width:2.5%;">7</td> </tr> </table>	W	A	7	8	9	0	0	0	8	9	6	7
W	A	7	8	9	0	0	0	8	9	6	7			

OFFICIAL USE ONLY		
Application Approved	Date Received (month/ day / year)	Comments

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or If this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. First Application (place an "X" below and provide the appropriate date)

<input type="checkbox"/> 1. Existing Facility (See instructions for definition of "existing" facility. Complete item below.)	<input type="checkbox"/> 2. New Facility (Complete item below.)
-------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------

<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>MO</th><th>DAY</th><th>YEAR</th></tr> <tr><td>03</td><td>22</td><td>1943</td></tr> </table>	MO	DAY	YEAR	03	22	1943	*For existing facilities, provide the date (mo/day/yr) operation began or the date construction commenced. (use the boxes to the left) *The date construction of the Hanford Facility commenced	<table border="1" style="width:100%; border-collapse: collapse;"> <tr><th>MO</th><th>DAY</th><th>YEAR</th></tr> <tr><td> </td><td> </td><td> </td></tr> </table>	MO	DAY	YEAR				For new facilities, provide the date (mo/day/yr) operation began or is expected to begin
MO	DAY	YEAR													
03	22	1943													
MO	DAY	YEAR													

B. Revised Application (Place an "X" below and complete Section I above)

<input checked="" type="checkbox"/> 1. Facility has an interim Status Permit	<input checked="" type="checkbox"/> 2. Facility has a Final Permit
-------------------------------------------------------------------------------------	---------------------------------------------------------------------------

III. PROCESSES - CODES AND DESIGN CAPACITIES

A. Process Code - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the codes(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process (including its design capacity) in the space provided on the (Section III-C).

B. Process Design Capacity - For each code entered in column A enter the capacity of the process.

- Amount - Enter the amount.
- Unit of Measure - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
STORAGE:		
Container (barrel, drum, etc.)	S01	Gallons or liters
Tank	S02	Gallons or liters
Waste pile	S03	Cubic yards or cubic meters
Surface impoundment	S04	Gallons or liters
	S06	Cubic yards or cubic meters*
DISPOSAL:		
Injection well	D80	Gallons or liters
Landfill	D81	Acre-feet (the volume that would cover one acre to a Depth of one foot) or hectare-meter
Land application	D82	Acres or hectares
Ocean disposal	D83	Gallons per day or liters per day
Surface impoundment	D84	Gallons or liters
TREATMENT:		
Tank	T01	Gallons per day or liters per day
Surface impoundment	T02	Gallons per day or liters per day
Incinerator	T03	Tons per hour or metric tons per hour; gallons per hour or liters-per hour
Other (use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	Gallons per day or liters per day

Unit of Measure	Unit of Measure Code	Unit of Measure	Unit of Measure Code	Unit of Measure	Unit of Measure Code
Gallons.....	G	Liters Per Day.....	V	Acre-Feet.....	A
Liters.....	L	Tons Per Hour.....	D	Hectare-Meter.....	F
Cubic Yards.....	Y	Metric Tons Per Hour.....	W	Acres.....	B
Cubic Meters.....	C	Gallons Per Hour.....	E	Hectares.....	Q
Gallons Per Day.....	U	Liters Per Hour.....	H		

III. PROCESS - CODES AND DESIGN CAPACITIES (continued)

Example for Completing Section III (shown in line numbers X-1 and X-2 below): A facility has two storage tanks; one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

Line No.	A. Process Code (from list above)			B. process Design Capacity			For Official Use Only				
				1. Amount (Specify)	2. Unit of Measure (enter code)						
X-1	S	0	2	600		G					
X-2	T	0	3	20		E					
1	S	0	4	88,500,000		L					
2	T	0	2	88,500,000		V					
3											
4											
5											
6											
7											
8											
9											
10											

C. Space for additional process codes or for describing other process (code "T04"). For each process entered here include design capacity.

Construction of the Liquid Effluent Retention Facility (LERF) began in 1990. Waste management operations began at LERF in April 1994.

IV. DESCRIPTION OF DANGEROUS WASTES

A. Dangerous Waste Number - Enter the digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four-digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. Estimated Annual Quantity - For each listed waste entered in column A, estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A, estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. Unit of Measure - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
Pounds	P	Kilograms	K
Tons	T	Metric Tons	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. Processes

1. Process Codes:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. Process Description: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

- Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
- In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "Included with above" and make no other entries on that line.
- Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

Example for completing Section IV (shown in line numbers X-1, X-2, X-3, and X-4 below) - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste.

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)		D. Processes			
								1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))	
X-1	K	0	5	4	900		P	T03	D80		
X-2	D	0	0	2	400		P	T03	D80		
X-3	D	0	0	1	100		P	T03	D80		
X-4	D	0	0	2				T03	D80		Included with above

Photocopy this page before completing if you have more than 26 wastes to list.

I.D. Number (enter from page 1)										
W	A	7	8	9	0	0	0	8	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)		D. Processes			
								1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))	
1	D	0	0	1	88,497,000	K		S04	T02		Storage/Treatment-Surface Impoundment
2	D	0	0	2		K		S04	T02		Storage/Treatment-Surface Impoundment
3	D	0	0	3		K		S04	T02		Storage/Treatment-Surface Impoundment
4	D	0	0	4		K		S04	T02		Storage/Treatment-Surface Impoundment
5	D	0	0	5		K		S04	T02		Storage/Treatment-Surface Impoundment
6	D	0	0	6		K		S04	T02		Storage/Treatment-Surface Impoundment
7	D	0	0	7		K		S04	T02		Storage/Treatment-Surface Impoundment
8	D	0	0	8		K		S04	T02		Storage/Treatment-Surface Impoundment
9	D	0	0	9		K		S04	T02		Storage/Treatment-Surface Impoundment
10	D	0	1	0		K		S04	T02		Storage/Treatment-Surface Impoundment
11	D	0	1	1		K		S04	T02		Storage/Treatment-Surface Impoundment
12	D	0	1	8		K		S04	T02		Storage/Treatment-Surface Impoundment
13	D	0	1	9		K		S04	T02		Storage/Treatment-Surface Impoundment
14	D	0	2	2		K		S04	T02		Storage/Treatment-Surface Impoundment
15	D	0	2	8		K		S04	T02		Storage/Treatment-Surface Impoundment
16	D	0	2	9		K		S04	T02		Storage/Treatment-Surface Impoundment
17	D	0	3	0		K		S04	T02		Storage/Treatment-Surface Impoundment
18	D	0	3	3		K		S04	T02		Storage/Treatment-Surface Impoundment
19	D	0	3	4		K		S04	T02		Storage/Treatment-Surface Impoundment
20	D	0	3	5		K		S04	T02		Storage/Treatment-Surface Impoundment
21	D	0	3	6		K		S04	T02		Storage/Treatment-Surface Impoundment
22	D	0	3	8		K		S04	T02		Storage/Treatment-Surface Impoundment
23	D	0	3	9		K		S04	T02		Storage/Treatment-Surface Impoundment
24	D	0	4	0		K		S04	T02		Storage/Treatment-Surface Impoundment
25	D	0	4	1		K		S04	T02		Storage/Treatment-Surface Impoundment
26	D	0	4	3		K		S04	T02		Storage/Treatment-Surface Impoundment
27	F	0	0	1		K		S04	T02		Storage/Treatment-Surface Impoundment
28	F	0	0	2		K		S04	T02		Storage/Treatment-Surface Impoundment
29	F	0	0	3		K		S04	T02		Storage/Treatment-Surface Impoundment
30	F	0	0	4		K		S04	T02		Storage/Treatment-Surface Impoundment
31	F	0	0	5		K		S04	T02		Storage/Treatment-Surface Impoundment
32	F	0	3	9		K		S04	T02		Storage/Treatment-Surface Impoundment
33	W	T	0	1		K		S04	T02		Storage/Treatment-Surface Impoundment
34	W	T	0	2		K		S04	T02		Storage/Treatment-Surface Impoundment
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46											

IV. DESCRIPTION OF DANGEROUS WASTE (continued)

Use this space to list additional process codes from Section D(1) on page 3.

V. FACILITY DRAWING Refer to attached drawing(s).

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS Refer to attached photograph(s).

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

This information is provided on the attached drawings and photos.

LATITUDE (degrees, minutes, & seconds)

LONGITUDE (degrees, minutes, & seconds)

VIII. FACILITY OWNER

- A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information," place an "X" in the box to the left and skip to Section XI below.
- B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. Name of Facility's Legal Owner		2. Phone Number (area code & no.)	
3. Street or P.O. Box		4. City or Town	5. St.
		6. Zip Code	

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Name (print or type) John D. Wagoner, Manager U.S. Department of Energy Richland Operations Office	Signature L. L. Piper for	Date Signed Revision 6 signed 05/22/1998
-------------------------------------------------------------------------------------------------------------	------------------------------	------------------------------------------------

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Name (Print Or Type) See attachment	Signature	Date Signed
----------------------------------------	-----------	-------------

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

L. L. Piper for

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

5/22/98

Date Revision 6 Signed

H. J. Hatch

Co-Operator
H. J. Hatch,
President and Chief Executive Officer
Fluor Daniel Hanford, Inc.

5/14/98

Date Revision 6 Signed

FORM 3	DANGEROUS WASTE PERMIT APPLICATION	I. EPA/State I.D. No.
		W A 7 8 9 0 0 0 8 9 6 7

R OFFICIAL USE ONLY		
Application Approved	Date Received (month/ day / year)	Comments

II. FIRST OR REVISED APPLICATION

Place an "X" in the appropriate box in A or B below (mark one box only) to indicate whether this is the first application you are submitting for your facility or a revised application. If this is your first application and you already know your facility's EPA/STATE I.D. Number, or If this is a revised application, enter your facility's EPA/STATE I.D. Number in Section I above.

A. First Application (place an "X" below and provide the appropriate date)

1. Existing Facility (See instructions for definition of "existing" facility. Complete item below.)

MO	DAY	YEAR
03	22	1943

*For existing facilities, provide the date (mo/day/yr) operation began or the date construction commenced. (use the boxes to the left)

2. New Facility (Complete item below.)

MO	DAY	YEAR

For new facilities, provide the date (mo/day/yr) operation began or is expected to begin

*The date construction of the Hanford Facility commenced

B. Revised Application (Place an "X" below and complete Section I above)

1. Facility has an interim Status Permit

2. Facility has a Final Permit

III. PROCESSES - CODES AND DESIGN CAPACITIES

A. Process Code - Enter the code from the list of process codes below that best describes each process to be used at the facility. Ten lines are provided for entering codes. If more lines are needed, enter the codes(s) in the space provided. If a process will be used that is not included in the list of codes below, then describe the process (including its design capacity) in the space provided on the (Section III-C).

B. Process Design Capacity - For each code entered in column A enter the capacity of the process.

- Amount - Enter the amount.
- Unit of Measure - For each amount entered in column B(1), enter the code from the list of unit measure codes below that describes the unit of measure used. Only the units of measure that are listed below should be used.

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
STORAGE:		
Container (barrel, drum, etc.)	S01	Gallons or liters
Tank	S02	Gallons or liters
Waste pile	S03	Cubic yards or cubic meters
Surface impoundment	S04	Gallons or liters
	S06	Cubic yards or cubic meters*
DISPOSAL:		
Injection well	D80	Gallons or liters
Landfill	D81	Acre-feet (the volume that would cover one acre to a Depth of one foot) or hectare-meter
Land application	D82	Acres or hectares
Ocean disposal	D83	Gallons per day or liters per day
Surface impoundment	D84	Gallons or liters
TREATMENT:		
Tank	T01	Gallons per day or liters per day
Surface impoundment	T02	Gallons per day or liters per day
Incinerator	T03	Tons per hour or metric tons per hour; gallons per hour or liters per hour
Other (use for physical, chemical, thermal or biological treatment processes not occurring in tanks, surface impoundments or incinerators. Describe the processes in the space provided; Section III-C.)	T04	Gallons per day or liters per day

Unit of Measure	Unit of Measure Code	Unit of Measure	Unit of Measure Code	Unit of Measure	Unit of Measure Code
Gallons.....	G	Liters Per Day	V	Acre-Feet	A
Liters.....	L	Tons Per Hour.....	D	Hectare-Meter	F
Cubic Yards.....	Y	Metric Tons Per Hour	W	Acres	B
Cubic Meters.....	C	Gallons Per Hour	E	Hectares	Q
Gallons Per Day.....	U	Liters Per Hour.....	H		

III. PROCESS - CODES AND DESIGN CAPACITIES (continued)

Example for Completing Section III (shown in line numbers X-1 and X-2 below): A facility has two storage tanks; one tank can hold 200 gallons and the other can hold 400 gallons. The facility also has an incinerator that can burn up to 20 gallons per hour.

Line No.	A. Process Code (from list above)			B. process Design Capacity		For Official Use Only			
				1. Amount (Specify)	2. Unit of Measure (enter code)				
X-1	S	0	2	600	G				
X-2	T	0	3	20	E				
1	T	0	1	817,646	V				
2	S	0	2	7,608,654	L				
3	S	0	1	147,630	L				
4	T	0	4	18,927	V				
5									
6									
7									
8									
9									
10									

C. Space for additional process codes or for describing other process (code "T04"). For each process entered here include design capacity.

Construction of the 200 Area Effluent Treatment Facility (ETF) began in 1992. Waste management operations began at ETF in November of 1995.

T04

Sludge that accumulates in the bottoms of ETF process tanks is removed periodically and placed into containers. The waste is solidified by decanting the supernate from the container and the remainder of the liquid is allowed to evaporate, or absorbents are added, as necessary, to address the residual liquid. The process design capacity for treatment of waste in containers is 18,927 liters per day.

IV. DESCRIPTION OF DANGEROUS WASTES

Dangerous Waste Number - Enter the digit number from Chapter 173-303 WAC for each listed dangerous waste you will handle. If you handle dangerous wastes which are not listed in Chapter 173-303 WAC, enter the four-digit number(s) that describes the characteristics and/or the toxic contaminants of those dangerous wastes.

B. Estimated Annual Quantity - For each listed waste entered in column A, estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A, estimate the total annual quantity of all the non-listed waste(s) that will be handled which possess that characteristic or contaminant.

C. Unit of Measure - For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
Pounds	P	Kilograms	K
Tons	T	Metric Tons	M

If facility records use any other unit of measure for quantity, the units of measure must be converted into one of the required units of measure taking into account the appropriate density or specific gravity of the waste.

D. Processes

1. Process Codes:

For listed dangerous waste: For each listed dangerous waste entered in column A select the code(s) from the list of process codes contained in Section III to indicate how the waste will be stored, treated, and/or disposed of at the facility.

For non-listed dangerous wastes: For each characteristic or toxic contaminant entered in Column A, select the code(s) from the list of process codes contained in Section III to indicate all the processes that will be used to store, treat, and/or dispose of all the non-listed dangerous wastes that possess that characteristic or toxic contaminant.

Note: Four spaces are provided for entering process codes. If more are needed: (1) Enter the first three as described above; (2) Enter "000" in the extreme right box of item IV-D(1); and (3) Enter in the space provided on page 4, the line number and the additional code(s).

2. Process Description: If a code is not listed for a process that will be used, describe the process in the space provided on the form.

NOTE: DANGEROUS WASTES DESCRIBED BY MORE THAN ONE DANGEROUS WASTE NUMBER - Dangerous wastes that can be described by more than one Waste Number shall be described on the form as follows:

- Select one of the Dangerous Waste Numbers and enter it in column A. On the same line complete columns B, C, and D by estimating the total annual quantity of the waste and describing all the processes to be used to treat, store, and/or dispose of the waste.
- In column A of the next line enter the other Dangerous Waste Number that can be used to describe the waste. In column D(2) on that line enter "Included with above" and make no other entries on that line.
- Repeat step 2 for each other Dangerous Waste Number that can be used to describe the dangerous waste.

Example for completing Section IV (shown in line numbers X-1, X-2, X-3, and X-4 below) - A facility will treat and dispose of an estimated 900 pounds per year of chrome shavings from leather tanning and finishing operation. In addition, the facility will treat and dispose of three non-listed wastes. Two wastes are corrosive only and there will be an estimated 200 pounds per year of each waste.

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)			D. Processes				
									1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))		
X-1	K	0	5	4	900		P	T03	D80				
X-2	D	0	0	2	400		P	T03	D80				
X-3	D	0	0	1	100		P	T03	D80				
X-4	D	0	0	2				T03	D80				Included with above

Photocopy this page before completing if you have more than 26 wastes to list.

I.D. Number (enter from page 1)											
W	A	7	8	9	0	0	0	8	8	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)		D. Processes			
								1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))	
1	D	0	0	1	298,434,296	K		T01			Treatment-Tank
2	D	0	0	2		K		T01			Treatment-Tank
3	D	0	0	3		K		T01			Treatment-Tank
4	D	0	0	4		K		T01			Treatment-Tank
5	D	0	0	5		K		T01			Treatment-Tank
6	D	0	0	6		K		T01			Treatment-Tank
7	D	0	0	7		K		T01			Treatment-Tank
8	D	0	0	8		K		T01			Treatment-Tank
9	D	0	0	9		K		T01			Treatment-Tank
10	D	0	1	0		K		T01			Treatment-Tank
11	D	0	1	1		K		T01			Treatment-Tank
12	D	0	1	8		K		T01			Treatment-Tank
13	D	0	1	9		K		T01			Treatment-Tank
14	D	0	2	2		K		T01			Treatment-Tank
15	D	0	2	8		K		T01			Treatment-Tank
16	D	0	2	9		K		T01			Treatment-Tank
17	D	0	3	0		K		T01			Treatment-Tank
18	D	0	3	3		K		T01			Treatment-Tank
19	D	0	3	4		K		T01			Treatment-Tank
20	D	0	3	5		K		T01			Treatment-Tank
21	D	0	3	6		K		T01			Treatment-Tank
22	D	0	3	8		K		T01			Treatment-Tank
23	D	0	3	9		K		T01			Treatment-Tank
24	D	0	4	0		K		T01			Treatment-Tank
25	D	0	4	1		K		T01			Treatment-Tank
26	D	0	4	3		K		T01			Treatment-Tank
27	F	0	0	1	K		T01			Treatment-Tank	
28	F	0	0	2	K		T01			Treatment-Tank	
29	F	0	0	3	K		T01			Treatment-Tank	
30	F	0	0	4	K		T01			Treatment-Tank	
31	F	0	0	5	K		T01			Treatment-Tank	
32	F	0	3	9	K		T01			Treatment-Tank	
33	W	T	0	1	K		T01			Treatment-Tank	
34	W	T	0	2	K		T01			Treatment-Tank	
35	D	0	0	1	30,433,326	K		S02			Storage-Tank
36	D	0	0	2		K		S02			Storage-Tank
37	D	0	0	3		K		S02			Storage-Tank
38	D	0	0	4		K		S02			Storage-Tank
39	D	0	0	5		K		S02			Storage-Tank
40	D	0	0	6		K		S02			Storage-Tank
41	D	0	0	7		K		S02			Storage-Tank
42	D	0	0	8		K		S02			Storage-Tank
43	D	0	0	9		K		S02			Storage-Tank
44	D	0	1	0		K		S02			Storage-Tank
45	D	0	1	1		K		S02			Storage-Tank
46	D	0	1	8		K		S02			Storage-Tank

Photocopy this page before completing if you have more than 26 wastes to list.

I.D. Number (enter from page 1)										
W	A	7	8	9	0	0	0	8	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)			D. Processes	
	1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))							
47	D	0	1	9		K		S02	Storage-Tank	
48	D	0	2	2		K		S02	Storage-Tank	
49	D	0	2	8		K		S02	Storage-Tank	
50	D	0	2	9		K		S02	Storage-Tank	
51	D	0	3	0		K		S02	Storage-Tank	
52	D	0	3	3		K		S02	Storage-Tank	
53	D	0	3	4		K		S02	Storage-Tank	
54	D	0	3	5		K		S02	Storage-Tank	
55	D	0	3	6		K		S02	Storage-Tank	
56	D	0	3	8		K		S02	Storage-Tank	
57	D	0	3	9		K		S02	Storage-Tank	
58	D	0	4	0		K		S02	Storage-Tank	
59	D	0	4	1		K		S02	Storage-Tank	
60	D	0	4	3		K		S02	Storage-Tank	
61	F	0	0	1		K		S02	Storage-Tank	
62	F	0	0	2		K		S02	Storage-Tank	
63	F	0	0	3		K		S02	Storage-Tank	
64	F	0	0	4		K		S02	Storage-Tank	
65	F	0	0	5		K		S02	Storage-Tank	
66	F	0	3	9		K		S02	Storage-Tank	
67	W	T	0	1		K		S02	Storage-Tank	
68	W	T	0	2		K		S02	Storage-Tank	
69	D	0	0	1	1,986,735	K		S01	Storage-Container	
70	D	0	0	2		K		S01	Storage-Container	
71	D	0	0	3		K		S01	Storage-Container	
72	D	0	0	4		K		S01	Storage-Container	
73	D	0	0	5		K		S01	Storage-Container	
74	D	0	0	6		K		S01	Storage-Container	
75	D	0	0	7		K		S01	Storage-Container	
76	D	0	0	8		K		S01	Storage-Container	
77	D	0	0	9		K		S01	Storage-Container	
78	D	0	1	0		K		S01	Storage-Container	
79	D	0	1	1		K		S01	Storage-Container	
80	D	0	1	8		K		S01	Storage-Container	
81	D	0	1	9		K		S01	Storage-Container	
82	D	0	2	2		K		S01	Storage-Container	
83	D	0	2	8		K		S01	Storage-Container	
84	D	0	2	9		K		S01	Storage-Container	
85	D	0	3	0		K		S01	Storage-Container	
86	D	0	3	3		K		S01	Storage-Container	
87	D	0	3	4		K		S01	Storage-Container	
88	D	0	3	5		K		S01	Storage-Container	
89	D	0	3	6		K		S01	Storage-Container	
90	D	0	3	8		K		S01	Storage-Container	
91	D	0	3	9		K		S01	Storage-Container	
92	D	0	4	0		K		S01	Storage-Container	

Photocopy this page before completing if you have more than 26 wastes to list.

I.D. Number (enter from page 1)											
W	A	7	8	9	0	0	0	8	9	6	7

IV. DESCRIPTION OF DANGEROUS WASTES (continued)

Line No.	A. Dangerous Waste No. (enter code)				B. Estimated Annual Quantity of Waste	C. Unit of Measure (enter code)		D. Processes			
								1. Process Codes (enter)		2. Process Description (if a code is not entered in D(1))	
93	D	0	4	1		K		S01			Storage-Container
94	D	0	4	3		K		S01			Storage-Container
95	F	0	0	1		K		S01			Storage-Container
96	F	0	0	2		K		S01			Storage-Container
97	F	0	0	3		K		S01			Storage-Container
98	F	0	0	4		K		S01			Storage-Container
99	F	0	0	5		K		S01			Storage-Container
100	F	0	3	9		K		S01			Storage-Container
101	W	T	0	1		K		S01			Storage-Container
102	W	T	0	2		K		S01			Storage-Container
103	D	0	0	1	81,310	K		T04			Treatment-Containers
104	D	0	0	2		K		T04			Treatment-Containers
105	D	0	0	3		K		T04			Treatment-Containers
106	D	0	0	4		K		T04			Treatment-Containers
107	D	0	0	5		K		T04			Treatment-Containers
108	D	0	0	6		K		T04			Treatment-Containers
109	D	0	0	7		K		T04			Treatment-Containers
110	D	0	0	8		K		T04			Treatment-Containers
111	D	0	0	9		K		T04			Treatment-Containers
112	D	0	1	0		K		T04			Treatment-Containers
113	D	0	1	1		K		T04			Treatment-Containers
114	D	0	1	8		K		T04			Treatment-Containers
115	D	0	1	9		K		T04			Treatment-Containers
116	D	0	2	2		K		T04			Treatment-Containers
117	D	0	2	8		K		T04			Treatment-Containers
118	D	0	2	9		K		T04			Treatment-Containers
119	D	0	3	0		K		T04			Treatment-Containers
120	D	0	3	3		K		T04			Treatment-Containers
121	D	0	3	4		K		T04			Treatment-Containers
122	D	0	3	5		K		T04			Treatment-Containers
123	D	0	3	6		K		T04			Treatment-Containers
124	D	0	3	8		K		T04			Treatment-Containers
125	D	0	3	9		K		T04			Treatment-Containers
126	D	0	4	0		K		T04			Treatment-Containers
127	D	0	4	1		K		T04			Treatment-Containers
128	D	0	4	3		K		T04			Treatment-Containers
129	F	0	0	1		K		T04			Treatment-Containers
130	F	0	0	2		K		T04			Treatment-Containers
131	F	0	0	3		K		T04			Treatment-Containers
132	F	0	0	4		K		T04			Treatment-Containers
133	F	0	0	5		K		T04			Treatment-Containers
134	F	0	3	9		K		T04			Treatment-Containers
135	W	T	0	1		K		T04			Treatment-Containers
136	W	T	0	2		K		T04			Treatment-Containers

IV. DESCRIPTION OF DANGEROUS WASTE (continued)

Use this space to list additional process codes from Section D(1) on page 3.

V. FACILITY DRAWING Refer to attached drawing(s).

All existing facilities must include in the space provided on page 5 a scale drawing of the facility (see instructions for more detail).

VI. PHOTOGRAPHS Refer to attached photograph(s).

All existing facilities must include photographs (aerial or ground-level) that clearly delineate all existing structures; existing storage, treatment and disposal areas; and sites of future storage, treatment or disposal areas (see instructions for more detail).

VII. FACILITY GEOGRAPHIC LOCATION

This information is provided on the attached drawings and photos.

LATITUDE (degrees, minutes, & seconds)

LONGITUDE (degrees, minutes, & seconds)

VIII. FACILITY OWNER

- A. If the facility owner is also the facility operator as listed in Section VII on Form 1, "General Information," place an "X" in the box to the left and skip to Section XI below.
- B. If the facility owner is not the facility operator as listed in Section VII on Form 1, complete the following items:

1. Name of Facility's Legal Owner

2. Phone Number (area code & no.)

3. Street or P.O. Box

4. City or Town

5. St.

6. Zip Code

IX. OWNER CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Name (print or type)

Signature

Date Signed

John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

L. L. Piper for

Revision 3 signed
5/22/1998

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

Name (Print Or Type)

Signature

Date Signed

See attachment

X. OPERATOR CERTIFICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

L. L. Piper for

Owner/Operator
John D. Wagoner, Manager
U.S. Department of Energy
Richland Operations Office

5/22/98

Date Revision 3 Signed

H. J. Hatch

Co-Operator
H. J. Hatch,
President and Chief Executive Officer
Fluor Daniel Hanford, Inc.

5/14/98

Date Revision 3 Signed

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11
12
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3.0 WASTE ANALYSIS [C]

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 x 10 ⁻⁴	pounds per square inch

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

1 **3.1 INTRODUCTION**

2 In accordance with the federal and state regulations set forth in 40 Code of Federal Regulations (CFR)
3 264.13 and in Washington State Department of Ecology (Ecology) *Dangerous Waste Regulations*,
4 Washington Administrative Code (WAC) 173-303-300, this waste analysis plan (WAP) has been
5 prepared for operation of the Liquid Effluent Retention Facility (LERF) and the 200 Area Effluent
6 Treatment Facility (ETF) located in the 200 East Area on the Hanford Site, Richland, Washington.

7 The Permittees shall comply with all the requirements, subsections, figures, tables, and appendices,
8 included in the "Waste Analysis Plan for Liquid Effluent Retention Facility and 200 Area Effluent
9 Treatment Facility, except that the "Wastewater Profile Sheet Form" is included as an example only. The
10 actual Wastewater Profile Sheet format may vary, but will contain the same substantive information as the
11 example form.

12 The purpose of this WAP is to document the sampling and analytical methods, and describe the
13 procedures used for all dangerous waste managed in the specific treatment storage, and disposal (TSD)
14 units identified in the Part A, Form 3, for the LERF and ETF. This WAP also documents the
15 requirements for generators sending aqueous waste to the LERF or ETF for treatment. Throughout this
16 WAP, the term generator includes any Hanford Site unit, including TSD units, whose process produces an
17 aqueous waste.

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

- 24 • Influent Waste Acceptance Process - determines the acceptability of a particular aqueous waste at the
25 LERF or ETF pursuant to applicable permit conditions, regulatory requirements, and operating
26 capabilities prior to acceptance of the waste at the LERF or ETF for treatment or storage. Refer to
27 Section 3.2.
- 28 • Special Management Requirements - identifies the special management requirements for aqueous
29 wastes managed in the LERF or ETF. Refer to Section 3.3.
- 30 • Influent Aqueous Waste Sampling and Analysis - describes influent sampling and analyses used to
31 characterize an influent aqueous waste to ensure proper management of the waste and for compliance
32 with the special management requirements. Also includes rationale for analyses. Refer to
33 Section 3.4.
- 34 • Treated Effluent Sampling and Analysis - describes sampling and analyses of treated effluent
35 (i.e., treated aqueous waste) for compliance with State Waste Discharge Permit (Ecology 1995a) and
36 Final Delisting [40 CFR 261, Appendix IX, Table 2 (EPA, 1995)] limits. Also includes rationale for
37 analyses. Refer to Section 3.5.
- 38 • ETF Generated Waste Sampling and Analysis - describes the sampling and analyses used to
39 characterize the secondary waste streams generated from the treatment process and to characterize
40 waste generated from maintenance and operations activities. Also includes rationale for analyses.
41 Refer to Section 3.6.
- 42 • Quality Assurance and Quality Control - ensures the accuracy and precision of sampling and analysis
43 activities. Refer to Section 3.7.

1 This WAP meets the specific requirements of the following:

- 2 • Land Disposal Restrictions Treatment Exemption for the LERF under 40 CFR 268.4,
3 U.S. Environmental Protection Agency, December 6, 1994 (Appendix C)
- 4 • Final Delisting for ETF, 40 CFR 261, Appendix IX, Table 2 (EPA 1995)
- 5 • Washington State Waste Discharge Permit, No. ST 4500, as amended, (Ecology 2000)
- 6 • *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment,*
7 *Storage, and Disposal of Dangerous Waste, Hanford Facility Permit WA7890008967,*
8 *September 28, 1994 (Ecology 1994).*

9 This plan also includes the specific elements of a WAP, as identified in the *Dangerous Waste Permit*
10 *Application Requirements* (Ecology 1996a). Attachment 34, Chapter 5.0, Groundwater Monitoring
11 addresses groundwater monitoring.

12 The conditions of the Washington State Discharge Permit, Number ST 4500 (Discharge Permit) are
13 included in this WAP for completeness, although they are not within the scope of RCRA or
14 WAC 173-303. Therefore, revisions of this WAP that are not governed by the requirements of
15 WAC 173-303 will not be considered as a modification subject to review or approval by Ecology.
16 However, any revisions to this WAP will be incorporated into the Hanford Dangerous Waste Permit at
17 least annually through the modification process.

18 **3.1.1 Liquid Effluent Retention Facility and Effluent Treatment Facility Description**

19 The LERF and ETF comprise an aqueous waste treatment system located in the 200 East Area
20 (Figure 3.1). Both LERF and ETF may receive aqueous waste through several inlets. ETF generally
21 receives aqueous waste directly from the LERF. However, aqueous waste can be transferred from the
22 Load-In Station to ETF. The Load-In Station is located just east of ETF and currently consists of two
23 37,854-liter storage tanks and a pipeline that connects to either LERF or ETF through fiberglass pipelines
24 with secondary containment.

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

30 The LERF consists of three lined surface impoundments with a nominal capacity of 29.5 million liters
31 each. Aqueous waste from LERF is pumped to ETF through a double-walled fiberglass pipeline. The
32 pipeline is equipped with leak detection located in the annulus between the inner and outer pipes. Each
33 basin is equipped with six available sample risers constructed of 6-inch-perforated pipe. A seventh
34 sample riser in each basin is dedicated to influent waste receipt piping, and an eighth riser in each basin
35 contains liquid level instrumentation. Each riser extends along the sides of each basin from the top to the
36 bottom of the basin. Detailed information on the construction and operation of the LERF is provided in
37 Attachment 34, Chapter 4.0.

38 ETF was designed to treat the contaminants anticipated in process condensate (PC) from the
39 242-A Evaporator and other aqueous wastes from the Hanford Site. Section 3.1.2 provides more
40 information on the sources of these wastes.

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

1 ETF consists of a primary and a secondary treatment train (Figure 3.2). The primary treatment train
2 removes or destroys dangerous and mixed waste components from the aqueous waste. In the secondary
3 treatment train, the waste components are concentrated and dried into a powder. This waste is
4 containerized, and transferred to a waste treatment, storage, and/or disposal (TSD) unit.

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

- 7 • Surge tank
- 8 • Rough filter
- 9 • Ultraviolet light oxidation (UV/OX)
- 10 • pH adjustment
- 11 • Hydrogen peroxide decomposer
- 12 • Fine filter
- 13 • Degasification
- 14 • Reverse osmosis (RO)
- 15 • Polisher [ion exchange (IX) column]
- 16 • Final pH adjustment and verification.

17 The secondary treatment train uses the following systems:

- 18 • Secondary waste receiving tanks
- 19 • Evaporator (mechanical vapor recompression)
- 20 • Concentrate tank
- 21 • Thin film dryer
- 22 • Container handling
- 23 • Supporting systems.

24 A dry powder waste is generated from the secondary treatment train, from the treatment of an aqueous
25 waste. The secondary waste treatment system typically receives and processes by-products generated
26 from the primary treatment train. However, in an alternate operating scenario, some aqueous wastes may
27 be fed to the secondary treatment train before the primary treatment train. Detailed information on the
28 treatment trains and the unit operations is provided in Attachment 34, Chapter 4.0 for the LERF and ETF.

29 The treated effluent is contained in verification tanks where the effluent is sampled to confirm that the
30 effluent meets the 'delisting' criteria. Under 40 CFR 261, Appendix IX, Table 2, the treated effluent from
31 ETF is considered a delisted waste; that is, the treated effluent is no longer a dangerous or hazardous
32 waste subject to the hazardous waste management requirements of RCRA. The treated effluent is
33 discharged under the Discharge Permit as a nondangerous, delisted waste to the SALDS, located in the
34 600 Area, north of the 200 West Area (Figure 3.1). Some delisted wastewater is recycled in the treatment
35 process. Verification tank water is used to dilute bulk acid and caustic to meet processing needs reducing
36 the demand for process water.

37 **3.1.2 Sources of Aqueous Waste**

38 ETF was intended and designed to treat a variety of mixed wastes. However, PC from the
39 242-A Evaporator was the only mixed waste identified for storage and treatment in the LERF and ETF.
40 As cleanup activities at Hanford progress, many of the aqueous wastes generated from site remediation
41 and waste management activities will be sent to the LERF and ETF for treatment and storage.

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

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

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

12 3.2 INFLUENT WASTE ACCEPTANCE PROCESS

13 Throughout the acceptance process, there are certain criteria that must be met for an influent waste (i.e.,
14 aqueous waste) to be accepted. These criteria are identified in the following sections and summarized in
15 Table 3.2. It should be noted that if an aqueous waste initially does not meet these criteria, it is not
16 necessarily rejected. In many instances, ETF process or the LERF and ETF permits can be modified to
17 accommodate the treatment and storage of that waste. A discussion of the reevaluation process is
18 provided in Section 3.2.3.

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

27 Acceptance Process is performed as follows.

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

40 Specific waste acceptance criteria are defined within the individual discussions on regulatory and
41 operational acceptability.

42 Re-evaluation Process is performed to ensure the characterization is accurate and current. This process
43 also provides a mechanism for re-evaluating an aqueous waste stream that does not meet the waste
44 acceptance criteria.

1 Record Information/Decision Process provides that information used in the decision. The evaluation and
2 the decision are documented as part of ETF Operating Record.

3 **3.2.1 Acceptance Process**

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

10 **3.2.1.1 Waste Characterization**

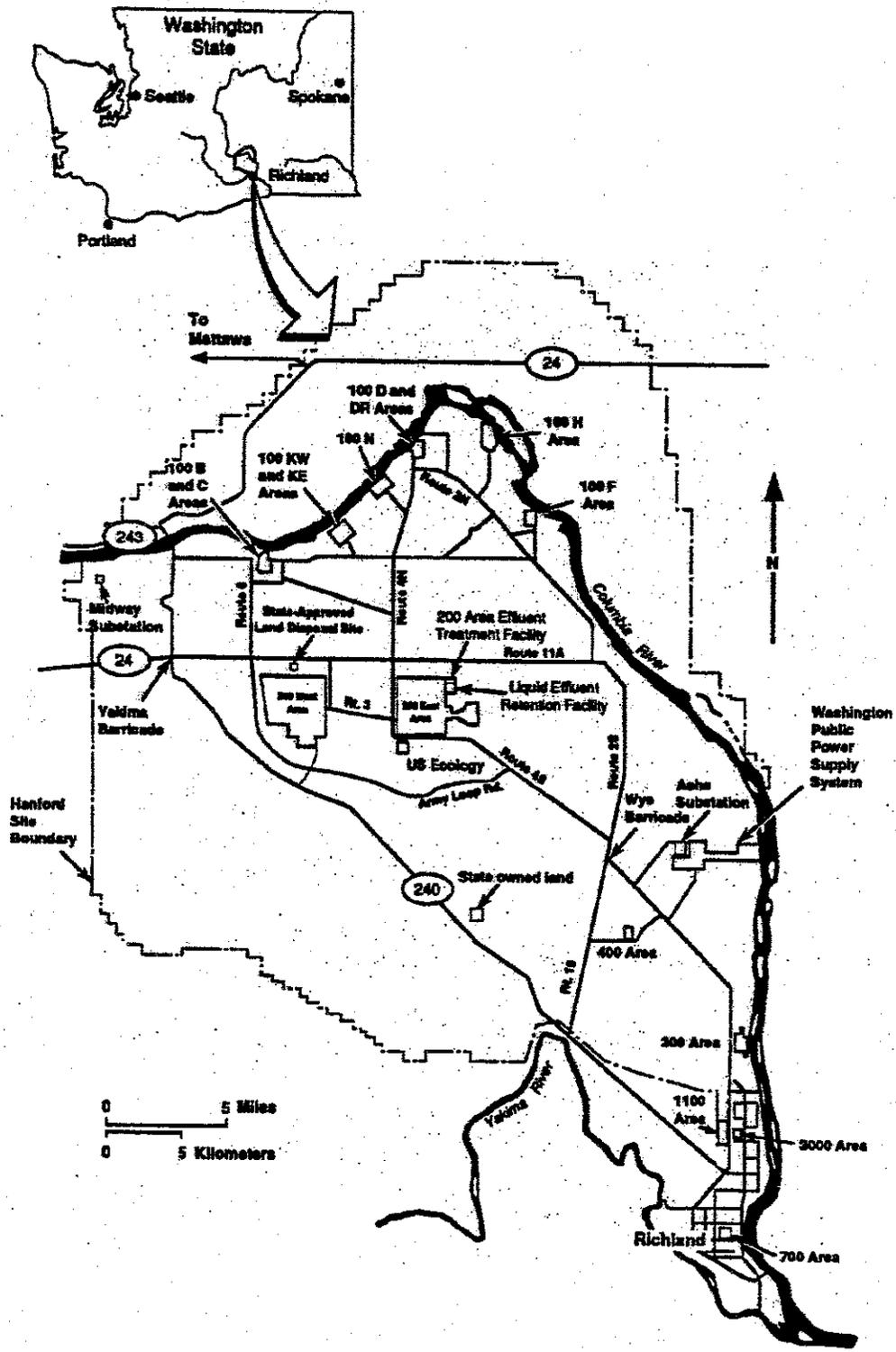
11 Because the constituents in the individual aqueous waste streams vary, each stream is characterized and
12 evaluated for acceptability on a case-by-case basis. The generator is required to designate an aqueous
13 waste, which generally will be backed up by analytical data. However, a generator may use process
14 knowledge to substantiate the waste designation, or for general characterization information. Examples
15 of acceptable process knowledge include the following:

- 16 • Documented data or information on processes similar to that which generated the aqueous waste
17 stream
- 18 • Information/documentation that dangerous waste constituents are from specific, well documented
19 processes, e.g., F-listed wastes
- 20 • Information/documentation that sampling/analyzing a waste stream would pose health and safety
21 risks to personnel
- 22 • Information/documentation that the waste does not lend itself to collecting a laboratory sample.

23 When a generator submits process knowledge for the characterization of a dangerous and/or mixed waste
24 stream, LERF and ETF personnel review the process knowledge as part of the waste acceptance process.
25 Specifically, LERF and ETF personnel review the generator's processes to verify the integrity of the
26 process knowledge, and determine whether the process knowledge is current and consistent with current
27 regulations. LERF/ETF management or their designee determines the final decision on the adequacy of
28 the process knowledge. The persons reviewing generator process knowledge and those making decisions
29 on the adequacy of process knowledge are trained according to the requirements of the Dangerous Waste
30 Training Plan, Attachment 34, Chapter 8.0 for the LERF and ETF.

31

Figure 3.1. Location of the LERF, 200 Area ETF, and the State Approved Land Disposal Site



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 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).

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 Figure 3.3 for the corresponding analytical methods. The generator may use process knowledge in lieu of some analyses, as determined by LERF/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 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, regulatory history, 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 ETF, each new waste stream generator is required to complete and provide this form to LERF and 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. This form could be modified to accommodate changes in regulations, operational concerns at the LERF or ETF, Hanford Facility needs, or other needs. However, the basic elements of the example form (e.g., waste source information) will be maintained in any future revision.

The LERF and ETF management determine whether the information on the WPS is sufficient. The LERF and ETF management use this information to evaluate the acceptability of the aqueous waste for storage and treatment in the LERF and 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 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 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/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 (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 ETF. Before an aqueous waste can be stored or treated in either the LERF or ETF, the regulatory history must be determined. Information on the regulatory history 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 ETF is allowed under and in compliance with WAC 173-303, RCRA Permit Attachment 34, Final Delisting for ETF, and the Discharge Permit for ETF.

3.2.2.1.1 Dangerous Waste Regulations/Permits

Before an aqueous waste stream is sent to the LERF or ETF, the generator will characterize and designate the stream with the appropriate dangerous/hazardous waste numbers according to WAC 173-303-070. The Part A, Form 3, for the LERF and ETF, and the Final Delisting for ETF identify the specific waste numbers for dangerous/mixed waste that can be managed in the LERF and ETF. Dangerous waste designated with waste numbers not specified in the Part A, Form 3, cannot be treated or stored in the LERF or ETF, until the Part A, Form 3, 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 Part A, Form 3, 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 regulatory history 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 1995a)
- Groundwater Quality Criteria (WAC 173-200)
- Final Delisting levels (EPA 1995)
- Background groundwater concentrations as measured at ETF disposal site.

The conditions of the Discharge Permit also require a demonstration that 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 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 ETF. The versatility of the LERF and ETF is better explained in the following examples:

- The typical operating configuration of 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, 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 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 ETF treatment process is recycled to 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 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 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 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 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 ETF or for the individual treatment units. Attachment 34, Chapter 4.0 for the LERF and ETF provides a detailed discussion of the individual treatment units. Treatment efficiencies also may be determined or confirmed by 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 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 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 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 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.

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 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
- magnesium
- potassium
- barium
- nitrate
- sulfate
- manganese
- bromide
- specific conductivity
- pH
- calcium
- sodium
- silica
- iron
- chloride
- aluminum
- phosphate

These constituents are identified in Table 3.2.

3.2.2.2.2 Compatibility

Corrosion Control. Because of the materials of construction used in 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 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 3.10.

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 Method 9090 (EPA 1996), 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.

Except for PC, 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.

PC from each 242-A Evaporator campaign is sampled and analyzed, and the results compared to the limits in Table 3.1 to ensure continued compatibility with the liner. Additionally, before a waste stream is processed at the 242-A Evaporator, DST analytical data are reviewed and administrative and process controls developed and implemented 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.

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; this evaluation confirms the compatibility of two or more aqueous wastes from different sources. 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 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 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 ETF management have been notified, or have reason to believe that the process generating the waste has changed.
- The LERF and 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 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 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 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 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 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 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 ETF are documented as part of ETF Operating Record, which is maintained at 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) ^a	Limit (mg/L) ^b (sum of constituent concentrations)
Alcohol/glycol	benzyl alcohol, 1-butanol	500,000
Alkanone ^c	acetone, 2-hexanone, methyl ethyl ketone, methyl isobutyl ketone, and 2-pentanone	200,000
Alkenone ^d	none targeted	NA
Aromatic/cyclic hydrocarbon	acetophenone, benzene, chlorobenzene, cresol, 1,4-dichlorobenzene, 2,4-dinitrotoluene, di-n-octyl phthalate, naphthalene, tetrahydrofuran, toluene, xylene	2000
Halogenated hydrocarbon	carbon tetrachloride, chloroform, 1,2-dichloroethane, 1,2-dichloroethene, 1,1-dichloroethylene, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, trichloroethylene, vinyl chloride	2000
Aliphatic hydrocarbon	hexachloroethane	500,000
Ether	2-butoxyethanol	2000
Other hydrocarbons	dimethylnitrosamine, tributyl phosphate	2000
Oxidizers	none targeted	NA
Acids, Bases, Salts	ammonium	100,000
pH	pH	0.5 < pH < 13.0

^a Analytical methods for the parameters and constituents are provided in Section 3.10.

^b Analytical data for a chemical family (as indicated) are summed using the following 'sum of the fraction technique'. The individual constituent concentration, sum concentration (for families), and pH values for a waste stream are then evaluated against the compatibility limit.

$$\sum_{n=1}^i \left(\frac{\text{Conc}_n}{\text{LIMIT}_n} \right) \leq 1$$

Where i is the number of organic constituents detected

^c Ketone containing saturated alkyl group(s).

^d Ketone containing unsaturated alkyl group(s).

mg/L = milligrams per liter.

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 ETF can store and treat influent aqueous wastes with waste numbers identified in the Part A, Form 3, for the LERF and ETF, and the Final Delisting for 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: <ol style="list-style-type: none"> 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: <table style="margin-left: 20px; border: none;"> <tr><td>total dissolved solids</td><td>silica</td></tr> <tr><td>total organic carbon</td><td>potassium</td></tr> <tr><td>total suspended solids</td><td>sodium</td></tr> <tr><td>specific conductivity</td><td>barium</td></tr> <tr><td>calcium</td><td>nitrate</td></tr> <tr><td>magnesium</td><td>chloride</td></tr> <tr><td>manganese</td><td>phosphate</td></tr> <tr><td>bromide</td><td>sulfate</td></tr> <tr><td>aluminum</td><td>iron</td></tr> </table> 	total dissolved solids	silica	total organic carbon	potassium	total suspended solids	sodium	specific conductivity	barium	calcium	nitrate	magnesium	chloride	manganese	phosphate	bromide	sulfate	aluminum	iron
	total dissolved solids	silica																	
total organic carbon	potassium																		
total suspended solids	sodium																		
specific conductivity	barium																		
calcium	nitrate																		
magnesium	chloride																		
manganese	phosphate																		
bromide	sulfate																		
aluminum	iron																		
B. Determine whether an aqueous waste stream is compatible, considering: <ol style="list-style-type: none"> 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). 																			

1 **3.3 SPECIAL MANAGEMENT REQUIREMENTS**

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

4 **3.3.1 Monitoring the Variability of Process Condensate**

5 The Discharge Permit (Ecology 1995a, Section S5) requires sampling of PC in the LERF basins until
6 sufficient data are collected, which adequately assess the variability of ammonia and total Kjeldahl
7 nitrogen (TKN). The PC will be analyzed for these parameters to assess the range of concentrations
8 present in the PC and the results reported to Ecology. In addition, the 10 highest concentrations of
9 tentatively identified compounds (TICs) will be reported from each PC sampling event, as required by the
10 discharge permit. Tentatively identified compounds are non-targeted organic compounds or fragments of
11 compounds with unique chromatographic spectra that are qualitatively identified by comparing them to
12 standard databases of spectra. Because these compounds are identified qualitatively, their concentration
13 only can be estimated.

14 Reports have been submitted to Ecology that included the results of ammonia and TKN analysis, and the
15 10 highest TICs. The data in these reports suggested that there is very little variability in the PC.

1 **3.3.2 Conditions on Process Condensate for Newly Identified Waste Numbers**

2 In January 1995, the U.S. Department of Energy, Richland Operations Office (DOE-RL) notified Ecology
3 and the U.S. Environmental Protection Agency that small amounts of listed waste might have been
4 introduced to the DST System, upstream of the LERF and ETF. This listed waste previously had not
5 been identified in the Dangerous Waste Part A, Form 3, for the DST System, LERF, or ETF. In a
6 March 7, 1995 letter from Ecology to DOE-RL (Ecology 1995b), Ecology exercised its enforcement
7 discretion with respect to the designation of this waste so long as several conditions are met. As long as
8 these conditions are met, the waste numbers will not be included in the Part A, Form 3s, for the LERF or
9 ETF. These conditions only apply to PC. The constituent's vanadium, formate, and cyanide will be
10 analyzed in the PC to meet these conditions.

11 **3.3.3 Land Disposal Restriction Compliance at Liquid Effluent Retention Facility**

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

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

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

26 Therefore, the residue component subject to this condition is the supernatant (liquid component). As
27 indicated above, solids are not anticipated to accumulate in a LERF basin. Additionally, an aqueous
28 waste stream is evaluated for the potential to deposit solids in a LERF basin (i.e., an aqueous waste that
29 contains sludge). If necessary, filtration at the waste source could be required before acceptance into
30 LERF. The contingency for removal of solids will be addressed during closure [as indicated in the
31 Attachment 34, Chapter 11.0, Closure Plan, for LERF and ETF.

32 The conditions of the treatment exemption also require that treatment residues (i.e., aqueous wastes),
33 which do not meet the LDR treatment standards "must be removed at least annually"
34 [40 CFR 268.4(a)(2)(ii)]. To address the conditions of this exemption, an influent aqueous waste is
35 sampled and analyzed and the LDR status of the aqueous waste is established as part of the acceptance
36 process. The LERF basins are then managed such that any aqueous waste(s), which exceeds an LDR
37 standard, is removed annually from a LERF basin, except for a heel of approximately 1 meter. A heel is
38 required to stabilize the LERF liner. The volume of the heel is approximately 1.9 million liters.

39 **3.4 INFLUENT AQUEOUS WASTE SAMPLING AND ANALYSIS**

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

1 3.4.1 Sampling Procedures

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

13 3.4.1.1 Batch Samples

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

23 Several sample ports are also located at ETF, including a valve on the recirculation line at ETF surge
24 tank, and a sample valve on a tank discharge pump line at ETF Load-In Station. All samples are obtained
25 at the LERF or ETF are collected in a manner consistent with SW-846 procedures (EPA 1986).

26 3.4.1.2 Flow-Through Samples at the Liquid Effluent Retention Facility

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

33 3.4.2 Analytical Rationale

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

40 The analytical methods for these parameters are provided in Section 3.10. All methods are EPA methods.
41 Additional analyses may be required if historical information and process knowledge indicate that an
42 influent aqueous waste contains constituents not included in the target list of parameters. For example, if
43 process knowledge indicates that an aqueous waste contains a parameter that is regulated by the
44 Groundwater Quality Criteria (WAC 173-200), that parameter(s) would be added to the suite of analyses
45 required for that aqueous waste stream.

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

- 4 • Set operating conditions in the LERF and ETF (e.g., to determine operating configuration - refer to
5 Section 3.2.2.2)
- 6 • Identify concentrations of some constituents which may also interfere with, or foul ETF treatment
7 process (e.g., fouling of the RO membranes - refer to Section 3.2.2.2)
- 8 • Evaluate LERF liner and piping material compatibility
- 9 • Determine treatability to evaluate if applicable constituents in the treated effluent will meet Discharge
10 Permit and Delisting limits
- 11 • Estimate concentrations of some constituents in the waste generated in the secondary treatment train
12 (i.e., dry powder waste).

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

- 15 • Formate analysis is required for compliance with special conditions for PC (refer to Section 3.3.2).
- 16 • Total Kjeldahl nitrogen (TKN) analysis required under the Discharge Permit to meet special
17 conditions for PC (until discharge permit is modified, refer to Section 3.3.1).
- 18 • Total dissolved solids analysis to predict volume of powder waste from the secondary treatment train.
19 •

Table 3.3. Target Parameters for Influent Aqueous Waste Analyses

VOLATILE ORGANIC COMPOUNDS	SEMIVOLATILE ORGANIC COMPOUNDS
Acetone Benzene 1-Butyl alcohol (1-Butanol) Carbon tetrachloride Chlorobenzene Chloroform 1,2-Dichloroethane (total) 1,1-Dichloroethylene 2-Hexanone Methyl ethyl ketone (2-Butanone) Methyl isobutyl ketone (Hexone, 4-Methyl-2-pentanone) 2-Pentanone Tetrachloroethylene Tetrahydrofuran Toluene 1,1,1-Trichloroethane 1,1,2-Trichloroethane Trichloroethylene Vinyl chloride	Acetophenone Benzyl alcohol 2-Butoxyethanol Cresol (o, p, m) 1,4-Dichlorobenzene Dimethylnitrosamine (N-Nitrosodimethylamine) Di-n-octyl phthalate Hexachloroethane Naphthalene Tributyl phosphate
TOTAL METALS	
Aluminum Antimony Arsenic Barium Beryllium Cadmium Calcium Chromium Copper Iron Lead Magnesium Manganese Mercury Nickel Potassium Selenium Silicon Silver Sodium Uranium Vanadium Zinc	

Table 3.3. Target Parameters for Influent Aqueous Waste Analyses

ANIONS	GENERAL CHEMISTRY PARAMETERS
Bromide	Ammonia
Chloride	Total Kjeldahl nitrogen
Fluoride	Cyanide
Formate ¹	pH
Nitrate	Total suspended solids
Nitrite	Total dissolved solids
Phosphate	Total organic carbon
Sulfate	Specific conductivity

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

3 **3.5 TREATED EFFLUENT SAMPLING AND ANALYSIS**

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

8 **3.5.1 Rationale for Effluent Analysis Parameter Selection**

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

- 10 • Delisting criteria from the Final Delisting (EPA 1995)
11 • Effluent limits from the State Waste Discharge Permit (Ecology 1995a)
12 • Early warning values from the State Waste Discharge Permit (Ecology 1995a).

13 The Final Delisting provides two testing regimes for the treated effluent. Under the initial verification-
14 testing regime, the first three verification tanks must be sampled and analyzed, and the data submitted to
15 the U.S. Environmental Protection Agency (EPA). Following EPA approval, the subsequent verification-
16 testing regime is implemented, where every 10th tank is analyzed for the delisting constituents. If the
17 concentration of any analyte is found to exceed a Discharge Permit enforcement limit or a Delisting
18 criterion, the contents of the verification tank are reprocessed and/or re-analyzed. If the concentration of
19 any analyte exceeds an early warning value, as a monthly average from treated effluent that is discharged,
20 an early warning value report is prepared and submitted to Ecology.

21 **3.5.2 Effluent Sampling Strategy: Methods, Location, Analyses, and Frequency**

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

24 **3.5.2.1 Effluent Sampling Method and Location**

25 Samples of treated effluent are collected and analyzed to verify the treatment process using ETF-specific
26 sampling protocol. These verification samples can be collected at two locations. At the first sampling
27 location, a representative grab sample is collected from a sampling port on the verification tank
28 recirculation line. The second sampler is located upstream of the verification tanks where flow
29 proportional composite samples are collected for all analyses except VOC analysis. For VOCs, a
30 zero-headspace, time proportional sampler capable of collecting a sample over a multiple-day period is
31 used. Section 3.10 presents the sample containers, preservatives, and holding times for each parameter
32 monitored in the effluent.

1 **3.5.2.2 Analyses of Effluent**

2 The parameters required by the current Discharge Permit and Delisting conditions are presented in
3 Table 3.4. The analytical methods and PQLs associated with each parameter are provided in
4 Section 3.10. The methods and PQLs are equivalent to those used in the analysis of influent aqueous
5 waste. With the exception of formic acid (analyzed as formate), analyses for the constituents associated
6 with the newly listed waste numbers (Section 3.3.2) already are required analyses for the effluent. An
7 analysis for formate is not required unless this constituent is identified in the influent aqueous waste.

8 **3.5.2.3 Frequency of Sampling**

9 Treated effluent is tested for all parameters listed in Table 3.4 on a frequency consistent with the
10 conditions of the Discharge Permit and the Final Delisting. This effluent must meet the Discharge Permit
11 and Delisting limits associated with these parameters. Under normal operating conditions, grab samples
12 are collected from each verification tank. When a composite sample is called for, the sample is collected
13 over the period required to fill one verification tank.

14 During operation of ETF, if one or more of the constituents exceeds a Delisting criterion, the Delisting
15 conditions require the analysis of samples from the following two verification tanks volumes before
16 effluent can be discharged. Treated effluent that does not meet Delisting criteria and Discharge Permit is
17 not discharged to the SALDS and is recycled for further treatment.

18 **3.6 EFFLUENT TREATMENT FACILITY GENERATED WASTE SAMPLING**
19 **AND ANALYSIS**

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

- 23 • Secondary waste generated from the treatment process, including the following waste forms:
- 24 - dry powder waste
 - 25 - concentrate tanks slurry
 - 26 - sludge removed from process tanks.
- 27 • Waste generated by operations and maintenance activities
- 28 • Miscellaneous waste generated within ETF.

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

31

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

Parameter	Final Delisting ¹	Discharge Permit ²	
		Enforcement Limit	Early Warning Value
VOLATILE ORGANIC COMPOUNDS			
Acetone	X		
Benzene	X		X
1-Butyl alcohol	X		
Carbon tetrachloride	X	X	
Chlorobenzene	X		
Chloroform	X		X
1,2-Dichloroethane	X		
1,1-Dichloroethylene	X		
Methyl ethyl ketone (2-Butanone)	X		
Methyl isobutyl ketone (4-methyl-2-Pentanone)	X		
Tetrachloroethylene	X	X	
Tetrahydrofuran			X
Toluene	X		
1,1,1-Trichloroethane	X		
1,1,2-Trichloroethane	X		X
Trichloroethylene	X		
Vinyl chloride	X		
SEMIVOLATILE ORGANIC COMPOUNDS			
Acetophenone			X
Benzyl alcohol	X		
Cresol (total)	X		
1,4-Dichlorobenzene	X		
Dimethylnitrosamine		X	
Di-n-octyl phthalate	X		
Hexachloroethane	X		
Naphthalene	X		
Tributyl phosphate	X		
TOTAL METALS³			
Antimony	X		
Arsenic	X	X	
Barium	X		
Beryllium	X		X
Cadmium	X		X
Chromium	X	X	
Copper			X
Lead	X		X
Mercury	X		X
Nickel	X		
Selenium	X		
Silver	X		
Vanadium	X		
Zinc	X		

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

Parameter	Final Delisting ¹	Discharge Permit ²	
		Enforcement Limit	Early Warning Value
ANIONS			
Fluoride	X		
Nitrate (as N)		X	
Nitrite (as N)			X
Sulfate			X
OTHER ANALYSES			
Ammonia ⁴ (as N)	X		X
Total Kjeldahl nitrogen (as N)			X
Cyanide	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 (EPA 1995).

² Parameters required by the current conditions of the State Waste Discharge Permit, No. ST 4500 (Ecology 1995a).

³ Metals reported as total concentrations.

⁴ Although the Final Delisting lists "ammonium" (NH₄⁺), the standard analytical methods measure ammonia (NH₃). Ammonia is assumed the contaminant of concern.

X Rationale for measuring this parameter in treated effluent.

M Monitor only; no limit defined.

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 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 Attachment 34, Chapter 4.0 for LERF and ETF.

3.6.1.1 Rationale for Selection of Parameters for Analysis

ETF secondary waste is anticipated to consist primarily of sulfate salts minor amounts of metals and mixed waste. The designation of 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 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 ETF treatment processes, also are used to determine the LDR status of 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 ETF secondary waste are provided in Table 3.5. The specific analytical methods for these analyses are provided in Section 3.10. 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 1986) 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 3.10.

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.

3.6.1.3 Sampling Frequency

ETF secondary waste is sampled at a frequency of two containers per batch. 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 (e.g., change in well-head)
- Change in process chemistry.

Up to a maximum of three representative samples will be collected from the concentrate tanks, if waste from the concentrate tanks is used for characterization of a batch of influent waste. These samples 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 will be used to represent the powder waste generated from the treatment of that aqueous waste(s). The dry powder or concentrate tanks will be re-sampled in the following situations:

- The LERF and 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 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 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). 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 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 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 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 3.10.

3.6.3 Other Waste Generated at the 200 Area Effluent Treatment Facility

There are two other potential sources of waste at ETF: spills and/or overflows, and discarded chemical products. Spilled material that potentially might be dangerous waste generally is routed to 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 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 3.10.

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
• Nitrate	• Address receiving TSD waste acceptance requirements
• pH	• Waste designation

¹ For 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.

3.7 QUALITY ASSURANCE/QUALITY CONTROL

The following quality assurance/quality control (QA/QC) information for ETF and LERF is provided as required by WAC 173-303-810(6). The sampling and analysis activities at ETF and LERF conform to the requirements of an ETF/LERF-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, July 1992, as referenced in WAC 173-303-110.
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-7-020, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, March 1993.

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 generally is sampled in the dry powder form; however, the secondary waste also could be sampled while in slurry form for characterization. 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 3.10. 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 ETF/LERF-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 ETF and LERF 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 Hanford Site standard requirements and the regulatory requirements. All analytical data are defensible and traceable to specific, related QC samples and calibrations. Offsite laboratories employed by ETF and LERF 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 ETF and LERF data is maintained. The SW-846 analytical methods are followed (as indicated in Section 3.10). 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 3.10 are used to characterize an influent aqueous waste, effluent waste, and 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 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.

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 goal of ± 20 percent for 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 ETF and LERF 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 ETF and LERF 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.

DOE/RL-97-03, *Hanford Facility Dangerous Waste Permit Application, Liquid Effluent Retention Facility and 200 Area Effluent Treatment Facility*, U.S. Department of Energy, Richland Operations Office, Richland, Washington.

Ecology, 1994, *Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste*, Number WA7890008967, (Revision 3, December 1996), Washington State Department of Ecology, Olympia, Washington.

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.

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, 1996a, *Dangerous Waste Permit Application Permit Requirements*, #95-402, June 1996, Washington State Department of Ecology, Olympia, Washington.

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.

EPA, 1986, *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846* (Third Edition, November 1986, 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, 1995, Final Delisting [Exclusion], issued to U.S. Department of Energy, 40 CFR 261, Appendix IX, Table 2 (60 FR 31115, June 13, 1995), 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	Accuracy/ Precision for Method ^c (percent)	Sample container ^c / Preservative ^c / Holding time ^d
VOLATILE ORGANIC COMPOUNDS				
Acetone	8260A	40	50-100	<u>Sample container</u> 2 x 40-mL amber glass with septum ¹ <u>Preservative</u> 1:1 HCl to pH<2; 4°C ¹ <u>Holding time</u> 14 days
Benzene		5	40-150	
1-Butyl alcohol (1-Butanol)		500	40-150	
Carbon tetrachloride		5	65-130	
Chlorobenzene		5	40-150	
Chloroform		5	50-130	
1,2-Dichloroethane		5	50-150	
1,2-Dichloroethene		5	50-150	
1,1-Dichloroethylene		5	60-130	
2-Hexanone		50	60-130	
Methylene chloride ^f		5	50-150	
Methyl ethyl ketone (2-Butanone)		100	65-130	
Methyl isobutyl ketone (Hexone, 4-Methyl-2-pentanone)		50	50-160	
2-Pentanone		10	50-160	
Tetrachloroethylene		5	65-140	
Tetrahydrofuran		100	47-150	
Toluene		5	50-160	
1,1,1-Trichloroethane		5	50-150	
1,1,2-Trichloroethane		5	50-150	
Trichloroethylene		5	70-155	
Xylene		5	50-150	
Vinyl chloride		10	40-130	
SEMIVOLATILE ORGANIC COMPOUNDS				
Acetophenone	8270B	10	70-110	<u>Sample container</u> 4 x 1-liter amber glass <u>Preservative</u> 4°C <u>Holding time</u> 7 days for extraction; 40 days for analysis after extraction
Benzyl alcohol		20	70-120	
2-Butoxyethanol		1000	65-105	
Cresol (o, p, m)		10	55-115	

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

Parameter	Analytical method ^a	Method PQL ^b	Accuracy/ Precision for Method ⁱ (percent)	Sample container ^c / Preservative ^e / Holding time ^d
1,4-Dichlorobenzene		10	45-95	
Dimethylnitrosamine		10	50-120	
2,4-Dinitrotoluene		10	65-100	
Di-n-octyl phthalate		10	70-130	
Hexachloroethane		10	50-110	
Naphthalene		10	60-120	
Tributyl phosphate		100	75-125	
TOTAL METALS				
Aluminum	6010A/EPA-600 200.7	450	75 - 125	<u>Sample container</u> 1 x 0.5-liter plastic/glass <u>Preservative</u> 1:1 HNO ₃ to pH<2 <u>Holding time</u> 180 days; mercury 28 days
Antimony	EPA-600 200.8	30	75 - 125	
Arsenic	EPA-600 200.8	15	75 - 125	
Barium	6010A/EPA-600 200.7	20	75 - 125	
Beryllium	6010A/EPA-600 200.7	40	75 - 125	
Cadmium	EPA-600 200.8	5	75 - 125	
Calcium	6010A/EPA-600 200.7	100	75 - 125	
Chromium	7191/EPA-600 200.8	20	75 - 125	
Copper	6010A/EPA-600 200.7	70	75 - 125	
Iron	6010A/EPA-600 200.7	100	75 - 125	
Lead	EPA-600 200.8	10	75 - 125	
Magnesium	6010A/EPA-600 200.7	300	75 - 125	
Manganese	6010A/EPA-600 200.7	50	75 - 125	
Mercury	EPA 245.1/EPA-600 200.8	2	75 - 125	
Nickel	6010A/EPA-600 200.7	75	75 - 125	
Potassium	6010A/EPA-600 200.7	10,000	75 - 125	
Selenium	EPA-600 200.8	20	75 - 125	
Silicon	6010A/EPA-600 200.7	580	75 - 125	
Silver	6010A/EPA-600 200.7	70	75 - 125	
Sodium	6010A/EPA-600 200.7	290	75 - 125	
Uranium	EPA-600 200.8	5	75 - 125	
Vanadium	6010A/EPA-600 200.7	80	75 - 125	
Zinc	6010A/EPA-600 200.7	20	75 - 125	
GENERAL CHEMISTRY				
Bromide	EPA-600 300.0	2000	75 - 125	<u>Sample container</u> 1 x 1-liter glass <u>Preservative</u> 4°C <u>Holding time</u> 28 days
Chloride		1000	75 - 125	
Fluoride		500	75 - 125	
Formate ⁱ		1250	75 - 125	
Nitrate		100	75 - 125	
Nitrite		100	75 - 125	

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

Parameter	Analytical method ^a	Method PQL ^b	Accuracy/ Precision for Method ⁱ (percent)	Sample container ^c / Preservative ^e / Holding time ^d
Sulfate		10,000	75 - 125	
Phosphate		1500	75 - 125	
Ammonia ^e	EPA-600 350.3/350.1	40	75 - 125	<u>Sample container</u> 250 mL glass <u>Preservative</u> H ₂ SO ₄ to pH<2; 4°C <u>Holding time</u> 28 days
Total Kjeldahl nitrogen	EPA-600 351.2	600	75 - 125	
Cyanide	9010A / EPA-600 335.3	100	75 - 125	<u>Sample container</u> 500 mL polyethylene <u>Preservative</u> 6M NaOH to pH>12; 4°C <u>Holding time</u> 14 days
Total dissolved solids	EPA-600 160.1	RL 10,000	75 - 125	<u>Sample container</u> 1 L glass <u>Preservative</u> None <u>Holding time</u> 7 days for pH - as soon as practical
Total suspended solids	EPA-600 160.2	RL 4,000	75 - 125	
Specific conductivity	EPA-600 120.1 (in lab)	RL 10 ^g	75 - 125	
pH ^h	EPA-600 150.1/9040	RL +/- 0.1	75 - 125	
Total organic carbon	9060A	RL 1,000	75 - 125	<u>Sample container</u> 250 mL glass <u>Preservative</u> HCl or H ₂ SO ₄ to pH<2; 4°C <u>Holding time</u> 28 days

^a SW-846 methods are presented unless otherwise noted. Other methods might be substituted if the applicable PQL can be met.

^b PQL is determined from method detection level (MDL), where PQL = 10 x MDL (for reagent-grade water); however, PQL is affected by sample matrix. PQL units are parts per billion unless otherwise noted.

^c Sample bottle and preservatives could be adjusted, as applicable, to minimize sample volume.

^d Holding time = time between sampling and analysis.

^e Although the Final Delisting lists "ammonium" (NH₄⁺), the standard analytical methods measure ammonia (NH₃). Ammonia is assumed the contaminant of concern.

^f Conductivity reported in micromhos per centimeter

^g pH monitored in influent aqueous waste only.

^h Analysis for formate only required if detected in the influent aqueous waste.

ⁱ Accuracy/precision used to confirm or re-establish MDL.

^j VOC refrigerated composite sampler with syringe requires no chemical preservative.

mL = milliliter.

NA = not applicable.

RL = reporting limit.

ND = not determined.

MDL = method detection level.

PQL = practical quantitation limit

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

Parameter	Analytical Method ^a	PQL ^b	Accuracy/ Precision for Method ^c (percent)	Container ^d	Preservative	Holding time ^e
Total Solids	EPA-600 160.3	10,000	75 - 125	1-liter glass	None	180 days
pH	WAC 173-303-110 (3)(a)(ii) ^g / EPA-600 150.1/9040	±0.1				as soon as practical
Nitrate	EPA-600 300.0/9056	Refer to Table 3.6				28 days
Volatile organic compounds (combined method target compound lists)	8240 or 8260A	Refer to Table 3.6	Refer to Table 3.6	2-40 ml amber glass w/septum	None	7 days
Semivolatile organic compounds (method target compound list)	8270B	Refer to Table 3.6	Refer to Table 3.6	4-1,000 ml amber glass	None	Extract within 7 days; analyze extract within 40 days
Mercury	EPA-600 200.8, 245.1/6020	Refer to Table 3.6	75 - 125	500 ml plastic/glass	None	Mercury 28 days; 6 months all others
Selenium	EPA-600 200.8/6020	Refer to Table 3.6				
Arsenic	EPA-600 200.8/6020	Refer to Table 3.6				
Cadmium	EPA-600 200.8/6020	Refer to Table 3.6				
Total metals (method target list)	EPA-600 200.8 6020/6010A/7000 Series	Refer to Table 3.6				
Toxicity Characteristic Leaching Procedure ^h	1311	NA	NA	NA	NA	NA

- 1 ^a SW-846 methods are presented unless otherwise noted. Other methods might be substituted if the applicable PQL
- 2 can be met.
- 3 ^b PQL is determined from method detection level (MDL), where PQL = 10 x MDL (may vary depending on
- 4 matrix). PQL units are parts per billion unless otherwise noted.
- 5 ^c Container size and type could be changed as directed by the laboratory, or as required by the analytical method.
- 6 ^d No preservatives are added to containers because of the anticipated high concentrations of salts.
- 7 ^e Holding time equals time between sampling and analysis.
- 8 ^f For solid waste.
- 9 ^g Extraction procedure, as applicable; extract analyzed by referenced methods [WAC 173-303-110(3)(c)].
- 10 PQL = practical quantitation limit
- 11 MDL = method detection level
- 12 mL = milliliter

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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 that 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

1 very low-density polyethylene is stretched over each basin above the primary liner. These covers serve to
2 keep unwanted material from entering the basins, and to minimize evaporation of the liquid contents.

3 **4.2 EFFLUENT TREATMENT FACILITY PROCESS DESCRIPTION**

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

10 The ETF generally receives aqueous waste directly from the LERF. However, aqueous waste also can be
11 transferred from the Load-In Station to the ETF. Aqueous waste is treated and stored in the ETF process
12 area in a series of tank systems, referred to as process units. Within the ETF, waste also is managed in
13 containers through treatment and/or storage. Figure 4.2 provides the relative locations of the process and
14 container storage areas within the ETF.

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

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

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

34 **4.2.1 Load-In Station**

35 The ETF receives aqueous waste from LERF or the Load-In Station. The ETF Load-In Station, located
36 due east of the surge tank and outside of the perimeter fence (Figure 4.4), was designed and constructed to
37 provide the capability to unload, store, and transfer aqueous waste to the ETF or LERF from tanker trucks
38 and other containers (such as drums). The Load-In Station consists of two load-in tanks, transfer pumps,
39 filtration system, level instrumentation for tanker trucks, leak detection capabilities for the containment
40 basin and transfer line, and an underground transfer line that connects to lines in the surge tank berm,
41 allowing transfers to either the ETF surge tank or LERF.

42 Tanker trucks and other containers are used to unload aqueous waste at the Load-In Station. To perform
43 unloading, the tanker truck is positioned on a truck pad, a 'load-in' transfer line is connected to the truck,

1 and the tanker contents are pumped into one of the Load-In Station tanks, the surge tank, or directly to the
2 LERF. For container unloading, the container is placed on the truck pad and the container contents are
3 pumped into one of the Load-In Station tanks, the surge tank, or directly to the LERF.

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

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

9 **4.2.2 Effluent Treatment Facility Operating Configuration**

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

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

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

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

27 **4.2.3 Primary Treatment Train**

28 The primary treatment train consists of the following processes:

- 29 • Influent Receipt/Surge tank - inlet, surge capacity
- 30 • Filtration - for suspended solids removal
- 31 • UV/OX - organic destruction
- 32 • pH adjustment - waste neutralization
- 33 • Hydrogen peroxide decomposition - removal of excess hydrogen peroxide
- 34 • Degasification - removal of carbon dioxide
- 35 • RO - removal of dissolved solids
- 36 • IX - removal of dissolved solids
- 37 • Verification - holding tanks during verification.

38 **Reverse Osmosis.** The RO system (Figure 4.9) uses pressure to force clean water molecules through
39 semi-permeable membranes while keeping the larger molecule contaminants such as dissolved solids and
40 large molecular weight organic materials, in the membrane. The RO process uses a staged configuration
41 to maximize water recovery. The process produces two separate streams, including a clean 'permeate' and

1 a concentrate (or retentate), which are concentrated as much as possible to minimize the amount of
2 secondary waste produced.

3 **Influent Receipt/Surge Tank.** Depending on the configuration of the ETF, the surge tank is one inlet
4 used to feed an aqueous waste into the ETF for treatment. In Configuration 1 (Figure 4.5), the surge tank
5 is the first component downstream of the LERF. The surge tank provides a storage/surge volume for
6 chemical pretreatment and controls feed flow rates from the LERF to the ETF. However, in
7 Configuration 2 (Figure 4.6), aqueous waste from LERF is fed directly into the treatment units. In this
8 configuration, the surge tank receives aqueous waste that has been processed in the RO units and
9 provides the feed stream to the remaining downstream process units. In yet another configuration, some
10 small volume aqueous waste could be received into the secondary treatment train first for processing. In
11 this case, the aqueous waste would be received directly into the secondary waste receiving tanks. Finally,
12 the surge tank also receives waste extracted from various systems within the primary and secondary
13 treatment train while in operation.

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

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

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

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

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

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

43 **pH Adjustment.** The pH of a waste stream is monitored and controlled at different points throughout the
44 treatment process. Within the primary treatment train, the pH of a waste can be adjusted with sulfuric

1 acid or sodium hydroxide to optimize operation of downstream treatment processes or adjusted before
2 final discharge. For example, the pH of an aqueous waste would be adjusted in the pH adjustment tank
3 after the UV/OX process and before the RO process. In this example, pH is adjusted to cause certain
4 chemical species such as ammonia to form ammonium sulfate, thereby increasing the rejection rate of the
5 RO.

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

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

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

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

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

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

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

43 Spent resins are transferred into a disposal container should regeneration of the IX resins become
44 inefficient. The container is designed to provide dewatering with remote monitoring of the resin and

1 water levels within the container. Displaced air from the vessels is exhausted through an entrainment
2 separator (to remove water drops) and a high-efficiency particulate air filter and into the vessel off gas
3 system. Free water is removed from the container and returned to the surge tank. Dewatered resins are
4 transferred to a final storage/disposal point.

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

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

14 4.2.4 Secondary Treatment Train

15 The secondary treatment system typically receives and processes the following by-products generated
16 from the primary treatment train: concentrate from the first RO stage, filter backwash, regeneration waste
17 from the ion exchange system, and spillage or overflow received into the process sumps. Depending on
18 the operating configuration, however, some aqueous waste could be processed in the secondary treatment
19 train before the primary treatment train (refer to Figures 4.5 and 4.6 for example operating
20 configurations).

21 The secondary treatment train provides the following processes:

- 22 • Secondary waste receiving - tank receiving
- 23 • Evaporation - concentrates secondary waste streams
- 24 • Concentrate staging - concentrate receipt and pH adjustment in concentrate tanks
- 25 • Thin film drying - dewatering of secondary waste streams
- 26 • Container handling - packaging of dewatered secondary waste.

27 **Secondary Waste Receiving.** Waste to be processed in the secondary treatment train is received into two
28 secondary waste receiving tanks, where the pH can be adjusted with sulfuric acid or sodium hydroxide for
29 optimum evaporator performance.

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

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

39 The vapor that is released from the ETF evaporator is routed to the entrainment separator, where water
40 droplets and/or particulates are separated from the vapor. The 'cleaned' vapor is routed to the vapor
41 compressor and heater. The steam from the vapor compressor/heater is used to heat the recirculating
42 concentrate in the ETF evaporator. From the vapor compressor/heater, the steam is condensed and fed to

1 the distillate flash tank, where the saturated condensate received from the heater drops to atmospheric
2 pressure and cools to the normal boiling point through partial flashing (rapid vaporization caused by a
3 pressure reduction). The resulting distillate is routed to the surge tank. Noncondensable vapors, such as
4 air, are exhausted by a vacuum blower to the vessel off gas system.

5 **Concentrate Staging.** The concentrate tanks make up the head end of the thin film drying process. From
6 the ETF evaporator, concentrate is pumped into two concentrate tanks and pH adjusted. The concentrate
7 tanks function alternately between concentrate receiver and feed tank for the thin film dryer.

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

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

16 Overhead vapor released by the drying of the concentrate is condensed in the distillate condenser. Excess
17 heat is removed from the distillate by a water-cooled heat exchanger. Part of the distillate is circulated
18 back to the condenser spray nozzles. The remaining distillate is pumped to the surge tank. Any
19 noncondensable vapors and particulates from the spray condenser are exhausted to the vessel off gas
20 system.

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

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

36 4.2.5 Other Effluent Treatment Facility Systems

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

- 40 • Monitor and control system
- 41 • Vessel off gas system
- 42 • Sump collection system
- 43 • Chemical injection feed system

- 1 • Verification tank recycle system
- 2 • Utilities.

3 **4.2.5.1 Monitor and Control System**

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

9 **4.2.5.2 Vessel Off gas System**

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

- 15 • Surge tank
- 16 • ETF evaporator
- 17 • pH adjustment tank
- 18 • Concentrate tanks
- 19 • Degasification system
- 20 • First and second RO stages
- 21 • Dry powder hopper
- 22 • Effluent pH adjustment tank
- 23 • Drum capping station
- 24 • Secondary waste receiving tanks
- 25 • Resin dewatering system
- 26 • Distillate condenser (off the thin film dryer)
- 27 • Sump tanks 1 and 2.

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

34 **4.2.5.3 Sump Collection System**

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

1 **4.2.5.4 Chemical Injection Feed System**

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

6 **4.2.5.5 Verification Tank Recycle System**

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

- 10 • 4% H²SO₄ solution tank and ancillary equipment
- 11 • 4% NaOH solution tank and ancillary equipment
- 12 • Clean-in-place tank and ancillary equipment
- 13 • ETF evaporator boiler and ancillary equipment
- 14 • Thin film dryer boiler and ancillary equipment.

15 **4.2.5.6 Utilities**

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

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

25 The following utilities support ETF activities:

- 26 • Electrical power
- 27 • Sanitary water
- 28 • Communication systems
- 29 • Raw water.

30 **4.3 CONTAINERS**

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

33 A list of dangerous and/or mixed waste managed in containers at the ETF is presented in Attachment 34,
34 Chapter 1.0. The types of dangerous and/or mixed waste managed in containers in the ETF could include
35 the following secondary waste generated by the ETF processes:

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

38 The secondary treatment train processes the waste by-products from the primary treatment train, which
39 are concentrated and dried into a powder. Containers are filled with dry powder waste from the thin film
40 dryer via a remotely controlled system. Miscellaneous waste generated from maintenance and operations

1 activities are stored at the ETF. The waste could include process waste, such as used filter elements;
2 spent RO membranes; damaged equipment, and decontamination and maintenance waste, such as
3 contaminated rags, gloves, and other personal protective equipment. Liquids generally are packaged with
4 absorbents at a 2 to 1 ratio.

5 Several container collection areas could be located within the ETF process and container handling areas.
6 These collection areas are used only to accumulate waste in containers. Once a container is filled, the
7 container is transferred to the container storage area (Figure 4.3), to another TSD unit, or to a less-than-
8 90-day storage pad. The container storage area, a 22.9 x 8.5-meter room, is located adjacent to the ETF
9 process area. The containers within the container storage area are clearly labeled, and access to these
10 containers is limited by barriers and by administrative controls. The ETF floor provides secondary
11 containment, and the ETF roof and walls protects all containers from exposure to the elements.

12 Waste also could be placed in containers for treatment as indicated in Attachment 34, Chapter 1.0. For
13 example, sludge that accumulates in the bottoms of the process tanks is removed periodically and placed
14 into containers. In this example, the waste is solidified by decanting the supernate from the container and
15 the remainder of the waste is allowed to evaporate, or absorbents are added, as necessary, to address
16 remaining liquids. Following treatment, this waste either is stored at the ETF or transferred to another
17 TSD unit.

18 **4.3.1 Description of Containers**

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

26 Current operating practices indicate the use of new 208-liter containers that have either a polyethylene
27 liner or a protective coating. Any reused or reconditioned container is inspected for container integrity
28 before use. Overpack containers are available for use with damaged containers. Overpack containers
29 typically are unlined steel or polyethylene. Per Attachment 34, Chapter 1.0, a maximum of 147,630 liters
30 of dangerous and/or mixed waste could be stored in containers in the ETF.

31 **4.3.2 Container Management Practices**

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

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

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

6 **4.3.3 Container Labeling**

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

12 **4.3.4 Containment Requirements for Managing Containers**

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

16 **4.3.4.1 Secondary Containment System Design**

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

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

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

33 The container storage area is separated from the process area by a common wall and a door for access to
34 the two areas (Figure 4.3). These two areas also share a common floor and trenches that, with the
35 15.2-centimeter rise of the containing walls, form the secondary containment system for the process area
36 and the container storage area.

37 **4.3.4.1.1 Structural Integrity of Base**

38 Engineering calculations were performed showing the floor of the container storage area is capable of
39 supporting the weight of containers. These calculations were reviewed and certified by a professional
40 engineer (Mausshardt 1995). The concrete was inspected for damage during construction. Cracks were

1 identified and repaired to the satisfaction of the professional engineer. Documentation of these
2 certifications is included in the engineering assessment (Mausshardt 1995).

3 **4.3.4.1.2 Containment System Capacity**

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

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

17 **4.3.4.1.3 Control of Run-on**

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

20 **4.3.4.2 Removal of Liquids from Containment Systems**

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

25 **4.3.4.3 Prevention of Ignitable, Reactive, and Incompatible Wastes in Containers**

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

32 **4.4 TANK SYSTEMS**

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

1 4.4.1 Design Requirements

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

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

12 This assessment was documented in the *Final RCRA Information Needs Report* (Mausshardt 1995); the
13 engineering assessment performed for the ETF tank systems by an independent professional engineer. A
14 similar assessment of design requirements was performed for the load-in tanks and is documented in
15 *200 Area Effluent BAT/AKART Implementation, ETF Truck Load-In Facility, Project W-291H Integrity*
16 *Assessment Report* (KEH 1994).

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

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

29 The shell thicknesses of the tanks identified in Section 4.4.1.1 represent a nominal thickness of a new tank
30 when placed into operation. The tank capacities identified in this table represent the maximum operating
31 volumes. For certain tanks (as indicated in the table), the maximum operating volume is also the nominal
32 (routine) operating capacity. Nominal tank volumes represent the volume between the low-level and
33 high-level shutoffs in a tank unit.

34

35 4.4.1.1 Codes and Standards for Tank System Construction

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

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

2 <u>Tank name</u>	<u>Tank number</u>
3 Surge tank	2025E-60A-TK-1
4 pH adjustment tank	2025E-60C-TK-1
5 Effluent pH adjustment tank	2025E-60C-TK-2
6 First RO feed tank	2025E-60F-TK-1
7 Second RO feed tank	2025E-60F-TK-2
8 Verification tanks (three)	2025E-60H-TK-1A/1B/1
9 Secondary waste receiving tanks (two)	2025E-60I-TK-1A/1B
10 Concentrate tanks (two)	2025E-60J-TK-1A/1B
11 Sump tanks (two)	2025E-20B-TK-1/2
12 Distillate flash tank	2025E-60I-TK-2
13 Load-in tanks	TK-109/117

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

17 ASME - B31.3	Chemical Plant and Petroleum Refinery Piping (ASME 1990)
18 ASME Sect. VIII, Division I	Pressure Vessels (ASME 1992a)
19 AWS - D1.1	Structural Welding Code - Steel (AWS 1992)
20 ANSI - B16.5	Pipe Flanges and Flanged Fittings (ANSI 1992)
21 ASME Sect. IX	Welding and Brazing Qualifications (ASME 1992b)
22 API 620	Design and Construction of Large Welded Low Pressure Storage 23 Tanks (API 1990)
24 AWWA - D100	Welded Steel Tanks for Water Storage (AWWA 1989)
25 AWWA - D103	Factory-Coated Bolted Steel Tanks for Water Storage (AWWA 1987)
26 AWWA - D120	Thermosetting Fiberglass-Reinforced Plastic Tanks (AWWA 1984).

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

34 **4.4.1.2 Design Information for Tanks Located Outside of Effluent Treatment Facility**

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

37 **Load-In Tanks and Ancillary Equipment.** The load-in tanks are heated and constructed of stainless
38 steel, and have a nominal capacity of 37,900 liters. Ancillary equipment includes transfer pumps, a
39 filtration system, a double encased, fiberglass transfer pipeline, level instruments for tanker trucks, and
40 leak detection equipment. From the Load-In Station, aqueous waste can be routed to the surge tank or to

1 the LERF through a double-encased line. The load-in tanks, sump, pumps, and truck pad are all provided
2 with secondary containment.

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

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

15 Ancillary equipment includes a return pump that provides circulation of treated effluent through the
16 eductors. The return pump also recycles effluent back to the ETF for retreatment and can provide service
17 water for ETF functions. Two transfer pumps are used to discharge treated effluent to SALDS or back to
18 the LERF.

19 **4.4.1.3 Design Information for Tanks Located Inside the Effluent Treatment Facility Building**

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

22 **pH Adjustment Tank and Ancillary Equipment.** The pH adjustment tank has a nominal capacity of
23 9,800 liters. Ancillary equipment for this tank includes overflow lines to a sump tank and pumps to
24 transfer waste to other units in the main treatment train.

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

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

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

38 **Effluent Treatment Facility Evaporator and Ancillary Equipment.** The ETF evaporator, the principal
39 component of the evaporation process, is a cylindrical pressure vessel with a conical bottom. Aqueous
40 waste is fed into the lower portion of the vessel. The top of the vessel is domed and the vapor outlet is

1 configured to prevent carryover of liquid during the foaming or bumping (violent boiling) at the liquid
2 surface. The ETF evaporator has a capacity of approximately 21,000 liters.

3 The ETF evaporator includes the following ancillary equipment:

- 4 • Preheater
- 5 • Recirculation pump
- 6 • Waste heater with steam level control tank
- 7 • Concentrate transfer pump
- 8 • Entrainment separator
- 9 • Vapor compressor with silencers
- 10 • Silencer drain pump.

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

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

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

22 4.4.1.4 Design Information for Effluent Treatment Facility Process Units

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

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

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

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

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

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

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

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

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

14 4.4.2 Integrity Assessments

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

- 20 • Adequacy of the standards used during design and construction of the facility
- 21 • Characteristics of the solution in each tank
- 22 • Adequacy of the materials of construction to provide corrosion protection from the solution in each
23 tank
- 24 • Results of the leak tests and visual inspections.

25 The results of these assessments demonstrate that tanks and ancillary equipment have sufficient structural
26 integrity and are acceptable for storing and treating dangerous and/or mixed waste. The assessments also
27 state that the tanks and building were designed and constructed to withstand a design-basis earthquake.
28 These tank assessments were certified by independent, qualified registered professional engineers.

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

36 Consistent with the recommendations of the integrity assessment, a corrosion inspection program was
37 developed. Periodic integrity assessments are scheduled for those tanks that are predicted to have the
38 highest potential for corrosion. These inspections are scheduled annually or longer to follow the end of a
39 treatment campaign. These 'indicator tanks' include the concentrate tanks, secondary waste receiving
40 tanks, and verification tanks. One of each of these tanks will be inspected yearly to determine if corrosion
41 or coating failure has occurred. Should significant corrosion or coating failure be found, an additional
42 tank of the same type would be inspected during the same year. In the case of the verification tanks, if
43 corrosion or coating failure is found in the second tank, the third tank also will be inspected. If significant

1 corrosion were observed in all three sets of indicator tanks, the balance of the ETF tanks would be
2 considered for inspection. For tanks predicted to have lower potential for corrosion, inspections also are
3 performed nonroutinely as part of the corrective maintenance program.

4 **4.4.3 Additional Requirements for New Tanks**

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

17 **4.4.4 Secondary Containment and Release Detection for Tank Systems**

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

20 **4.4.4.1 Secondary Containment Requirements for All Tank Systems**

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

27 **4.4.4.1.1 Common Elements**

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

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

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

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

- 3 • Load-in tanks
- 4 • Surge tank
- 5 • Process area (including sump tanks)
- 6 • Verification tanks
- 7 • Transfer piping and pipe trenches.

8 All of the secondary containment systems are designed with reinforcing steel and base and berm thickness
9 to minimize failure caused by pressure gradients, physical contact with the waste, and climatic conditions.
10 Classical theories of structural analysis, soil mechanics, and concrete and structural steel design were used
11 in the design calculations for the foundations and structures. These calculations are maintained at the
12 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).

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

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

20 Except for the sump tank vaults, all of the concrete surfaces in the secondary containment system,
21 including berms, trenches, and pits, are coated with a chemical-resistant, high-solids, epoxy coating that
22 consists of a primer, filler, and a top coating. This coating material is compatible with the waste being
23 treated, and with the sulfuric acid, sodium hydroxide, and hydrogen peroxide additives to the process.
24 The coating protects the concrete from contact with any chemical materials that might be harmful to
25 concrete and prevents the concrete from being in contact with waste material. Table 4.7 summarizes the
26 specifies types of filler, primer, second, and finish coats specified for the concrete and masonry surfaces
27 in the ETF. The epoxy coating is considered integral to the secondary containment system for the tanks
28 and ancillary equipment.

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

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

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

9 4.4.4.1.2 Specific Containment Systems

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

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

20 Adjacent to the pit is a 25.4-centimeter-thick reinforced concrete pad that serves as secondary
21 containment for the load-in tanker trucks, containers, transfer pumps, and filter system. The pad is
22 15.2 centimeters below grade with north and south walls gently sloped to allow truck access. The pad has
23 drainpipes to route waste solution to the adjacent load-in tank pit.

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

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

35 **Process Area Secondary Containment.** The process area contains the tanks and ancillary equipment of
36 the primary and secondary treatment trains, and has a jointed, reinforced concrete slab floor. The
37 concrete floor of the process area provides the secondary containment. This floor is a minimum of
38 15.2 centimeters thick. With doorsills 15.2 centimeter high, the process area has a containment volume of
39 76,200 liters. The largest tanks in the process area are the secondary waste receiving tanks, which
40 each have a maximum capacity of 56,800 liters.

41 The floor of the process area is sloped to drain liquids to two trenches that drain to a sump. Each trench is
42 approximately 38.1 centimeters wide with a sloped trough varying from 39.4 to 76.2 centimeters deep.

1 Leaks into the secondary containment are detected by routine visual inspections of the floor area near the
2 tanks, ancillary equipment, and in the trenches.

3 A small dam was placed in the trench that comes from the thin film dryer room to contain minor liquid
4 spills originating in the dryer room to minimize the spread of contamination into the process area. The
5 dryer room is inspected for leaks in accordance with the inspection schedule in Attachment 34, Chapter
6 6.0. Operators clean up these minor spills by removing the liquid waste and decontaminating the spill
7 area.

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

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

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

- 19 • Process area drain trenches
- 20 • Tank overflows and drains
- 21 • Container washing water
- 22 • Resin dewatering solution
- 23 • Steam boiler blow down
- 24 • Sampler system drains.

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

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

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

1 **4.4.4.2 Additional Requirements for Specific Types of Systems**

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

5 **4.4.4.2.1 Double-Walled Tanks**

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

13 **4.4.4.2.2 Ancillary Equipment**

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

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

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

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

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

39 The 3-inch transfer line between the load-in tanks and the surge tank has a 6-inch outer pipe in a pipe-
40 within-a-pipe arrangement. The piping is made of fiberglass-reinforced plastic and slopes towards the

1 load-in tank secondary containment pit. The drain valve and leak detection system for the load-in tank
2 pipelines are operated similarly to the leak detection system for the LERF to ETF pipelines.

3 As previously indicated, four reinforced concrete pipe trenches provide secondary containment for piping
4 under the roadway between the ETF and the verification tanks. Each trench is 1.2 meters wide,
5 0.76 meter deep, and slopes towards the sump containing the transfer pumps to SALDS. The floor of the
6 trenches is 30.5 centimeters thick and the sides are 15.2 centimeters thick. The concrete trenches are
7 coated with water sealant and covered with metal gratings at ground level to allow vehicle traffic on the
8 roadway.

9 **4.4.5 Tank Management Practices**

10 When an aqueous waste stream is identified for treatment or storage at ETF, the generating unit is
11 required to characterize the waste. Based on characterization data, the waste stream is evaluated to
12 determine if the stream is acceptable for treatment or storage. Specific tank management practices are
13 discussed in the following sections.

14 **4.4.5.1 Rupture, Leakage, Corrosion Prevention**

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

21 Additionally, the materials of construction used in the tanks systems (Table 4.5) make it unlikely that an
22 aqueous waste would corrode a tank. For more information on corrosion prevention, refer to the waste
23 analysis plan Attachment 34, Chapter 3.0.

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

31 **4.4.5.2 Overfilling Prevention**

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

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

- 1 **Tanks.** All tanks are equipped with liquid level sensors that give a reading of the tank liquid volume.
2 The surge tank, the verification tanks, the RO tanks, the secondary waste receiving tanks, and the
3 concentrate tanks are equipped further with liquid level alarms that are actuated if the liquid volume is
4 near the tank overflow capacity. In the actuation of the surge tank alarm, a liquid level switch trips,
5 sending a signal to the valve actuator on the tank influent lines, and causing the influent valves to close.
- 6 The operating mode for each verification tank, i.e., receiving, holding, or discharging, can be designated
7 through the MCS; modes also switch automatically. When the high-level set point on the receiving
8 verification tank is reached, the flow to this tank is diverted and another tank becomes the receiver. The
9 full tank is switched into verification mode. The third tank is reserved for discharge mode.
- 10 The liquid levels in the first and second RO feed tanks are maintained within predetermined operating
11 ranges. Should the second RO feed tank overflow, the excess waste is piped along with any leakage from
12 the feed pump to a sump tank.
- 13 When waste in a secondary waste-receiving tank reaches the high-level set point, the influent flow of
14 waste is redirected to the second tank and the first tank becomes the feed tank for the ETF evaporator.
- 15 In a similar fashion, the concentrate tanks switch modes when the high-level set point of one tank is
16 reached. The other tank switches from a discharging mode to a receiving mode and the first tank
17 becomes the discharge tank feeding waste to the thin film dryer.
- 18 **Filter Systems.** All filters at ETF (i.e., the Load-In Station, rough, fine and auxiliary filter systems) are in
19 leak-tight steel casings. For the rough and fine filters, a high differential pressure, which could damage
20 the filter element, activates a valve that shuts off liquid flow to protect the filter element from possible
21 damage. To prevent a high-pressure situation, the filters are cleaned routinely with pulses of compressed
22 air that force water back through the filter. Cleaning is terminated automatically by shutting off the
23 compressed air supply if high pressure develops. The differential pressure across the auxiliary filters also
24 is monitored. A high differential pressure in these filters would result in a system shutdown to allow the
25 filters to be changed out.
- 26 The Load-In Station filtration system has pressure gauges for monitoring the differential pressure across
27 each filter. A high differential pressure would result in discontinuing filter operation until the filter is
28 replaced.
- 29 **Ultraviolet Light/Oxidation System and Decomposers.** A rupture disk on the inlet piping to each of
30 the UV/OX reaction vessels relieves to the pH adjustment tank in the event of excessive pressure
31 developing in the piping system. Should the rupture disk fail, the aqueous waste would trip the moisture
32 sensor, shut down the UV lamps, and close the surge tank feed valve. Also provided is a level sensor to
33 protect UV lamps against the risk of exposure to air. Should those sensors be actuated, the UV lamps
34 would be shut down immediately.
- 35 The piping and valving for the hydrogen peroxide decomposers are configured to split the waste flow:
36 half flows to one decomposer and half flows to the other decomposer. Alternatively, the total flow of
37 waste can be treated in one decomposer or both decomposers can be bypassed. A safety relief valve on
38 each decomposer vessel can relieve excess system pressure to a sump tank.
- 39 **Degasification System.** The degasification column is typically supplied aqueous waste feed by the pH
40 adjustment tank feed pump. This pump transfers waste solution through the hydrogen peroxide
41 decomposer, the fine filter, and the degasification column to the first RO feed tank.

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

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

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

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

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

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

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

28 4.4.6 Labels or Signs

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

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

40 Tanks and vessels containing corrosive chemicals are posted with black and white signs bearing the word
41 "CORROSIVE". "DANGER - UNAUTHORIZED PERSONNEL KEEP OUT" signs are posted on all

1 exterior doors of the ETF, and on each interior door leading into the process area. Tank ancillary piping
2 is also labeled "PROCESS WATER" or "PROCESS LIQUID" to alert personnel which pipes in the
3 process area contains dangerous and/or mixed waste.

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

8 4.4.7 Air Emissions

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

15 4.4.8 Management of Ignitable or Reactive Wastes in Tanks Systems

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

22 4.4.9 Management of Incompatible Wastes in Tanks Systems

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

27 4.5 SURFACE IMPOUNDMENTS

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

31 The LERF consists of three lined surface impoundments (basins) with a design operating capacity of
32 29.5 million liters each. The maximum capacity of each basin is 34 million liters. The dimensions of
33 each basin at the anchor wall are approximately 103 meters by 85 meters. The typical top dimensions of
34 the wetted area are approximately 89 meters by 71 meters, while the bottom dimensions are
35 approximately 57 by 38 meters. Total depth from the top of the dike to the bottom of the basin is
36 approximately 7 meters. The typical finished basin bottoms lie at about 4 meters below the initial grade
37 and 175 meters above sea level. The dikes separating the basins have a typical height of 3 meters and
38 typical top width of 11.6 meters around the perimeter of the impoundments.

1 4.5.1 List of Dangerous Waste

2 A list of dangerous and/or mixed aqueous waste that can be stored in LERF is presented in
3 Attachment 34, Chapter 1.0. The waste analysis plan for the LERF and ETF Attachment 34, Chapter 3.0
4 also provides a discussion of the types of waste that are managed in the LERF.

5 4.5.2 Construction, Operation, and Maintenance of Liner System

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

9 4.5.2.1 Liner Construction Materials

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

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

- 19 • Primary 1.5-millimeter high-density polyethylene geomembrane
- 20 • Bentonite carpet liner
- 21 • Geotextile
- 22 • Drainage gravel (bottom) and geonet (sides)
- 23 • Geotextile
- 24 • Secondary 1.5-millimeter high-density polyethylene geomembrane
- 25 • Soil/bentonite admixture (91 centimeters on the bottom, 107 centimeters on the sides)
- 26 • Geotextile.

27 The primary geomembrane, made of 1.5-millimeter high-density polyethylene, forms the basin surface
28 that holds the aqueous waste. The secondary geomembrane, also 1.5-millimeter high-density
29 polyethylene, forms a barrier surface for leachate that might penetrate the primary liner. The high-density
30 polyethylene chemically is resistant to constituents in the aqueous waste and has a relatively high strength
31 compared to other lining materials. The high-density polyethylene resin specified for the LERF contains
32 carbon black, antioxidants, and heat stabilizers to enhance its resistance to the degrading effects of UV
33 light. The approach to ensuring the compatibility of aqueous waste streams with the LERF liner materials
34 and piping is discussed in the waste analysis plan Attachment 34, Chapter 3.0.

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

41 A 30.5-centimeters-thick gravel drainage layer on the bottom of the basins between the primary and
42 secondary liners provides a flow path for liquid to the leachate detection, collection, and removal system.

1 A geonet (or drainage net) is located immediately above the secondary geomembrane on the basin
2 sidewalls. The geonet functions as a preferential flow path for liquid between the liners, carrying liquid
3 down to the gravel drainage layer and subsequently to the leachate sump. The geonet is a mesh made of
4 high-density polyethylene, with approximately 13-millimeter openings.

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

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

19 Direct shear tests were performed according to ASTM D3080 test procedures (ASTM 1990) on
20 soil/bentonite samples of various ratios. Based on these results, the conservative minimum Mohr-
21 Coulomb shear strength value of 30 degrees was estimated for a soil/bentonite admixture containing
22 12 percent bentonite.

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

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

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

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

1 **4.5.2.1.1 Material Specifications.**

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

6 **Geomembrane Liners.** The high-density polyethylene resin for geomembranes for the LERF meets the
7 material specifications listed in Table 4.8. Key physical properties include thickness (1.5 millimeters)
8 [60 mil]) and impermeability (hydrostatic resistance of over 360,000 kilogram per square meter).
9 Physical properties meet National Sanitation Foundation Standard 54 (NSF 1985). Testing to determine
10 if the liner material is compatible with typical dilute waste solutions was performed and documented in
11 *9090 Test Results* (WHC 1991).

12 **Soil/Bentonite Liner.** The soil/bentonite admixture consists of 11.5 to 14.5 percent bentonite mixed into
13 well-graded silty sand with a maximum particle size of 4.75 millimeters (No. 4 sieve). Test fills were
14 performed to confirm the soil/bentonite admixture applied at LERF has hydraulic conductivity less than
15 10^{-7} centimeters per second, as required by WAC 173-303-650(2)(j) for new surface impoundments.

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

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

27 **Drainage Gravel.** The drainage layer consists of thoroughly washed and screened, naturally occurring
28 rock meeting the size specifications for Grading Number 5 in Washington State Department of
29 Transportation construction specifications (WSDOT 1988). The specifications for the drainage layer are
30 given in Table 4.9. Hydraulic conductivity tests (Chen-Northern 1992a, 1992b, 1992c) showed the
31 drainage rock used at LERF met the sieve requirements and had a hydraulic conductivity of at least
32 1 centimeter per second, which exceeded the minimum of at least 0.1 centimeters per second required by
33 WAC 173-303-650(2)(j) for new surface impoundments.

34 **Geonet.** The geonet is fabricated from two sets of parallel high-density polyethylene strands, spaced
35 1.3 centimeters center-to-center maximum to form a mesh with minimum two strands per 2.54 centimeter
36 in each direction. The geonet is located between the liners on the sloping sidewalls to provide a
37 preferential flow path for leachate to the drainage gravel and subsequently to the leachate sump.

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

- 41 • 25 millimeter high-density polyethylene flat stock (supporting the leachate riser pipe)
- 42 • Geotextile
- 43 • 1.5-millimeter high-density polyethylene rub sheet

- 1 • Secondary composite liner:
- 2 – 1.5-millimeter high-density polyethylene geomembrane
- 3 – 91 centimeters of soil/bentonite admixture
- 4 – Geotextile.

5 Specifications for these materials are identical to those discussed previously.

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

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

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

20 4.5.2.1.2 Loads on Liner System.

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

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

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

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

38 Additional calculations were performed to estimate the ability of the leachate riser pipe to withstand the
39 static and dynamic loading imposed by lightweight construction equipment riding on the gravel layer
40 (HNF 1997). Those calculations demonstrated that the pipe could buckle under the dynamic loading of

1 small construction equipment; therefore, the pipe was avoided by equipment during spreading of the
2 drainage gravel.

3 Installation of synthetic lining materials proceeded only when winds were less than 24 kilometers per
4 hour, and not during precipitation. The minimum ambient air temperature for unfolding or unrolling the
5 high-density polyethylene sheets was -10 C, and a minimum temperature of 0 C was required for seaming
6 the high-density polyethylene sheets. Between shifts, geomembranes and geotextile were anchored with
7 sandbags to prevent lifting by wind. Calculations were performed to determine the appropriate spacing of
8 sandbags on the geomembrane to resist lifting caused by 130 kilometer per hour winds (HNF 1997). All
9 of the synthetic components contain UV light inhibitors and no impairment of performance is anticipated
10 from the short-term UV light exposure during construction. Section 4.5.2.4 provides further detail on
11 exposure prevention.

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

15 **4.5.2.1.3 Static and Dynamic Loads and Stresses from the Maximum Quantity of Waste**

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

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

26 Because the LERF is not located in an area of seismic concern, as identified in Appendix VI of
27 40 CFR 264 and WAC 173-303-282(6)(a)(I), discussion and calculation of potential seismic events are
28 not required.

29 **4.5.2.1.4 Stresses Resulting from Settlement, Subsidence, or Uplift**

30 Uplift stresses from natural sources are expected to have negligible impact on the liner. Groundwater lies
31 approximately 62 meters below the LERF, average annual precipitation is only 16 centimeters, and the
32 average unsaturated permeability of the soils near the basin bottoms is high, ranging from about
33 5.5×10^4 centimeters per second to about 1 centimeter per second (Chen-Northern 1991b). Therefore, no
34 hydrostatic uplift forces are expected to develop in the soil underneath the basins. In addition, the soil
35 under the basins consists primarily of gravel and sand, and contains few or no organic constituents.
36 Therefore, uplift caused by gas production from organic degradation is not anticipated.

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

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

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

5 **4.5.2.1.5 Internal and External Pressure Gradients**

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

12 To prevent the buildup of gas between the liners, each basin is equipped with 21 vents in the primary
13 geomembrane that allow the reduction of any excess gas pressure. Gas passing through these vents exit
14 through a single pipe that penetrates the anchor wall into a carbon adsorption filter. This filter extracts
15 nearly all of the organic compounds, ensuring that emissions to the air from the basins are not toxic.

16 **4.5.2.2 Liner System Location Relative to High-Water Table**

17 The lowest point of each LERF basin is the northwest corner of the sump, where the typical subgrade
18 elevation is 175 meters above mean sea level. Based on data collected from the groundwater monitoring
19 wells at the LERF site, the seasonal high-water table is located approximately 62 meters or more below
20 the lowest point of the basins. This substantial thickness of unsaturated strata beneath the LERF provides
21 ample protection to the liner from hydrostatic pressure because of groundwater intrusion into the
22 soil/bentonite layer. Further discussion of the unsaturated zone and site hydrogeology is provided in
23 Attachment 34, Chapter 5.0.

24 **4.5.2.3 Liner System Foundation**

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

30 Analysis of five soil borings from the LERF site was conducted to characterize the natural foundation
31 materials and to determine the suitability of onsite soils for construction of the impoundment dikes and
32 determine optimal design factors. Well-graded gravel containing varying amounts of silt, sand, and
33 cobbles comprises the layer in which the basins were excavated. This gravel layer extends to depths of
34 10 to 11 meters below land surface (Chen-Northern 1990). The basins are constructed directly on the
35 subgrade. Excavated soils were screened to remove oversize cobbles (greater than 15 centimeters in the
36 largest dimension) and used to construct the dikes.

37 Settlement potential of the foundation material and soil/bentonite layer was found to be low. The
38 foundation is comprised of undisturbed native soils. The bottom of the basin excavation lies within the
39 well-graded gravel layer, and is dense to very dense. Below the gravel is a layer of dense to very dense
40 poorly graded and well-graded sand. Settlement was calculated for the gravel foundation soils and for the
41 soil/bentonite layer, under the condition of hydrostatic loading from 6.4 meters of fluid depth. The
42 combined settlement for the soils and the soil/bentonite layer is estimated to be about 2.7 centimeters.
43 This amount of settlement is expected to have minimal impact on overall liner or basin stability (Chen-

1 Northern 1991b). Settlement calculations are provided in *Calculations for Liquid Effluent Retention*
2 *Facility Part B Permit Application* (HNF 1997).

3 The load bearing capacity of the foundation material, based on the soil analysis discussed previously, is
4 estimated at about 48,800 kilograms per square meter [maximum advisable presumptive bearing capacity
5 (Hough 1969)]. Anticipated static and dynamic loading from a full basin is estimated to be less than
6 9,000 kilograms per square meter (Section 4.5.2.1.3), which provides an ample factor of safety.

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

13 Subsidence of undisturbed foundation materials is generally the result of fluid extraction (water or
14 petroleum), mining, or karst topography. Neither petroleum, mineral resources, nor karst are believed to
15 be present in the sediments overlying the Columbia River basalts. Potential groundwater resources do
16 exist below the LERF. Even if these sediments were to consolidate from fluid withdrawal, their depth
17 most likely would produce a broad, gently sloping area of subsidence that would not cause significant
18 strains in the LERF liner system. Consequently, the potential for subsidence related failures are expected
19 to be negligible.

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

23 4.5.2.4 Liner System Exposure Prevention

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

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

39 The entire lining system is covered by a very low-density polyethylene floating cover that is bolted to the
40 concrete anchor wall. The floating cover prevents evaporation and intrusion from dust, precipitation,
41 vegetation, animals, and birds. A patented tensioning system is employed to prevent wind from lifting the
42 cover and automatically accommodate changes in liquid level in the basins. The cover tension
43 mechanism consists of a cable running from the flexible geosynthetic cover over a pulley on the tension
44 tower (located on the concrete anchor wall) to a dead man anchor. These anchors (blocks) simply hang

1 from the cables on the exterior side of the tension towers. The anchor wall also provides for solid
2 attachment of the liner layers and the cover, using a 6.4-millimeter batten and neoprene gasket to bolt the
3 layers to the concrete wall, effectively sealing the basin from the intrusion of light, precipitation, and
4 airborne dust (Figure 4.16).

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

12 The upper 3.4 to 4.6 meters of the sidewall liner also could experience stresses in response to temperature
13 changes. Accommodation of thermal influences for the LERF geosynthetic layers is affected by inclusion
14 of sufficient slack as the liners were installed. Calculations demonstrate that approximately
15 67 centimeters of slack is required in the long basin bottom dimension, 46 centimeters across the basin,
16 and 34 centimeters from the bottom of the basin to the top of the basin wall (HNF 1997).

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

19 **4.5.2.4.1 Liner Repairs During Operations**

20 Should repair of a basin liner be required while the basin is in operation, the basin contents will be
21 transferred to the ETF or another available basin. After the liner around the leaking section is cleaned,
22 repairs to the geomembrane will be made by the application of a piece of high-density polyethylene
23 sheeting, sufficient in size to extend approximately 8 to 15 centimeters beyond the damaged area, or as
24 recommended by the vendor. A round or oval patch will be installed using the same type of equipment
25 and criteria used for the initial field installations.

26 **4.5.2.4.2 Control of Air Emissions**

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

32 **4.5.2.5 Liner Coverage**

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

36 **4.5.3 Prevention of Overtopping**

37 Overtopping prevention is accomplished through administrative controls and liquid-level instrumentation
38 installed in each basin. The instrumentation includes local liquid-level indication as well as remote
39 indication at the ETF. Before an aqueous waste is transferred into a basin, administrative controls are
40 implemented to ensure overtopping will not occur during the transfer. The volume of feed to be

1 transferred is compared to the available volume in the receiving basin. The transfer is not initiated unless
2 there is sufficient volume available in the receiving basin or a cut-off level is established. The transfer
3 into the basin would be stopped when this cut-off level is reached.

4 In the event of a 100-year, 24-hour storm event, precipitation would accumulate on the basin covers.
5 Through the self-tensioning design of the basin covers and maintenance of adequate freeboard, all
6 accumulated precipitation would be contained on the covers and none would flow over the dikes or
7 anchor walls. The 100-year, 24-hour storm is expected to deliver 5.3 centimeters of rain or approximately
8 61 centimeters of snow. Cover specifications include the requirement that the covers be able to withstand
9 the load from this amount of precipitation. Because the cover floats on the surface of the fluid in the
10 basin, the fluid itself provides the primary support for the weight of the accumulated precipitation.
11 Through the cover self-tensioning mechanism, there is ample 'give' to accommodate the overlying load
12 without overstressing the anchor and attachment points.

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

17 4.5.3.1 Freeboard

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

20 4.5.3.2 Immediate Flow Shutoff

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

27 4.5.3.3 Outflow Destination

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

35 4.5.4 Structural Integrity of Dikes

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

1 **4.5.4.1 Dike Design, Construction, and Maintenance**

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

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

11 **4.5.4.2 Dike Stability and Protection**

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

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

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

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

29 The standard horizontal acceleration required in the *Hanford Plant Standards*, "Standard Architectural-
30 Civil Design Criteria, Design Loads for Facilities" (DOE-RL 1988), for structures on the Hanford Site is
31 0.12 g. Adequate factors of safety for cut slopes in units of this type generally are considered 1.5 for
32 static conditions and 1.1 for dynamic stability (Golder 1989). Results of the stability analysis showed that
33 the LERF basin slopes were stable under horizontal accelerations of 0.10 and 0.15 g, with minimum
34 factors of safety of 1.32 and 1.17, respectively (Chen-Northern 1991b). Printouts from the PCSTABL5
35 program are provided in *Calculations for Liquid Effluent Retention Facility Part B Permit Application*
36 (HNF 1997).

37 **Hydrostatic Pressure.** Failure of the dikes due to buildup of hydrostatic pressure, caused by failure of
38 the leachate system or liners, is very unlikely. The liner system is constructed with two essentially
39 impermeable layers consisting of a synthetic layer overlying a soil layer with low-hydraulic conductivity.
40 It would require a catastrophic failure of both liners to cause hydrostatic pressures that could endanger
41 dike integrity. Routine inspections of the leachate detection system, indicating quantities of leachate
42 removed from the basins, provide an early warning of leakage or operational problems that could lead to
43 excessive hydrostatic pressure. A significant precipitation event (e.g., a 100-year, 24-hour storm) will not

1 create a hydrostatic problem because the interior sidewalls of the basins are covered completely by the
2 liners. The covers can accommodate this volume of precipitation without overtopping the dike
3 (Section 4.5.3), and the coarse nature of the dike and foundation materials on the exterior walls provides
4 for rapid drainage of precipitation away from the basins.

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

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

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

23 4.5.5 Piping Systems

24 Aqueous waste from the 242-A Evaporator is transferred to the LERF using a pump located in the
25 242-A Evaporator and approximately 1,500 meters of pipe, consisting of a 3-inch carrier pipe within a
26 6-inch outer containment pipeline. Flow through the pump is controlled through a valve at flow rates
27 from 150 to 300 liters per minute.

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

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

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

1 **4.5.5.1 Secondary Containment System for Piping**

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

12 **4.5.5.2 Leak Detection System**

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

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

25 **4.5.5.3 Certification**

26 Although an integrity assessment is not required for piping associated with surface impoundments, an
27 assessment of the transfer liner was performed, including a hydrostatic leak/pressure test at
28 10.5 kilograms per square centimeter gauge. A statement by an independent, qualified, registered
29 professional engineer attesting to the integrity of the piping system is included in *Integrity Assessment*
30 *Report for the 242-A Evaporator/LERF Waste Transfer Piping, Project W105* (WHC 1993), along with
31 the results of the leak/pressure test.

32 **4.5.6 Double Liner and Leak Detection, Collection, and Removal System**

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

- 36 • 30.5-centimeter layer of drainage gravel below the primary liner at the bottom of the basin
- 37 • Geonet below the primary liner on the sidewalls to direct leachate to the gravel layer
- 38 • 3.0-meter by 1.8-meter by 0.30-meter-deep leachate collection sump consisting of a 25 millimeter
39 high-density polyethylene flat stock, geotextile to trap large particles in the leachate, and 1.5-
40 millimeter high-density polyethylene rub sheet set on the secondary liner
- 41 • 10-inch and 4-inch perforated leachate high-density polyethylene riser pipes from the leachate
42 collection sump to the catch basin northwest of the basin

- 1 • Leachate collection sump level instrumentation installed in the 4-inch riser
- 2 • Level sensors, submersible leachate pump, and 1.5-inch fiberglass-reinforced epoxy thermoset resin
- 3 pressure piping installed in the 10-inch riser
- 4 • Piping at the catch basin to route the leachate through 1.5-inch high-density polyethylene pipe back to
- 5 the basins.

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

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

14 Automated controls maintain the fluid level in each leachate sump below 33 centimeters to prevent
15 significant liquid backup into the drainage layer. The leachate pump is activated when the liquid level in
16 the sump reaches about 28 centimeters, and is shut off when the sump liquid level reaches about
17 18 centimeters. This operation prevents the leachate pump from cycling with no fluid, which could
18 damage the pump. Liquid level control is accomplished with conductivity probes that trigger relays
19 selected specifically for application to submersible pumps and leachate fluids. A flowmeter/totalizer on
20 the leachate return pipe measures fluid volumes pumped and pumping rate from the leachate collection
21 sumps, and indicates volume and flow rate on local readouts. Other instrumentation provided is real-time
22 continuous level monitoring with a readout at the catch basin and the 242-A Evaporator control room. A
23 sampling port is provided in the leachate piping system at the catch basin. Leak detection is provided
24 through inspections of the leachate flow totalizer readings. For more information on inspections, refer to
25 Attachment 34, Chapter 6.0.

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

29 4.5.7 Construction Quality Assurance

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

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

36 For the soil/bentonite layer, test fills were first conducted in accordance with EPA guidance to
37 demonstrate compaction procedures and to confirm compaction and permeability requirements can be
38 met. The ratio of bentonite to soil and moisture content was monitored; lifts did not exceed
39 15 centimeters before compaction, and specific compaction procedures were followed. Laboratory and
40 field tests of soil properties were performed for each lift and for the completed test fill. The same suite of
41 tests was conducted for each lift during the laying of the soil/bentonite admixture in the basins.

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

4 **4.5.8 Proposed Action Leakage Rate and Response Action Plan**

5 An action leakage rate limit is established where action must be taken due to excessive leakage from the
6 primary liner. The action leak rate is based on the maximum design flow rate the leak detection system
7 can remove without the fluid head on the bottom liner exceeding 30 centimeters. The limiting factor in
8 the leachate removal rate is the hydraulic conductivity of the drainage gravel. An action leakage rate
9 (also called the rapid or large leak rate) of 20,000 liters per hectare per day was calculated for each basin
10 (WHC 1992b).

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

15 **4.5.9 Dike Structural Integrity Engineering Certification**

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

18 **4.5.10 Management of Ignitable, Reactive, or Incompatible Wastes**

19 Although ignitable or reactive aqueous waste might be received in small quantities at LERF, such
20 aqueous waste is mixed with dilute solutions in the basins, removing the ignitable or reactive
21 characteristics. For compatibility requirements with the LERF liner, refer to the waste analysis plan
22 Attachment 34, Attachment 34, Chapter 3.0.

23 **4.6 AIR EMISSIONS CONTROL**

24 This section addresses the ETF requirements of Air Emission Standards for Process Vents, under
25 40 CFR 264, Subpart AA (incorporated by reference in WAC 173-303-690) and Subpart CC. The
26 requirements of 40 CFR 264, Subpart BB (WAC 173-303-691) is not applicable because aqueous waste
27 with 10 percent or greater organic concentration would not be acceptable for processing at the ETF.

28 **4.6.1 Applicability of Subpart AA Standards**

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

35 The vessel off gas system provides a process vent system. This system provides a slight vacuum on the
36 ETF process vessels and tanks (refer to Section 4.2.5.2). Two vessel vent header pipes combine and enter
37 the vessel off gas system filter unit consisting of a demister, electric heater, prefilter, high-efficiency
38 particulate air filters, activated carbon absorber, and two exhaust fans (one fan in service while the other
39 is backup). The vessel off gas system filter unit is located in the high-efficiency particulate air filter room

1 west of the process area. The vessel off gas system exhaust discharges into the larger building ventilation
2 system, with the exhaust fans and stack located outside and immediately west of the ETF. The exhaust
3 stack discharge point is 15.5 meters above ground level.

4 The annual average flow rate for the ETF stack (which is the combined vessel off gas and building
5 exhaust flow rates) is 220 cubic meters per minute with a total annual flow of approximately
6 1.2 E+08 cubic meters. During waste processing, the airflow through just the vessel off gas system is
7 about 23 standard cubic meters per minute.

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

12 4.6.2 Process Vents - Demonstrating Compliance

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

16 4.6.2.1 Basis for Meeting Limits/Reductions

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

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

27 4.6.2.2 Demonstrating Compliance

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

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

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

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

13 **4.6.2.3 Reevaluating Compliance with Subpart AA Standards**

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

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

20 **4.6.3 Applicability of Subpart CC Standards**

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

27 TSD owner/operators are not required to determine the concentration of volatile organic compounds in a
28 hazardous waste if the wastes are placed in waste management units that employ air emission controls
29 that comply with the Subpart CC standards. Therefore, the approach to Subpart CC compliance at the
30 ETF and LERF is to demonstrate that the ETF and LERF meet the Subpart CC control standards
31 (40 CFR 264.1084 - 264.1086).

32 **4.6.3.1 Demonstrating Compliance with Subpart CC for Tanks**

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

35 **4.6.3.2 Demonstrating Compliance with Subpart CC for Containers**

36 Container Level 1 and Level 2 standards are met at the ETF by managing all dangerous and/or mixed
37 wastes in U.S. Department of Transportation containers [40 CFR 264.1086(f)]. Level 1 containers are

1 those that store more than 0.1 cubic meters and less than or equal to 0.46 cubic meters. Level 2
2 containers are used to store more than 0.46 cubic meters of waste, which are in "light material service".
3 Light material service is defined where a waste in the container has one or more organic constituents
4 with a vapor pressure greater than 0.3 kilopascals at 20 C, and the total concentration of such
5 constituents is greater than or equal to 20 percent by weight.

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

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

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

20 4.6.3.3 Demonstrating Compliance with Subpart CC for Surface Impoundments

21 The Subpart CC emission standards are met at LERF using a floating membrane cover that is constructed
22 of very-low-density polyethylene that forms a continuous barrier over the entire surface area
23 [40 CFR 264.1085(c)]. This membrane has both organic permeability properties equivalent to a high-
24 density polyethylene cover and chemical/physical properties that maintain the material integrity for the
25 intended service life of the material. The additional requirements for the floating cover at the LERF have
26 been met (Section 4.5.2.4).

27 4.7 ENGINEERING DRAWINGS

28 4.7.1 Liquid Effluent Retention Facility

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

33 **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

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

1 **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
LERF Piping and Instrumentation	H-2-88766, Sheet 2	P&ID; LERF Basin and ETF Influent
LERF Piping and Instrumentation	H-2-88766, Sheet 3	P&ID; LERF Basin and ETF Influent
LERF Piping and Instrumentation	H-2-88766, Sheet 4	P&ID; LERF Basin and ETF Influent
	H-2-89351, Sheet 1	Piping & Instrumentation Diagram - Legend

2 **4.7.2 200 Area Effluent Treatment Facility**

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

8 **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

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

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
Load-in tanks (2)	None	vent to atmosphere	concrete slab	SS skirt bolted to concrete	welded	flanged
Surge tank	None	pressure indicator/vacuu m 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/filtere d vent to atmosphere	reinforced concrete ring plus concrete slab	structural steel on concrete base	welded	flanged

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
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

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.
 DFT = distillate flash tank.
 VOG = vessel off gas system.

Table 4.6. 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 ₂ O 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
Dryer feed preheater		2025E-60J-E-3	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 4.7. 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 4.8. 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 \pm 10% (1.5 mm \pm 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	-40° C, maximum
Dimensional (%change each direction)	\pm 2%, 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 guid (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

1 **Table 4.9. 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

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

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1 **5.6 LIQUID EFFLUENT TREATMENT FACILITY GROUNDWATER MONITORING PLAN,**
2 **PNNL-11620.**

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Pacific Northwest National Laboratory

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U.S. Department of Energy

Liquid Effluent Retention Facility Final-Status Groundwater Monitoring Plan

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B. N. Bjornstad

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Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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**Liquid Effluent Retention Facility
Final-Status Groundwater
Monitoring Plan**

M. D. Sweeney
C. J. Chou
B. N. Bjornstad

September 1997

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1.0 Introduction

The following sections describe the groundwater-monitoring program for the Liquid Effluent Retention Facility (LERF). The LERF is regulated under the Resource Conservation and Recovery Act of 1976 (RCRA). The LERF is included in the "Dangerous Waste Portion of the Resource Conservation and Recovery Act Permit for the Treatment, Storage, and Disposal of Dangerous Waste, Permit WA890008967", (referred to herein as the Permit) (Ecology 1994) and is subject to final-status requirements for groundwater monitoring (WAC 173-303-645).

This document describes a RCRA/WAC groundwater detection-monitoring program for groundwater in the uppermost aquifer system at the LERF. This plan describes the LERF monitoring network, constituent list, sampling schedule, statistical methods, and sampling and analysis protocols that will be employed for the LERF. This plan will be used to meet the groundwater monitoring requirements from the time the LERF becomes part of the Permit and through the post-closure care period, until certification of final closure.

1.1 History of Groundwater Monitoring at the LERF

A groundwater-monitoring network was installed at the LERF in 1990 before final construction of the facility. Samples were collected quarterly from the four wells (one upgradient and three downgradient from the LERF) and interim-status evaluation of indicator parameters began before waste was transferred to the basins. Constituents analyzed during the first year of sampling included the analytes listed in 40 CFR 265 Appendix IX, groundwater-quality parameters, and several site-specific constituents. Data for these analytes are in the Hanford Environmental Information System (HEIS) database. The selection of site-specific constituents was based on waste-stream analysis of the primary generating facility, the 242-A Evaporator. Total organic carbon, total organic halogen, pH and specific conductivity, collectively known as indicator parameters, were also evaluated during the first year; the critical means specific to this facility were calculated for these parameters. Once the critical means were established, groundwater sampling was changed to a semiannual schedule.

1.2 Changes from Interim-Status Groundwater Monitoring

The LERF will enter final status in detection-level monitoring, a program similar to indicator-evaluation monitoring conducted under interim status. The two programs differ substantially, however, in sampling requirements and in statistical analysis. Interim-status regulations require the collection of multiple samples (replicates) in one sampling event. The default procedure under final-status regulations require independent samples, which involve waiting periods between samples. The proposed sampling method is described in Section 4.0. Statistical methods proposed in this document are also different than those used under interim-status, and the proposed method represents a preferred alternative to the default procedure as described in WAC 173-303-645 (h). The proposed program also relies on a shorter constituent list than did the previous program.

The "assessment" program under interim status is equivalent to a "compliance" program in final status. In compliance monitoring, specific constituents are chosen and compared to concentration limits. If these limits are exceeded, then the site enters a corrective-action phase.

The radioactive portion of mixed waste is interpreted by DOE to be regulated under the Atomic Energy Act of 1954; the non-radioactive hazardous portion of the mixed waste is interpreted to be regulated under RCRA and WAC 173-303. It is the position of DOE that any procedures, methods, data, or information associated with this monitoring program that relate solely to the radioactive constituent of mixed wastes is outside the scope of the Hanford Facility RCRA Permit but are included for the sake of completeness. It is the position of Ecology that the radioactive portion influences safe storage of the waste and, therefore, information about radioactive constituents is necessary to ensure compliance with WAC 173-303 and the RCRA permit. Both agencies acknowledge the other's position, but to avoid a conflict on the issue, DOE has agreed to provide information on the radioactive constituents without agreeing with Ecology's position and Ecology has agreed to accept the information in this context without giving up its position.

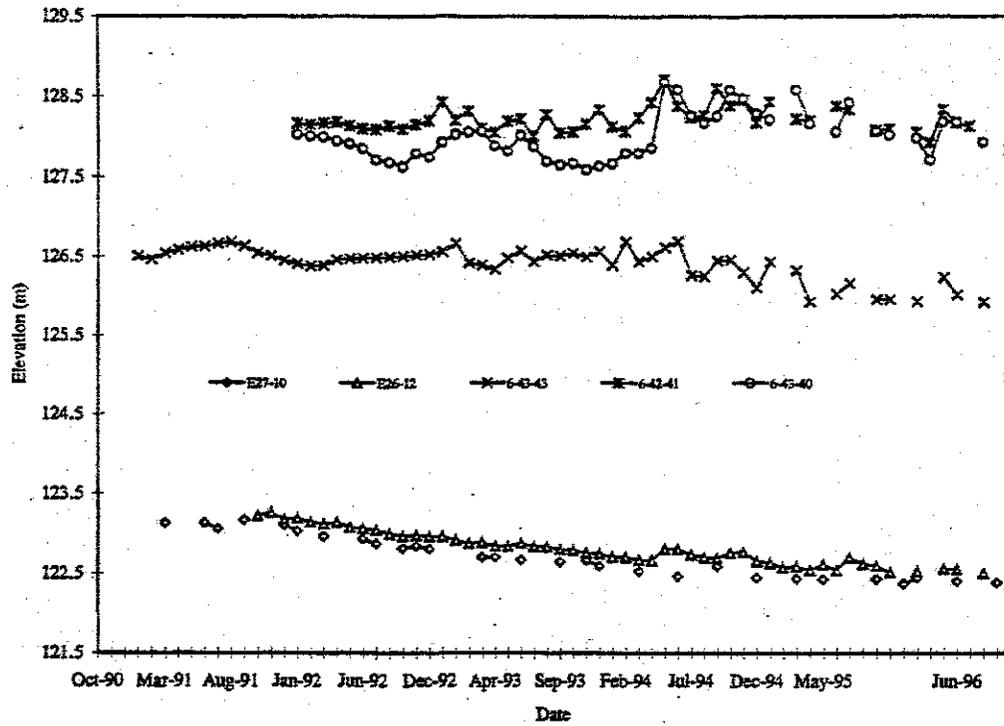


Figure 3.8. Hydrograph of Ground-Water Monitoring Wells Near the LERF Area

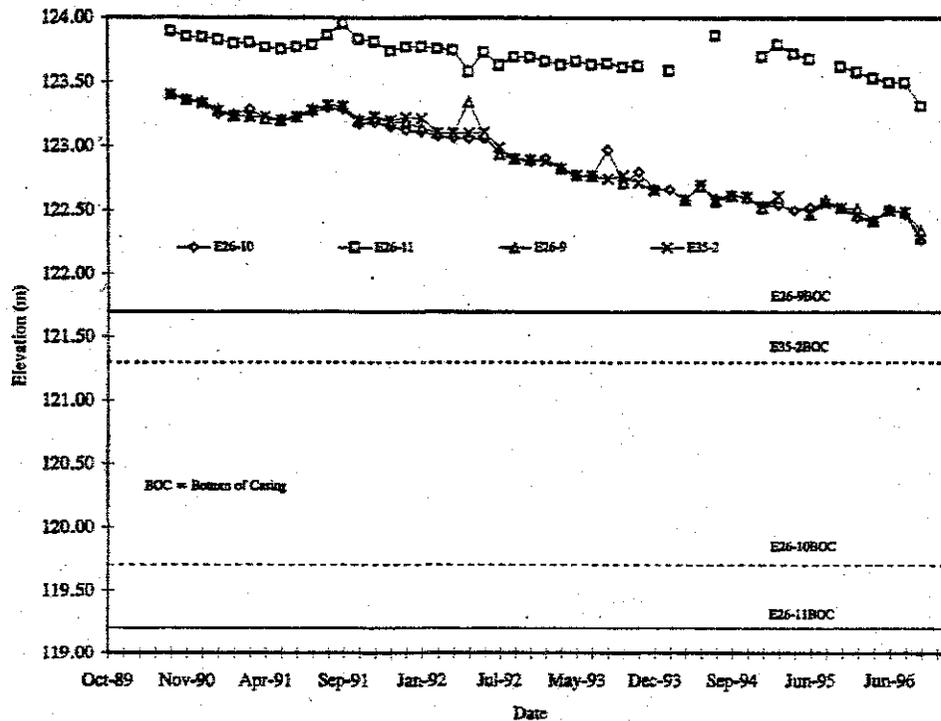
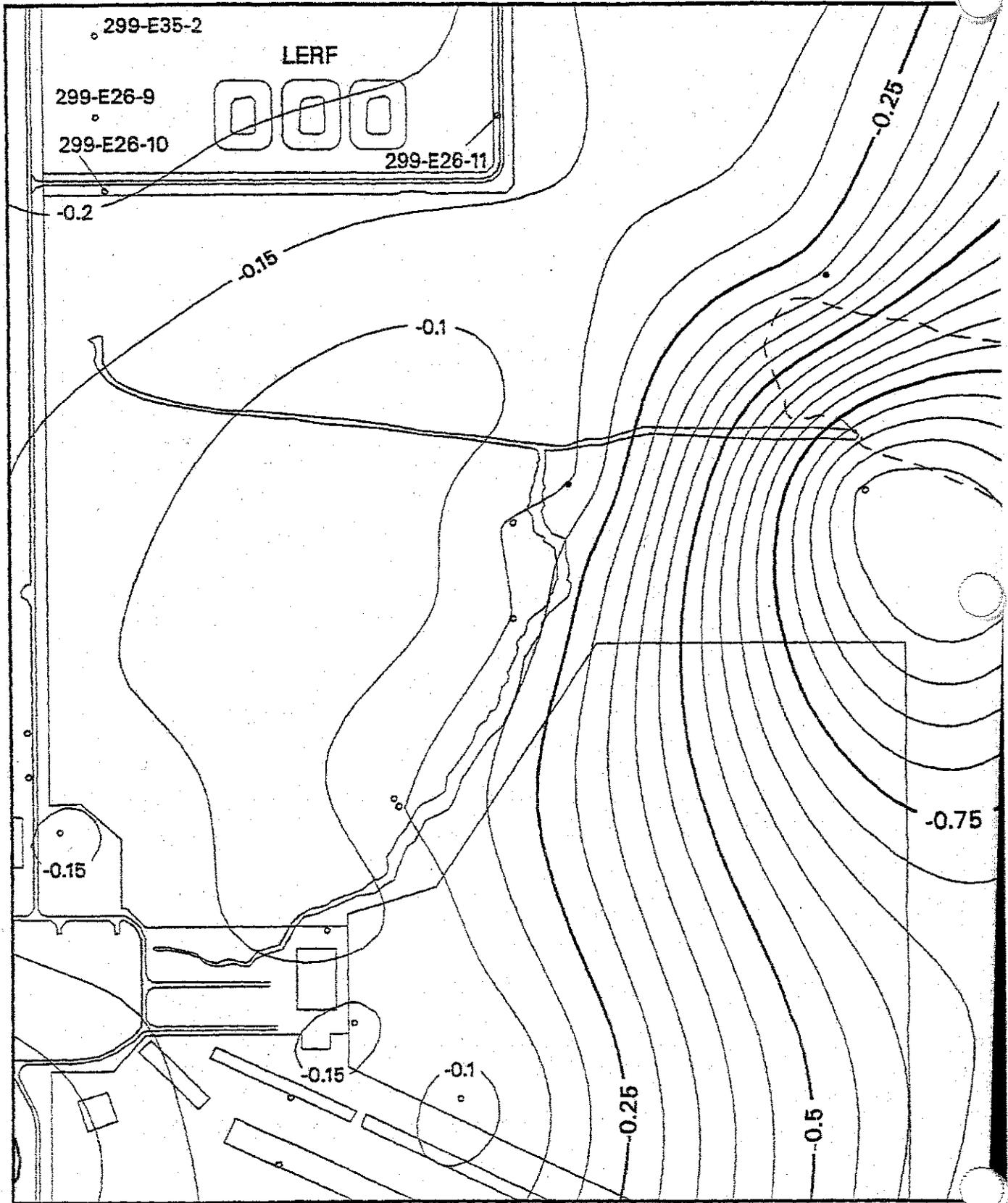


Figure 3.9. Hydrograph of LERF Ground-Water Monitoring Wells



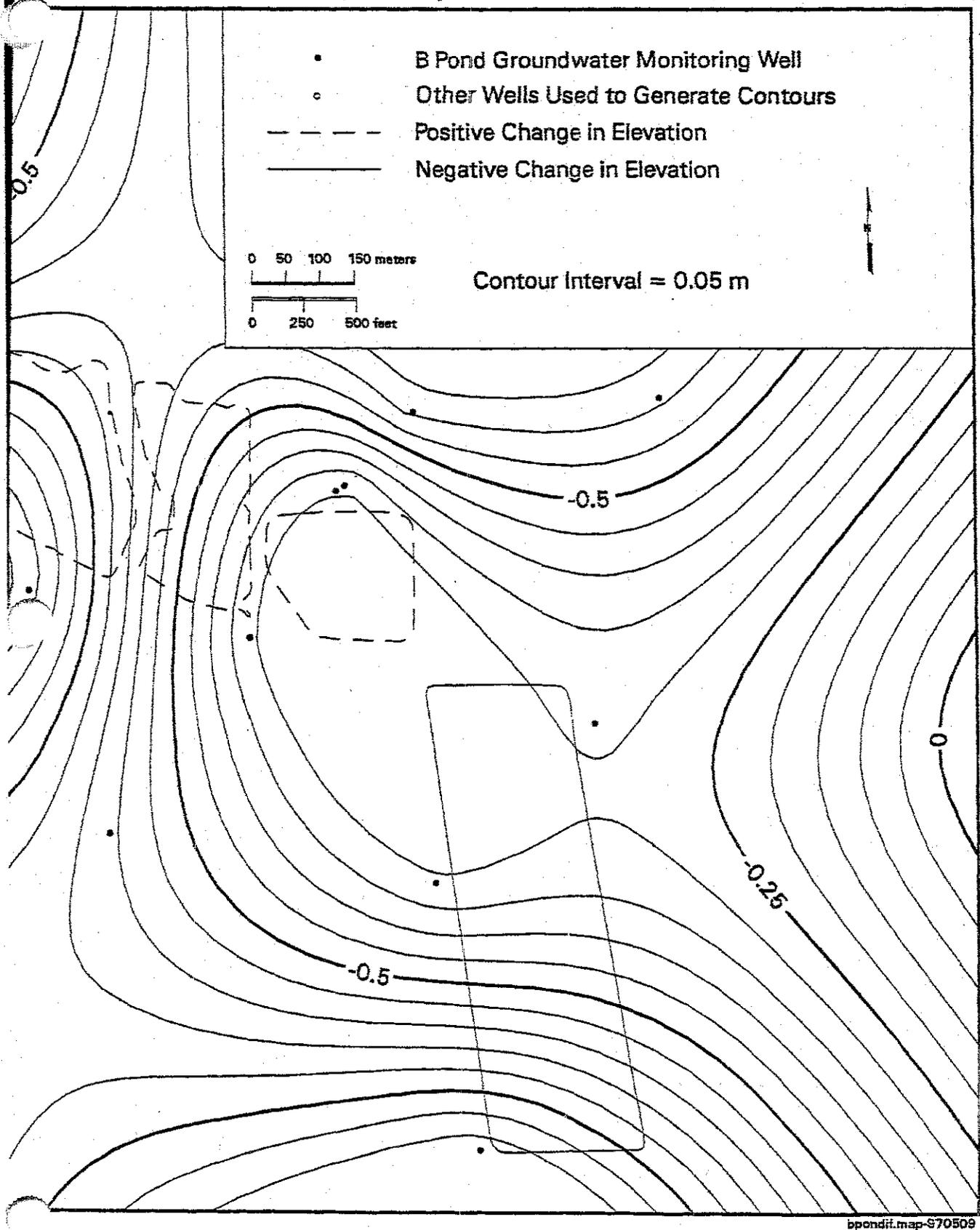


Figure 3.10. Ground-Water Elevation Differential, June 1996 to January 1997

bpondif.map-S70509

3.3 Groundwater Chemistry

Groundwater chemistry in the uppermost aquifer beneath the LERF has been affected by liquid waste discharged at the 216-B-3 Pond System. No specific pattern of chemical contamination has been identified, but groundwater has been significantly diluted because of the large volume of river water with lower dissolved solids than ambient groundwater (Reidel et al. 1995). Concentrations of arsenic (Johnson 1993) and elevated total organic halides (TOX) have been identified in groundwater beneath the 216-B-3 Pond System. The presence of arsenic has been proposed to be an artifact of discharges to other facilities (e.g., the 216-A-29 Ditch and the 216-A-37 or 216-A-30 Cribs [Reidel et al. 1995]). Arsenic, as well as uranium, was detected in the lower portion of well 699-37-47A. This well was drilled for the PUREX Plant Cribs in 1996 (Lindberg et al. 1997). The constituent identified as contributing to the elevated TOX is tris-2-chloroethyl phosphate (Hartman and Dresel 1997). The source of this constituent currently is being investigated. Neither of these constituents are increasing in concentration and are not considered to impact groundwater significantly in the LERF Area. No exceedences of interim-status groundwater-monitoring parameters have been found.

4.0 Groundwater-Monitoring Program

This section proposes a final-status RCRA detection-level groundwater-monitoring program for the LERF. The groundwater-monitoring program is designed to achieve the following goals in a technically sound and cost-effective manner:

- protect human health and the environment
- comply with the intent of final-status groundwater-monitoring requirements of WAC 173-303-645 and 40 CFR 264 Subpart F
- provide information for groundwater investigation and/or remediation.

This section presents a monitoring network design consisting of the existing wells; methods for sampling and analysis, and a statistical approach for data evaluation.

The elements of this monitoring program were developed through a data quality objectives (DQO) process (EPA 1993). The primary purpose of the DQO process is to ensure that the type, quantity, and quality of data used in monitoring are appropriate for their intended purposes.

4.1 Objectives of RCRA Monitoring

Three stages of groundwater monitoring programs are defined in WAC 173-303-645 with three separate objectives. The detection monitoring program [173-303-645(9)] is designed to determine whether a RCRA-regulated unit has adversely affected the groundwater quality in the uppermost aquifer beneath the regulated unit (i.e., whether a release has occurred). This is accomplished by comparing downgradient concentrations of constituents of concern to values indicative of background concentrations. If a statistically significant increase (or pH decrease) over background occurs in any downgradient well, then a compliance-monitoring program is initiated. In compliance monitoring, downgradient groundwater concentrations of constituents of concern are compared to the concentration limits set in the facility's permit. Concentration limits could be those specified in WAC 173-303-645 5(a)(ii) or alternative concentration limits established by Ecology. If concentration limits are exceeded, the regulated unit must implement a corrective action program. The objective of corrective-action is to protect human health and the environment by removing the dangerous waste constituents and parameters or treating them in place.

Results of the interim-status groundwater-monitoring program indicate that the LERF has not impacted the groundwater quality beneath the site. Thus, a detection-monitoring program is deemed appropriate for the site.

4.2 Chemical Parameters and Dangerous Constituents

Nitrate, TOX, total organic carbon (TOC), tritium, gross alpha- and gross beta-emitting isotopes were selected as the constituents of concern. The following factors were considered in deriving a constituent list for the LERF: 242-A Evaporator campaign analysis, history of detection in the site groundwater, and other potential source streams that have been identified for storage in the LERF. Because the likelihood is small that any release has occurred during LERF operational activities, the selection of the constituents of concern was not driven by patterns of groundwater contamination. A broad analytical approach was selected due to the inherent uncertainties associated with predicting long-term use of the LERF for effluent treatment. Although waste treatment campaigns of DST wastes have produced a relatively narrow range of effluent variability, future treatment campaigns may produce elevated levels of constituents that cannot be predicted. Also, cleanup efforts throughout the site will produce source streams beyond the narrowly defined chemical makeup of effluents generated by the 242-A Evaporator.

Nitrate was selected for groundwater analysis due to concentrations of ammonia in 242-A Evaporator process condensate. The TOX and TOC analyses were selected to detect a wide variety of organic constituents from various sources. These analytical methods will detect the presence of acetone, 1-butanol, 2-butanone, methyl isobutyl ketone, and pyridine in groundwater samples. As a group, these constituents represent the current process knowledge for organic contaminants in the 242-A Evaporator process condensate. Radiological contaminants entrained in the process condensate necessitated the use of screening techniques to identify gross activities for both beta- and alpha-emitting isotopes. Tritium was also identified in the process condensate and will be an early indication of contaminant transport to groundwater.

4.3 Concentration Limits

This section proposes the concentration limits for the LERF constituents of concern. These concentration limits serve as the compliance standards in case the regulated unit is found to impact the quality of groundwater and the facility enters into compliance-monitoring status. At that time, concentration limits for additional constituents of concern will be proposed and a revised groundwater-monitoring plan will be prepared. These concentration limits would be applied during compliance monitoring to determine whether corrective action might be necessary. It should be noted that concentration limits are not proposed for the general contamination-indicator parameters (i.e., TOC, TOX, gross alpha, and gross beta). These indicator species can only provide an indication of the presence of dangerous constituents in the groundwater. They cannot identify the specific constituent(s) that cause the degradation in groundwater quality.

- Nitrate: 45,000 ppb (as NO_3); based on final maximum contaminant level (MCL), 56 FR, January 30 1991
- Tritium: 80,000 pCi/L^(a) (Eckerman et al.).

(a) Concentration assumed to yield an effective dose equivalent of 4 mrem/yr from a drinking-water pathway.

4.4 Groundwater-Monitoring Network and Point of Compliance

The proposed groundwater-monitoring network for the LERF contains four wells. Upgradient monitoring is accomplished with well 299-E26-11. The downgradient wells drilled for this facility include 299-E26-9, 299-E26-10, and 299-E35-2 (Figure 2.1). All wells were drilled to fulfill the requirements for well network monitoring for RCRA sites (WAC 173-160). The well construction and completion summaries, including schematics, for the four wells can be found in Appendix A. Specifically, the objective was to select well locations that would monitor the uppermost aquifer for waste constituents of concern. In the instance of the LERF, the constituents of concern include TOX, TOC, nitrate, tritium, gross beta, and gross alpha. None of these constituents has been detected in significant quantities from LERF wells. The three downgradient wells are west of the LERF to intercept any groundwater contaminants emanating from the LERF and flowing with the groundwater in directions consistent with the operational history of the facility.

Based on the Monitoring Efficiency Model (Wilson et al. 1992), the proposed downgradient wells should provide a monitoring efficiency of approximately 95.5%, assuming a groundwater-flow direction to the west. The location of 299-E26-11 was selected to provide upgradient groundwater conditions for the facility while attempting to minimize the influences of the 216-B-3 Pond System. The capability of the monitoring network to provide representative samples will decline as groundwater reverts to the pre-weapons production easterly flow direction. This reversal will have less impact than the overall decline of water table elevation. The declines eventually will leave two downgradient wells without enough groundwater to provide representative samples.

The point of compliance (POC) is defined in 40 CFR 264.95 and WAC 173-303-645 (6) as a "vertical surface" located at the hydraulically downgradient limit of the waste management area that extends down into the uppermost aquifer underlying the regulated unit. For the LERF, the POC should be the three downgradient monitoring wells as described above (i.e., 299-E26-9, 299-E26-10, and 299-E35-2; Figure 2.1).

4.5 Compliance Period

The compliance period is the number of years equal to the active life of the unit (including any waste-management activity before permitting and the closure period). Typically, groundwater monitoring is required for a period of 30 years following completion of closure activities, although this period may be shortened or extended by the regulatory authority. If the regulated unit undergoes corrective action, then the compliance period will be extended until it can be demonstrated that the applicable limit has not been exceeded for a period of three consecutive years.

4.6 Sampling and Analysis

This section describes the sampling and analysis program for the regulated unit, including monitoring parameters, analytical methods, monitoring frequency, and sampling protocols.

4.6.1 Monitoring Parameters

Table 4.1 lists constituents to be analyzed for the regulated unit. This list includes the following:

- the indicator constituents identified in Section 4.2 (Only the constituents of concern to the LERF will be used to determine whether statistically significant evidence of contamination has occurred)
- additional constituents to aid data interpretation (alkalinity, anions, and inductively coupled plasma (ICP) metals)
- field parameters routinely acquired at the well head (pH, turbidity, specific conductance, and temperature).

4.6.2 Sampling Frequency

The hazardous-waste regulations under RCRA require owners and operators of hazardous-waste facilities to use design features and control features that prevent the release of hazardous waste into groundwater. Regulated units are also subject to the groundwater-monitoring and corrective-action standards of 40 CFR Part 264, Subpart F and WAC 173-303-645. These regulations require that a statistical method and sampling procedure approved by the regulator(s) be used to determine whether there are releases from regulated units into groundwater. Default statistical methods and sampling procedures are specified in these regulations; however, alternatives are available as discussed below.

Historically, the default statistical method for detecting release from the regulated unit is *the tests on mean concentrations* between upgradient (background) and downgradient wells. For facilities regulated under the interim-status regulations, for example, a t-test is required to make this determination [40 CFR 265.93(b)]. For facilities regulated under the final status regulations, the recommended approach at the time of promulgation was analysis of variance (ANOVA) (EPA 1989, page 4-1 and page 5-3) where the

Table 4.1. Constituent List for the 200 Areas LERF

Constituent List		
Indicator Constituents	Field Parameters	Other
TOC TOX Nitrate Tritium Gross Alpha Gross Beta	pH Turbidity Temperature Specific Conductance	Alkalinity Anions Metals (filtered) by ICP ^(a) Method
(a) ICP = Inductively Coupled Plasma.		

means of different groups of observations are compared to determine whether there are any significant differences among the groups (e.g., background wells and compliance wells). If so, then contrast procedures may be used to determine where the differences lie.

The owner and operator has the latitude within the interim-status regulations to choose a t-test that will accommodate the data collected, however. There is much less choice with regard to the data collection requirement. Four replicate measurements (analyzed on the same sample) must be collected for the general contamination-indicator parameters during each sampling event.

Under final status regulations, two sampling procedures are allowed: (1) a sequence of at least four samples taken at an interval that ensures, to the greatest extent technically feasible, that an independent sample is obtained (i.e., the default sampling procedure); and (2) an alternate sampling procedure proposed by the owner or operator and approved by the regulator(s) that is to be protective of human health and the environment [40 CFR 264.97(g)(1) and (2), WAC 173-303-645 (8)(g)(i) and (ii)]. Under the default sampling procedure, the minimum number of samples that are to be collected each testing period is *four*. This minimum number was selected by the EPA to maintain consistency with the prior requirements (i.e., interim-status requirements using a t-test on means) that specified that the owner or operator collect one sample from each well and divide it into four replicate samples for laboratory analysis (53FR, 39725). Hence, EPA contended that requiring four samples to be collected from each well for laboratory analysis should not impose an increase in the number of analyses but recognized that there may be an increase in the field sampling costs associated with this sampling procedure. The requirement of four independent samples, therefore, reflected EPA's position (in 1989) of being consistent with interim-status requirements to collect four replicate samples and to use a test on mean concentrations as a default statistical method.

The most far-reaching change is the extension of groundwater-monitoring requirements to solid waste facilities, mandated in the 40 CFR Part 258, Subtitle D regulations. In particular, the solid waste Final Rule of 1991 dropped the four independent samples per monitoring period requirement (only one measurement is required per monitoring event).

Another major change included the issuance of an Addendum (EPA 1992) to *Interim Final Guidance on Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities* (EPA 1989). This Addendum reflects more current thinking within the statistics profession and offers a series of currently recommended techniques and updated advice concerning the Interim Final Guidance document (EPA 1992, page 1). One of the revisions is the recommendation of using a two-phased testing strategy (EPA 1992, pages 67-74) that evaluates each sample *individually* rather than relying on a test of the mean concentrations of several independent samples (i.e., the ANOVA procedure). This revision is prompted because the ANOVA method is to be avoided in the groundwater-monitoring applications for the following reasons (see Gibbons 1994, page 260 and EPA 1992, page 67): (1) the ANOVA procedure may have lower power for detecting a narrow plume of contamination that affects only one or two wells in a much larger network (approximately twenty or more comparisons); (2) a significant ANOVA test result will not indicate which well or wells is potentially contaminated without further post-hoc comparisons (i.e., comparisons that are found to be of interest after the data were collected); (3) because the one-way ANOVA procedure is not designed to test multiple constituents simultaneously, the overall false positive rate will be approximately 5% *per constituent*, leading to a potentially high overall network-wide false-positive rate if many constituents need to

be tested (It should be noted that a site such as LERF with six indicator constituents will have a $26\% = 1 - (0.95)^6$ overall false positive rate); and (4) collection of four independent samples at a given well may necessitate a several-month wait if the natural groundwater velocity at that well is low.

In summary, the reason for the requirement of four independent samples during each monitoring event for facilities regulated under final status is that the one-way ANOVA can be performed (Davis and McNichols 1994). This requirement was dropped in the solid waste Final Rule of 1991. The EPA 1992 Addendum acknowledges that the one-way ANOVA procedures (parametric and nonparametric) are less attractive. It is desirable to seek alternative strategies (e.g., tolerance limits, prediction limits, or both) that allow statistical testing for each new groundwater sample individually as it is collected and analyzed. Furthermore, because each compliance well is compared with the interval limits separately, a narrow plume of contamination can be identified more efficiently than with an ANOVA procedure. That is, no post-hoc comparisons are necessary to find the contaminated wells, and the two-phased testing method has more power against the "needle-in-a-haystack" contamination hypothesis. The alternative strategy, set out below, is consistent with the Addendum to the Interim Final Guidance but does not require the collection of four independent samples during each monitoring event.

The regulations allow the use of an alternate sampling procedure [40 CFR 264.97(g) (2) and WAC 173-303-645 (8)(g)(ii)] and statistical method, provided they meet the performance standards as specified in 40 CFR 264.97(i) and in WAC 173-303-645(8)(ii). It also should be noted that in referring to "statistical methods" EPA endorsed a system approach to groundwater monitoring that evaluates the choice of a level of significance, the choice of a statistical test, the sampling requirement, the number of samples, and the frequency of sampling in their entirety, not by individual components (EPA 1989, page 2-4).

Based on justifications provided above, an alternate sampling procedure that is endorsed by EPA as being protective of human health and the environment is described briefly below. The compliance wells and background wells will be sampled for indicator constituents (see column 1 of Table 4.1) at least semi-annually during the compliance period. Other constituents will be sampled in all monitoring wells on an annual basis. A two-staged testing strategy as recommended by EPA (1992) is proposed (see Section 4.7 for detail). During each semiannual sampling event, one sample will be collected from each well and individually compared to the background values established for the regulated unit (i.e., the first stage). The second stage is applicable to instance(s) where an initial exceedance(s) has occurred. In this stage, an upper prediction limit (using background data) will be calculated and compared to results of verification samples (i.e., confirmation sampling). Specifically, two verification resamples are to be obtained sequentially (from each well which exceeds the tolerance limit) and analyzed for the constituent in question. A statistical exceedance is declared if both verification resamples exceed the prediction limit. The use of upgradient-monitoring data to establish the upper tolerance limits as background values (i.e., the first stage) is described in Section 4.7.2. The proposed resampling scheme (i.e., the second stage) is discussed in Section 4.7.3. Temporal variabilities caused by seasonal effects are not expected in groundwater at the LERF.

4.6.3 Sampling Procedures

Groundwater-sampling procedures, sample-collection documentation, sample preservation and shipment, and chain-of-custody requirements are described in Environmental Investigation Instructions (EII) (WHC 1992), or superseding equivalent contractor procedures, and in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1993) (or in superseding equivalent PNNL project quality assurance plan, in preparation). Work by subcontractors shall be conducted to their equivalent approved standard operating procedures.

All field-sampling activities will be recorded in the proper field logbook as specified in EII 1.5, or superseding procedures, and subsequent revisions. Before sampling each well, the static water level will be measured and recorded as specified in EII 10.2, or superseding procedures. Based on the measured water level and well construction details, the volume of water in the well will be calculated and documented on the well sampling form or field notebook. Each well will be purged until the approved criteria are met, as specified in EII 5.8, or superseding procedures. Purge water will be managed according to EII 10.3, or superseding procedures. If a well pumps dry because of very slow recharge or low water levels, then samples will be collected after recharge.

Quality assurance requirements are defined in the PNL-MA-70, *Quality Assurance Manual* (PNNL 1997) and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology and EPA 1996). The RCRA sampling and analysis program is supported by WHC (1993) or equivalent PNNL documents. Sample-preservation and chain-of-custody procedures are described in EII 5.1 (WHC-CM-7-7), or superseding procedures.

4.6.4 Analytical Procedures

Procedures for field measurements (pH, specific conductance, temperature, and turbidity) are specified in the user's manual for the meters used. The laboratory approved for the groundwater-monitoring program will operate under the requirements of current laboratory contracts and will use standard laboratory procedures as listed in the SW-846 (EPA 1986) or an alternate equivalent. Alternative procedures, when used, will meet the guidelines of SW-846, Chapter 10. Analytical methods and quality control for the RCRA groundwater-monitoring activities are described in WHC (1993) (or superseding PNNL quality assurance plan, in preparation).

4.7 Statistical Methods

This section proposes statistical evaluation procedures for the LERF groundwater monitoring program. Statistical evaluation of groundwater-monitoring data will comply with requirements set forth in the WAC 173-303-645(8)(h) and (i) final status regulations. Acceptable statistical methods for a final-status detection-monitoring program includes ANOVA, tolerance intervals, prediction intervals, control charts, test of proportions, or other statistical methods approved by Ecology [WAC 173-303-645(8)(h)]. The type of monitoring, the nature of the data, the proportions of nondetects, spatial and temporal variations are

important factors to consider when selecting appropriate statistical methods. Procedures outlined in the following EPA technical guidance documents will be followed:

- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Interim Final Guidance* (EPA 1989)
- *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities - Draft Addendum to Interim Final Guidance* (EPA 1992).

The concentrations of constituents of concern in POC wells will be compared with data from background wells semiannually to determine whether there is a statistically significant increase over background concentrations.

4.7.1 Approach

The goals of statistical evaluation methods proposed for the LERF are:

- The network-wide false-positive rate (across all constituents and wells being tested) should be kept at an acceptable low level. (Note that the false-positive rate [or Type I error rate] is the probability that the test will indicate contamination falsely although no contamination has occurred); and
- The test strategy should have adequate statistical power to detect real contamination when it occurs.

When the number of upgradient/downgradient comparisons is moderate to large (approximately twenty or more), the false-positive rate associated with the testing network as a whole can be quite high. If the test network consists of twenty separate comparisons (e.g., four wells multiplied by five constituents) and a false-positive rate for each individual well comparison is set at 1%, for example, then one would expect an overall network-wide (i.e., facility-wide) false positive rate of over 18% [note that $18\% = 1 - (0.99)^{20}$]. This means there is nearly one chance in five that one or more comparisons will register potential contamination falsely even if none has occurred, adding additional sampling and analysis expense to verify the false-positive results. To lower the network-wide false-positive rate, the number of tested constituents should be limited to the most useful indicators (EPA 1992, page 62; Gibbons 1994, page 16); therefore, only the constituents of concern will be subject to statistical evaluations for the LERF. Another strategy to lower the overall false-positive rate is to perform verification sampling to determine whether the statistically significant difference between background and compliance-point wells is an artifact caused by an error in sampling, analysis, statistical evaluation, or natural variation in groundwater chemistry.

Another goal of the statistical method is to maintain adequate statistical power for detecting contamination. The power of a test depends on several factors, including the background sample size, the type of test proposed, and the number of comparisons (i.e., the false-positive rate). Other things being equal, the larger the sample size (number of background samples), the larger the statistical power; therefore, the proposed statistical method should use historical groundwater-monitoring data (collected under

the interim-status) to the greatest extent possible. The ANOVA procedures (either the parametric method or the Kruskal-Wallis test) are not proposed because they may have less power for detecting a narrow plume of contamination. Furthermore, a significant ANOVA test result will not indicate which well or wells is potentially contaminated without further evaluation (see Section 4.6.2).

After careful evaluation of statistical methods (that are acceptable for a final-status detection monitoring), a two-phase testing strategy that is recommended by EPA (1992, pages 67-75) is proposed for the LERF. In the first stage, an upper tolerance limit (for each constituent of concern) with pre-specified average coverage will be calculated based on background (upgradient well) data and will be compared to individual compliance-point (downgradient well) samples. The second stage is applicable to instance(s) where an initial exceedance(s) occurred. In this stage, an upper prediction limit (using background data) will be calculated and compared to results of verification samples (i.e., confirmation sampling). Specifically, two verification resamples are to be obtained sequentially (from each well which exceeds the tolerance limit) and analyzed for the constituent in question. A statistical exceedance is declared if both verification re-samples exceed the prediction limit.

The use of an upper tolerance limit as an initial screening tool is more powerful than the use of an upper prediction limit. An upper tolerance limit is designed to cover a certain specified percentage of all future measurements from the background distribution with $(1 - \alpha)\%$ confidence. By contrast, an upper prediction limit is designed to cover 100% of the future k measurements. If the number of future comparisons (e.g., the product of the number of monitoring wells and the number of constituents) is moderate to large (e.g., \geq twenty), the tolerance limits will be smaller than prediction limits. The proposed screening approach results in a statistical comparison that is more conservative in detecting small releases, and is therefore more protective of human health and the environment. Once an initial exceedance is observed, however, an upper prediction limit should be used for the verification resampling to control the overall false positive rate; an artifact of the built-in failure rate associated the upper tolerance limit (i.e., incomplete well coverage). The use of upgradient monitoring data to establish the upper tolerance limits (i.e., the first stage) is described in Section 4.7.2. The proposed re-sampling scheme (i.e., the second stage) is discussed in Section 4.7.3.

4.7.2 Background Values

Certain assumptions concerning the statistical model or methods are required to determine and interpret background groundwater characteristics properly at the regulated unit. These assumptions and/or justifications are stated below.

- Groundwater-monitoring data are representative of actual groundwater conditions in the uppermost aquifer beneath the site. Representativeness is best satisfied by following prescribed sampling and analysis procedures and collecting a sufficient number of samples.
- Seasonal or temporal variations are insignificant. As discussed earlier, temporal variabilities caused by seasonal effects are not expected at the LERF.

- Groundwater-chemistry data are typically log-normally distributed. The use of a log-normal distribution as a default statistical model is justified because: (1) most groundwater-monitoring data are positively skewed and are restricted to positive values; (2) all of the available statistical tests for distribution assumptions are inadequate when the sample size is small (approximately less than twenty observations); (3) EPA's experience with contaminant concentration data, and groundwater-monitoring data in particular, suggests that a log-normal distribution generally is more appropriate as a default statistical model than normal distribution (EPA 1992, page 2); and (4) pollutant sources are randomly diluted in a multiplicative fashion through repeated dilution and mixing with uncontaminated water, which can lead mathematically to a log-normal distribution (Ott 1990).

Background values (area) are defined as the levels of chemical, physical, biological, and radiological constituents or parameters upgradient of a unit, practice, or activity that have not been affected by that unit, practice, or activity. Background groundwater concentration, for a particular constituent of concern, is defined statistically as the 95% ("the coverage") upper tolerance limit with a 95% confidence ("the tolerance coefficient") (Ecology 1996a, page 65). The use of a coverage of 95% and a tolerance coefficient of 95% is also recommended by EPA (1989 and 1992). These recommendations are consistent with methods for defining background concentrations as required under the "Model Toxics Control Act Cleanup Regulation," WAC 173-340 (Ecology 1996b amended). One-sided upper tolerance limit for normally distributed data is of the form:

$$\bar{x} + ks \tag{1}$$

where \bar{x} is the sample mean; k is a multiplier based on the coverage, the confidence level, and sample size; and s is the sample standard deviation. Values of k can be obtained from Natrella (1966) and Gilbert (1987, Table A.3). The upper tolerance limit for log-normally distributed data can be estimated by (1) transforming the raw data using \log_{10} (common logarithm) or \log_e (natural logarithm); (2) calculating the upper tolerance limit using the log-transformed data and Equation (1); and (3) back-transforming (antilog) to the original unit.

Before using these parametric limits that depend heavily on the normality (or log-normality) assumption, the adequacy of normal (or log-normal) distribution as a model will be assessed by probability plots and/or statistical goodness-of-fit tests, such as the Shapiro-Wilk test or the Lilliefors test of normality (Gilbert 1987; Conover 1980).

When the normal or log-normal distribution cannot be justified, the use of nonparametric tolerance intervals may be considered. The upper tolerance limit is usually the largest observed value in a random sample. The nonparametric tolerance intervals, however, require a large number of samples to provide a

reasonable coverage and tolerance coefficient. The number of samples needed for a minimum coverage of P% and a tolerance coefficient of (1 - α)% is (Gumbel 1958, page 68):

$$n = \frac{\log_{10} \alpha}{\log_{10} P} \quad (2)$$

To have a minimum coverage of 95% and 95% confidence, 59 background samples are needed. Due to the large background sample size requirement, a non-parametric tolerance limit (with a minimum coverage of 95% and a 95% confidence) may not be practical in groundwater-detection monitoring. If one can use an average coverage of 95% (not the minimum as discussed above), however, then at least nineteen background samples are needed to achieve 95% coverage on the average. [Note: When the maximum sample value is chosen as the upper tolerance limit, then it can be shown that the expected coverage is equal to $n/(n+1)$]. If background samples are less than nineteen, then a lower average coverage and/or a lower confidence level would result.

Analytical results were reviewed under the aegis of the RCRA quality-control (QC) program. The QC program that supports the sampling and analysis of groundwater from the LERF is described in the PNNL comprehensive groundwater-monitoring report (Hartman and Dresel 1997). For the LERF, verified and validated groundwater-monitoring data (from upgradient well 299-E26-11) except for TOC and TOX, were used to establish the background value for each dangerous constituent of concern using Equation (1).

The reasonableness of the assumed log-normal (or normal) distributions was tested using the Lilliefors test for normality of data. The test results indicated that all of the dangerous constituents of concern can be reasonably approximated by log-normal (or normal) distributions, except for nitrate. On further evaluation there appear to be two concentration groups. Concentrations of earlier nitrate data (collected from June 1991 to April 1992, four data points) range from 4,900 $\mu\text{g/L}$ to 6,100 $\mu\text{g/L}$. The range of the recent data (from July 1992 to January 1996, six data points) is from 7,400 $\mu\text{g/L}$ to 8,200 $\mu\text{g/L}$. Because the earlier nitrate data are not representative of the current conditions, they are not used in the background value derivation. A statistical goodness-of-fit test is not performed for nitrate data because of insufficient data (six data points); however, upper tolerance limits (for a log-normal, normal, and non-parametric distribution) were calculated and evaluated. These limits (normal = 8,700 $\mu\text{g/L}$, log-normal = 8,800 $\mu\text{g/L}$, and non-parametric = 8,200 $\mu\text{g/L}$) are fairly comparable. Hence, an upper-tolerance limit based on a log-normal distribution is proposed as the background value for nitrate. As more monitoring data are collected, this value will be re-evaluated.

TOX data analyzed during the period from January 1992 through October 1993 were flagged with "Y" (suspect) because of audit concerns. These data were eliminated from further statistical evaluation because the validity of such data is in doubt. In addition, the majority of the TOC and TOX data (from upgradient well) were essentially nondetects. These data were either reported with a "U" qualifier, indicating that data were below the method detection limit (MDL), or reported with a "L" qualifier, indicating that data were between the MDL and the contractually required detection limit. Furthermore, analytical laboratories and the MDLs have changed several times over time (from June 1991 to January 1997). It is not appropriate to

use these essentially not-detected TOC and TOX data to calculate the background values using Equation (1) because the lack of estimates of background variability precludes the determination of the upper-tolerance limits.

To overcome this problem, the limit of quantitation (LOQ) will be used as a surrogate background value for TOC and similarly for TOX. The LOQ is defined as the level above which quantitative results may be obtained with a specified degree of confidence (Keith 1991). It is determined by using field-blanks data. Note that the field blanks are QC samples that are introduced into a process to monitor the performance of the system. The use of field blanks to calculate LOQ is preferred over the use of laboratory blanks because field blanks provide a measure of the errors in the entire sampling and analysis system. Methods to calculate LOQ are described in detail in Schmid et al. (1991b).

Based on above discussions, the following background values are proposed for the LERF and are presented in Table 4.2. The necessary summary statistics and k values are also provided. It should be noted that the means and standard deviations shown in Table 4.2 are expressed in respective log unit of measurement (common logarithm).

Background values (i.e., upper tolerance limits) will be compared with individual sample results obtained from downgradient compliance wells semiannually. If an initial exceedance(s) occurs, then an upper prediction limit calculated from background data (see Section 4.7.3) will be calculated and compared to re-samples from well(s) which exceed the tolerance limit (i.e., confirmation sampling). In addition, background values will also be used to track the encroachment of upgradient sources of contaminant plumes. In order to assure that the background database contains independent and representative measurements, new data will be added that are determined to belong to the same background population. Background values (listed in Table 4.2) and the statistical approach will be evaluated and updated periodically to reflect these additions. If changes in groundwater flow directions result in changes in definition of upgradient well(s) or changes in site conditions, then background values will be re-established. If statistical evaluation methods are no longer effective to achieve its goals (see discussions in Section 4.7.1) caused by changing site conditions, then a new statistical approach will be proposed.

4.7.3 Confirmation Sampling

Tolerance limits have a built-in failure rate of $(1 - P)\%$; for example, one would expect 1 in every 20 samples to be outside of the upper 95% tolerance limit just by chance. Verification re-sampling is necessary to decrease the chance of a false-positive decision because of either the built-in failure rate or the effects of gross errors in sampling or analysis. This is the best currently available approach to balance false-positive and false-negative decisions in groundwater-monitoring applications (Gibbons 1994, page 15). In case of an initial exceedance, a verification sampling is needed to determine if the exceedance is an artifact caused by an error in sampling, analysis, or statistical evaluation or natural variation in the groundwater. Recent EPA guidance (1992) encourages the use of re-sampling as a means to reduce the facility-wide false-positive rate.

Table 4.2. Proposed Background Values^(a) for the LERF

Constituent of Concern	Number of Background Samples	Transformed Mean	Transformed Standard Deviation	Multiplier (K)	Upper Tolerance Limit
Tritium	14	3.267	0.0746	2.614	2,900 pCi/L
Nitrate ^(b)	6	3.8796	0.0174	3.711	8,800 µg/L
Gross Alpha	12	0.333	0.162	2.736	5.97 pCi/L
Gross Beta	12	0.7431	0.1324	2.736	12.74 pCi/L
TOC ^(c)	NA	NA	NA	NA	LOQ
TOX ^(c)	NA	NA	NA	NA	LOQ

(a) Background values are defined as the upper 95% tolerance limit with 95% confidence.
 (b) Nitrate data collected from 1/21/92 to 1/3/96 were used. Earlier nitrate data were not unrepresentative of current conditions.
 (c) Most recently calculated LOQ will be the surrogate background value.

As described in Section 4.7.1, a two-phase testing strategy is proposed for the LERF. The second-stage confirmation sampling is applicable to instance(s) where an initial exceedance(s) occurred. Each well that triggers the upper tolerance limit is re-sampled for only those constituents that triggered the limit and is retested using an upper prediction limit established from background (upgradient) data.

A prediction interval is a statistical interval constructed to include a specified number of future observations (or the average of several future observations) from a population or distribution with a specified probability. That is, after sampling background well(s) for some time and measuring the concentration of an analyte, the data can be used to construct an interval that will contain the next analyte sample or samples (assuming the distribution has not changed). If concentrations of future observation(s) (or their mean) at a compliance-point well are above the upper prediction limit, then evidence of contamination is indicated. The formula to calculate an upper parametric-prediction limit for a single future observation (appropriate for a normal distribution) is provided in EPA (1989, pp. 5-24 to 5-28) and is stated below:

$$\bar{X} + t_{(n-1, k, 1-\alpha)} * s * \sqrt{1 + \frac{1}{n}} \quad (3)$$

where \bar{X} and s are the mean and standard deviation for the background well data; n is the number of observations in the background data; k is the number of future comparisons (e.g., the product of the number of

monitoring wells and the number of constituents); and $t_{(n-1, k, 1-\alpha)}$ is the Bonferroni t-value, which is equivalent to the usual t-value at the $(1 - \alpha/k)$ level with $(n - 1)$ degrees of freedom. If data can be approximated by a log-normal distribution, then one should:

- Transform the original data into log units;
- Obtain estimates of mean and standard deviation of the log-transformed variable;
- Calculate the upper prediction limit using Equation (3); and
- Back-transform (anti-log) the calculated upper prediction limit into original unit.

When the parametric assumptions of a normal-based (or a log normal-based) prediction limit cannot be justified, then a non-parametric prediction interval may be considered. A non-parametric upper prediction limit typically is constructed by estimating the limit to be the maximum observed value of the set of background samples. If there are too few background measurements to achieve an adequate site-wide false positive rate using the non-parametric approach, Poisson prediction limits are a suitable replacement. The formula used to compute the Poisson prediction limit can be found in EPA (1992, pages 35-38) and in ASTM (1996, page 11).

Note that Equation (3) assumes that the future multiple comparisons (i.e., verification-sampling events) are independent. This is not true in the context of upgradient versus downgradient comparisons where each new monitoring measurement is compared to the same upgradient background limit. If background-sample sizes of $n = 20$ or more, then a prediction limit based on Bonferroni-adjusted t-value yields similar results to those obtained by the multivariate t-statistic that accounts for the correlation among repeated comparisons (Gibbons 1994, page 25).

The use of Bonferroni t-value to control the overall site-wide false-positive rate is not recommended when the number of future comparisons is large. In such an instance, it does so at the expense of the false-negative rate (i.e., failure to detect contamination when present). This is not acceptable. Conversely, control of the false-negative rate at the expense of the false-positive rate is also unacceptable. The best currently available approach to balancing false positive- and false-negative rates in groundwater-monitoring applications is the use of verification re-sampling (Gibbons 1994, page 15).

Confirmation retesting can be accomplished by taking a specific number of additional, independent samples from well(s) where a specific constituent triggers the initial exceedance. Because more independent data are added to the overall testing procedure, retesting of additional samples, in general, will make the statistical test more powerful and result in a more reliable determination of possible contamination. The objectives for the verification sampling, therefore, are to ensure: (1) quick identification and confirmation of contamination exceeding the background value, if any, and (2) the statistical independence of successive resamples from any well where initial exceedance has occurred. The performance of the statistical retesting strategy depends substantially on obtaining independent verification samples from the triggering well. These re-samples, therefore, must be separated enough by time so that the well could be recharged and restabilized.

Based on the results of simulation study described by Gibbons (1994, pages 18-32), it is proposed to accomplish confirmation retesting by adopting a plan in which both of two resamples must exceed the prediction limit for a statistically significant increase (over background) to be declared. Specifically, the verification sampling will be conducted as follows. If the initial sample result exceeds the upper tolerance limit (i.e., the first stage), then a re-sample is obtained from each of the triggering well(s) and analyzed for the constituent in question. If that measurement is less than the prediction limit (e.g., calculated using appropriate table from Gibbons) or less than the maximum observed background value, then no further sampling is necessary. A statistically significant result will be declared only if both re-sample results are larger than the upper prediction limit.

For constituents of concern, upper prediction limits cannot be calculated at the present time because the number of future comparisons (k) and the number of observations in the background database (n) at that time cannot be specified in advance. Recommended confidence levels $(1 - \alpha)\%$ for the two-staged retesting strategies are provided in EPA (1992, page 70). A 90% confidence level for the upper prediction limit and a 95% coverage for the tolerance limit is deemed appropriate for the LERF at the present time. One should refer to the table that provides parametric retest strategies (see EPA 1992, page 70), however, or refer to the appropriate tables provided in Gibbons (1994, pages 24-31), or to the formulas provided in ASTM (1996, pages 10-11), to find the best combination of confidence level and coverage ratio at the time when actual exceedance has occurred because the number of background samples would be different than that was used in Table 4.2.

4.7.4 Non-Detects

Non-detects will be handled using the recommendations stated in the EPA guidance documents (1989 and 1992). In general, non-detects will be less of a problem in using a nonparametric method to evaluate compliance data. If a parametric statistical method is used, then the handling of non-detects will depend on the percentage of detected values. Basically, a substitution method (use two of the detection limits to replace non-detects) will be used if less than 15% of all samples are non-detects. If the percent of non-detects is between 15% to 50%, then either Cohen's method (requires either normal or log-normal data) or Aitchison's adjustments will be used. Detailed descriptions of these methods can be found in EPA (1989 and 1992). When more than 50% of the sample values are non-detects, then the Poisson model may be used to derive a Poisson tolerance limit and a Poisson prediction limit (EPA 1992, pp. 35 - 40). If background data are essentially non-detects, then most recent LOQ will be used as the upper tolerance limit and upper prediction limit.

4.7.5 Outliers

An "outlier" is an observation that does not conform to the pattern established by other observations in the data set. Possible reasons for its occurrence include contaminated sampling equipment, inconsistent sampling or analytical procedure, data transcribing error, and true but extreme measurements. Statistical

methods such as Grubbs' method (Grubbs 1969) for testing of outliers and/or the box-and-whisker plot (Ostle and Malone 1988) may be used. Once an observation is found to be an outlier, then the following action can be taken:

- If the error can be identified and the correct value can be recovered through the data review process (see Section 5.1), then replace the outlier value with the corrected value.
- If the error can be documented but the correct value cannot be recovered, then the outlier should be deleted. Describe this deletion in the statistical report.
- If no error can be documented, then assume that the value is a valid measurement; however, obtain another sample to confirm the high value, if necessary.

4.8 Determining the Rate and Direction of Groundwater Flow

Depth to water will be measured in the four LERF groundwater-monitoring wells during sampling and as part of the site-wide water-table elevation model. Maps produced from the site-wide model will be used to interpret the direction of groundwater flow and to derive the water-table gradient for the LERF. The gradient, in turn, will be used with estimated values of hydraulic conductivity and effective porosity to calculate flow rate using the Darcy equation.

4.9 Continuation of Monitoring Compliance at the LERF

The general groundwater-flow direction is from west to east in the vicinity of the 200 East Area; artificial recharge due to the B Pond system perturbs the general trend. The resulting groundwater mound creates flow direction in the vicinity of the LERF that is currently opposite the general west-to-east flow directions. The inferred flow is from east to west beneath the LERF. As the influence of the groundwater mound diminishes with distance, the general west-to-east flow prevails. As discharge volumes continue to decline in the future, the perturbation in groundwater-flow direction discussed above will subside. In addition, the water table continues to decline beneath the facility in response to a decline in the groundwater mound beneath B-Pond.

Because groundwater elevations in the Central Plateau were not well documented before nuclear process operations at the Hanford Site, it is generally unknown at what elevation groundwater will stabilize. It is possible that the uppermost aquifer beneath the LERF will not reside in the Hanford formation or in remnants of the Ringold Formation. The next water-bearing interval occurs in the sediments of the Rattlesnake Ridge Interbed. This aquifer system exists under confined conditions between the Elephant Mountain and Pomona Members of the Saddle Mountain Basalt Formation.

The Hanford formation eventually will yield only negligible quantities of groundwater for representative samples. The LERF groundwater-monitoring network will then cease to fulfill its intended function. A replacement or alternate monitoring system will have to consider the changing hydrogeologic conditions beneath the facility. Monitoring efficiency studies will also address an expected groundwater flow reversal

that may precede the effective loss of water in the groundwater-monitoring network. Activities that will take place to obtain the necessary information to maintain compliance include:

- semi-annual groundwater elevation measurements from the LERF network and from wells in the vicinity of the facility
- monitoring efficiency modeling for the current network based on current flow conditions
- modeling of groundwater flow throughout the 200 East Area to predict possible future flow conditions
- combining modeling results to determine network efficiency and modification requirements for the network

It would not be prudent, therefore, to recommend specific countermeasures to correct the monitoring network because it is fully functional at this time. Projections of when the groundwater elevation beneath the LERF will reach a level where the network cannot fulfill regulatory requirements are not exact. The effective life-span of the network has exceeded earlier projections of water-level decline in LERF monitoring network wells (Wurstner and Freshley 1994) (Figure 3.9). There is a strong probability that the network will lose one well by 2000. Two wells out of the network might not provide representative samples in six years.

Because the methodology available for monitoring compliance at this facility at some arbitrary future time cannot be assumed, it is more reasonable to recommend a monitoring system close to the time when the groundwater network is no longer compliant.

5.0 Data Management and Reporting

This section describes data-management practices and reporting requirements for the regulated unit.

5.1 Data Storage and Retrieval

All contract analytical laboratory results are submitted by the laboratory in electronic form and are loaded into the HEIS database. Parameters measured in the field either are entered into HEIS manually or through electronic transfer. Data from the HEIS database may be downloaded to smaller databases, such as the Geosciences Data Analysis Toolkit (GeoDAT) for data validation, data reduction, and trend analysis.

Record copies of data are stored at the laboratory until the contract is terminated, then sent to PNNL for storage. Field records are stored at PNNL.

5.2 Data Verification and Validation

Verification and validation of groundwater chemistry and water-level data is or will be performed according to WHC-CM-7-8, Section 2.6 (WHC 1992) or an equivalent PNNL procedure. Data are flagged if quality control is suspect. Data are also screened for completeness and representativeness by a project scientist assigned to the regulated unit. Data are compared to historical and spatial trends. Suspect data are investigated through the data-review process and are flagged in the database.

5.3 Reporting

The results of the statistical evaluation will be submitted to Ecology in the form of RCRA quarterly reports and the groundwater annual monitoring report. The statistical results might include a list of groundwater parameters analyzed, detection and/or quantitation limits, and background values. If a statistically significant increase (after the confirmation resampling evaluation process) in one or more of the constituents of concern is determined, then the following steps will be taken:

- Notify Ecology in writing within 7 days of the finding with a report indicating which chemical parameters or dangerous-waste constituents have shown statistically significant increases over the background values, and which points of compliance (wells) are involved.
- Submit an application for a permit modification to establish a compliance-monitoring program to Ecology in 90 days.

In case of a false positive claim, the following procedures will be taken:

- Notify Ecology in writing within 7 days of the finding (i.e., exceedance) that a false-positive claim will be made.

- **Submit a report to Ecology within 90 days. This report should demonstrate that a source other than the LERF caused the contamination or that the detection resulted from an error in sampling, analysis, or evaluation or natural variation in groundwater.**
- **Submit an application for a permit modification, if necessary, to make appropriate changes to the detection-monitoring program within 90 days.**
- **Continue to monitor in accordance with the detection-monitoring program.**

6.0 Compliance-Monitoring Program

A compliance-monitoring program that satisfies requirements set forth in WAC 173-303-645 (10) will be established for the LEFF if groundwater sampling during detection-level monitoring reveals statistically significant increases (or pH decreases) over background concentrations for groundwater. If compliance monitoring is required, then the DQO process will be used to guide the selection of constituents of concern, sampling and analysis, statistical methods, etc. If other groundwater constituents indicative of migrating waste products are identified, then the list of groundwater parameters will be revised to include such constituents. In the compliance monitoring programs, the constituents of concern will be compared to concentration limits [maximum contaminant levels (MCLs)]. A revised groundwater-monitoring plan will be prepared and submitted to Ecology for approval.

7.0 Corrective-Action Program

If, at a point of compliance (a well), dangerous constituents of concern are measured in the groundwater at concentrations that exceed the applicable groundwater-concentration limit, Ecology must be notified in 7 days, and an application to modify the permit to include a corrective-action plan must be sent to Ecology within 90 days. After concurrence from Ecology, a corrective-action level-monitoring program will be established. The development of a corrective-action level-monitoring program will be initiated by integration of RCRA/CERCLA programs. A description of the groundwater-monitoring plan that will be used to assess the effectiveness of the corrective/remedial action measures will be prepared and submitted to Ecology when the need for corrective action is first identified.

8.0 References

Public Laws

Resource Conservation and Recovery Act of 1976, as amended, Public Law 94-580, 90 Stat. 2795, 42 USC 6901 et seq.

Code of Federal Regulations

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40 CFR 264, Code of Federal Regulations, Title 40, Part 264. *Standards for Owners of Hazardous Waste Treatment, Storage, and Disposal Facilities*.

40 CFR 265, Code of Federal Regulations, Title 40, Part 265. *Interim Status Standards for Owners of Hazardous Waste Treatment, Storage, and Disposal Facilities*.

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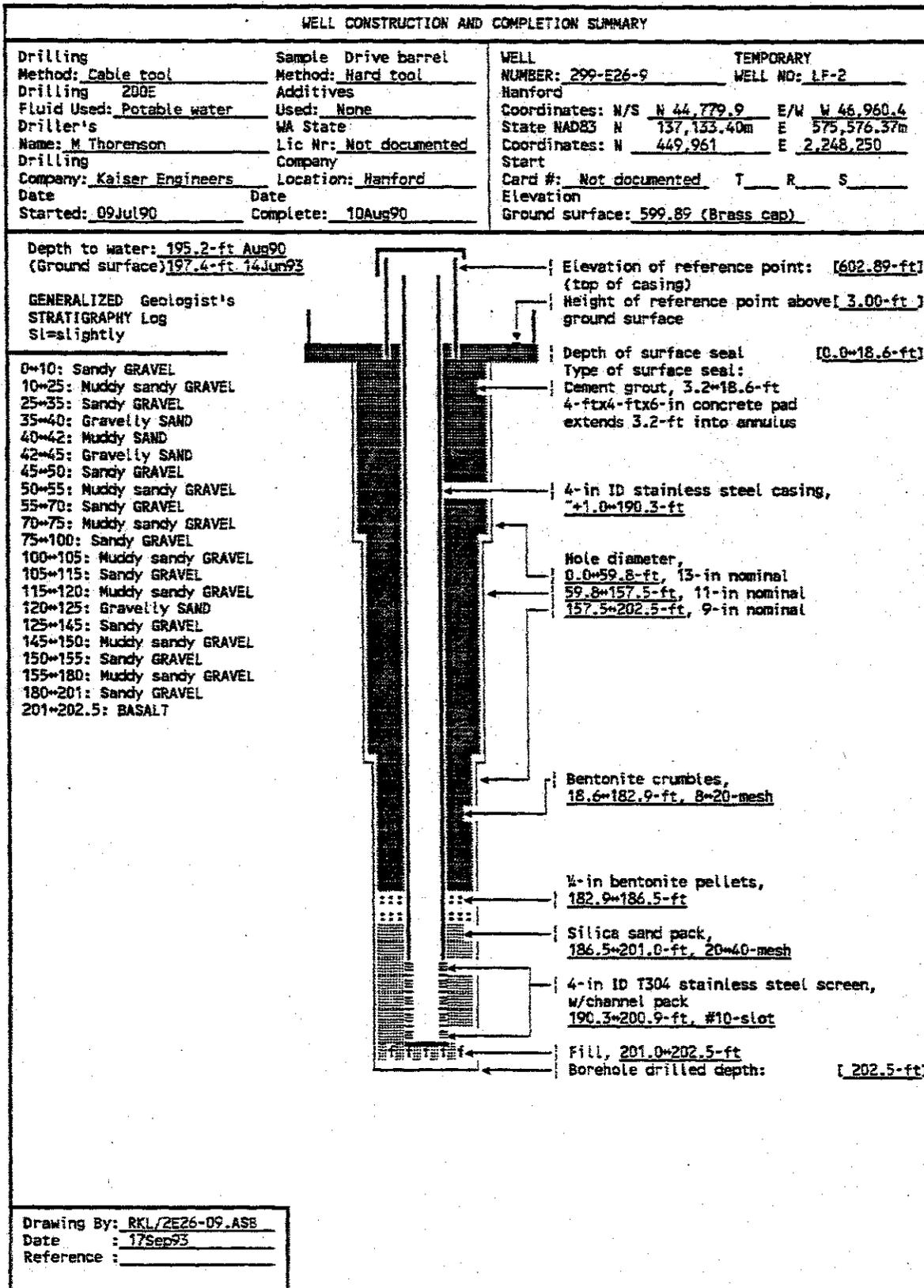
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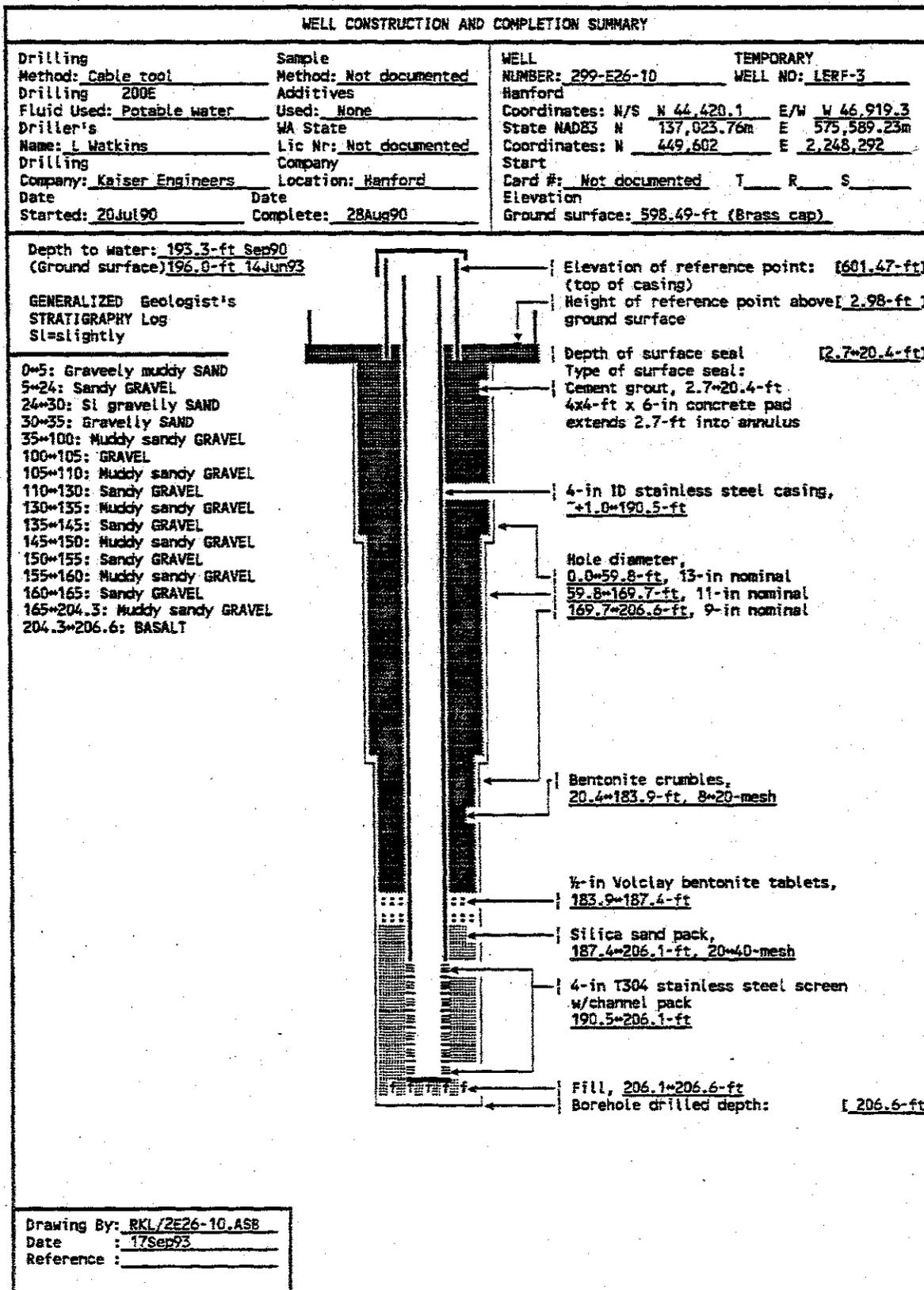
Appendix A

**Well Construction Diagrams for the LERF
Groundwater-Monitoring Network**



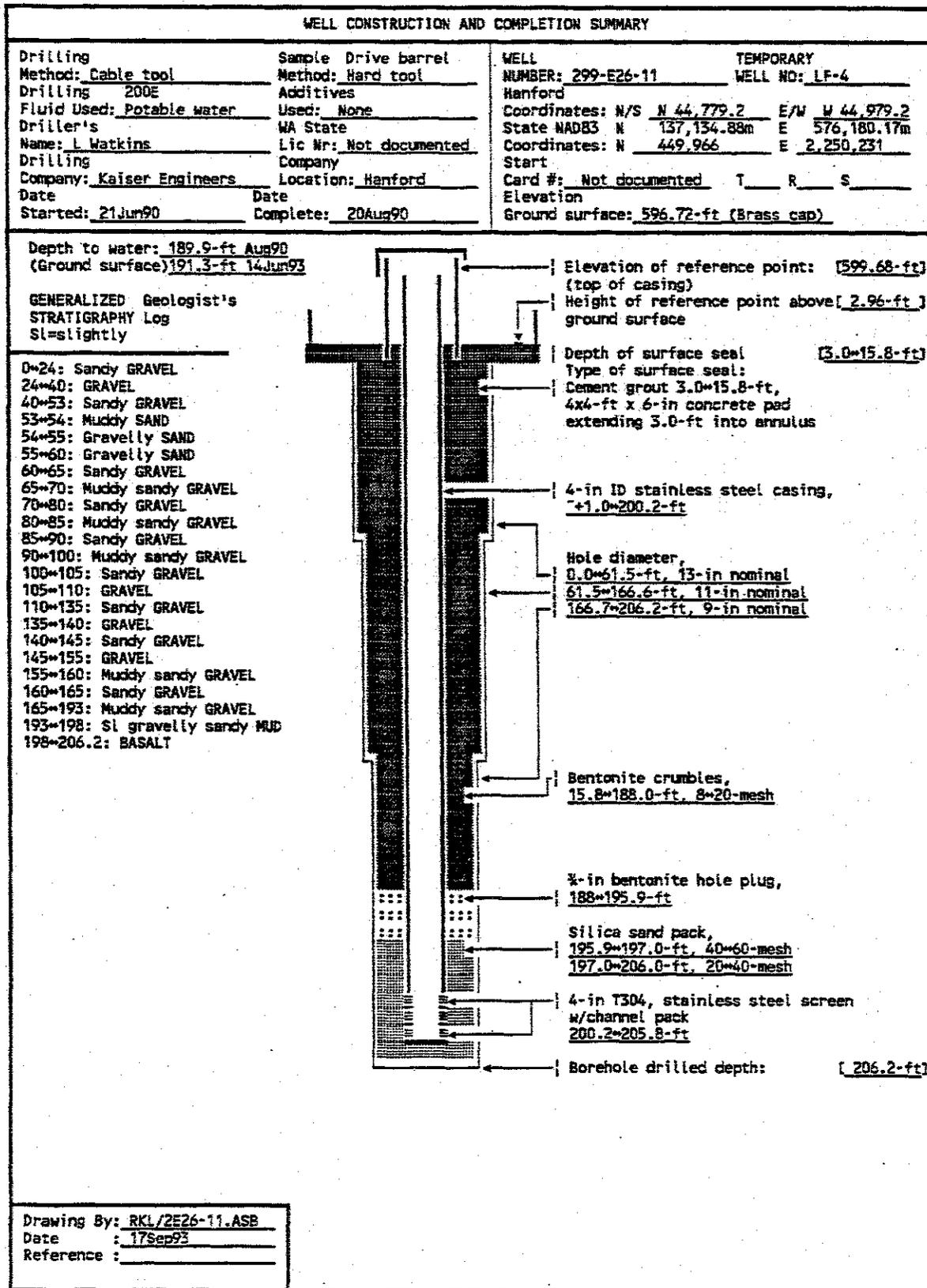
SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-9

WELL DESIGNATION : 299-E26-9
CERCLA UNIT : 200 Aggregate Area Management Study
RCRA FACILITY : LERF
NANFORD COORDINATES : N 44,779.9 W 46,960.4 [200E-18Sep90]
LAMBERT COORDINATES : N 449,961 E 2,248,250 [NANCONV]
N 137,133.40m E 575,576.37m [NAD83-18Sep90]
DATE DRILLED : Aug90
DEPTH DRILLED (GS) : 202.5-ft
MEASURED DEPTH (GS) : 201.6-ft, 25Jan93
DEPTH TO WATER (GS) : 195.2-ft, 01Aug90;
197.4-ft, 14Jun93
CASING DIAMETER : 4-in stainless steel, +1.0"190.3-ft;
6-in stainless steel, +3.0"10.5-ft
ELEV TOP CASING : 602.89-ft, [200E-18Sep90]
ELEV GROUND SURFACE : 599.89-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 190.3-200.9-ft, 4-in #10-slot stainless steel;
with channel pack
COMMENTS : FIELD INSPECTION, 25Jan93;
6-in stainless steel casing. 4-ft by 4-ft concrete pad, 4 posts, 1 removable
capped and locked, brass cap in pad with well ID.
Not in radiation zone. DTW=200.3-ft, DTB=204.6-ft (TOC)
OTHER:
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not applicable
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : LERF quarterly water level measurement, 01Feb91-14Jun93;
CURRENT USER : WRC ES&M w/l monitoring and RCRA sampling,
PNL sitewide sampling 93
PUMP TYPE : Hydrostar, intake @ 199.2-ft (GS)
MAINTENANCE :



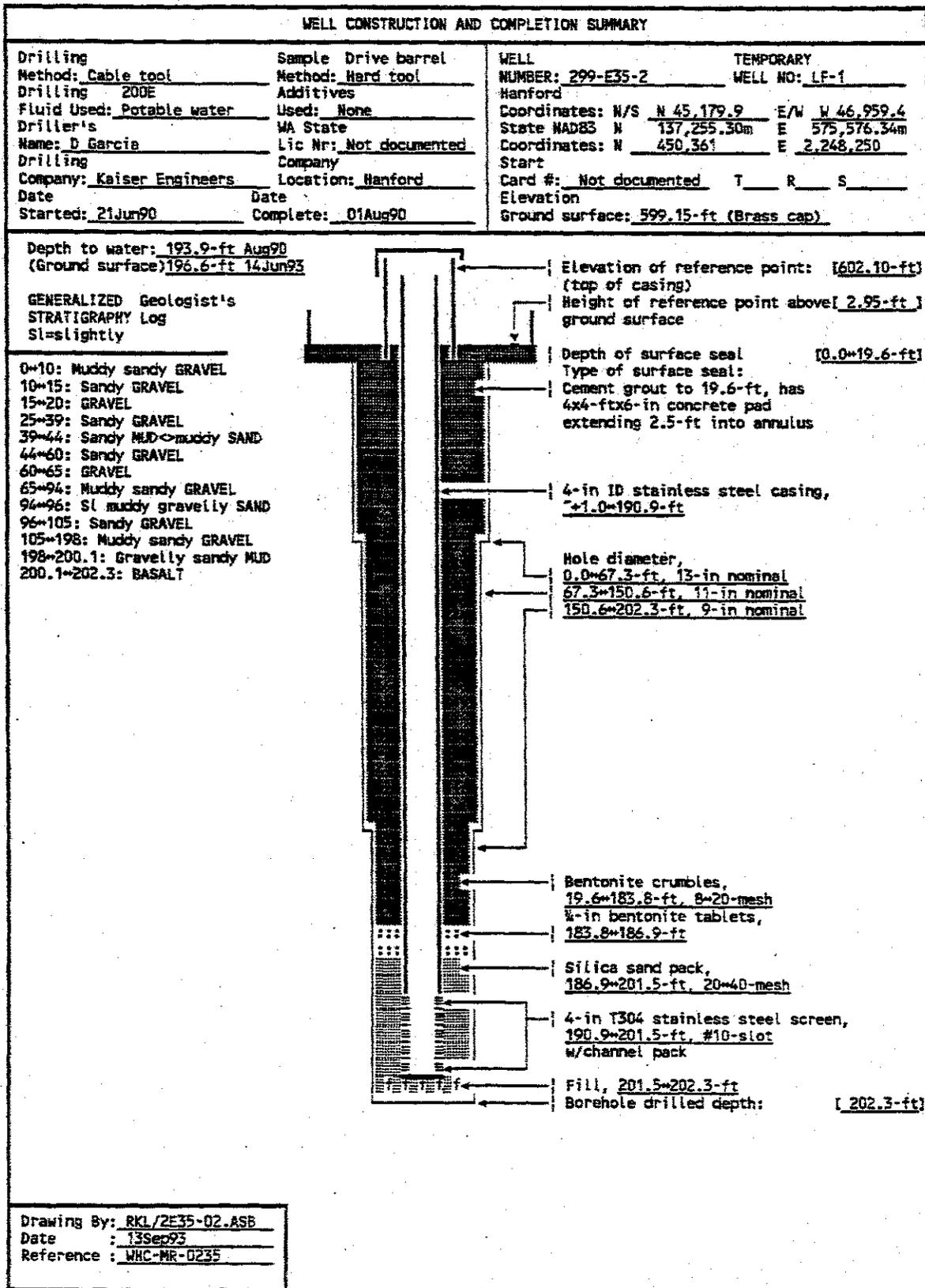
SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-10

WELL DESIGNATION : 299-E26-10
CERCLA UNIT : 200 Aggregate Area Management Study
RCRA FACILITY : LERF
NANFORD COORDINATES : N 44,420.1 W 46,919.3 [200E-18Sep90]
LAMBERT COORDINATES : N 449,602 E 2,248,292 [NANCONV]
N 137,023.76m E 575,589.23m [NAD83-18Sep90]
DATE DRILLED : Aug90
DEPTH DRILLED (GS) : 206.6-ft
MEASURED DEPTH (GS) : 206.7-ft, 27Aug93
DEPTH TO WATER (GS) : 193.3-ft, 04Sep90;
196.0-ft, 14Jun93
CASING DIAMETER : 4-in stainless steel, +1.0~190.5-ft;
6-in stainless steel, +3.0~0.5-ft
ELEV TOP CASING : 601.47-ft, [200E-18Sep90]
ELEV GROUND SURFACE : 598.49-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 190.5~206.1-ft, 4-in #10-slot stainless steel;
with channel pack
COMMENTS : FIELD INSPECTION, 27Aug93;
4 and 6-in stainless steel casing.
4-ft by 4-ft concrete pad, 4 posts, 1 removable.
Capped and locked, brass cap in pad with well ID.
Not in radiation zone.
OTHER:
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not applicable
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : LERF quarterly water level measurement, 01Feb91~14Jun93;
CURRENT USER : WNC ESEM w/l monitoring and RCRA sampling,
PNL sitewide sampling 93
PUMP TYPE : Hydrostar, intake @ 201.2-ft (GS)
MAINTENANCE :



SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E26-11

WELL DESIGNATION : 299-E26-11
CERCLA UNIT : 200 Aggregate Area Management Study
RCRA FACILITY : LERF
HANFORD COORDINATES : N 44,779.2 W 44,979.2 [200E-18Sep90]
LAMBERT COORDINATES : N 449,966 E 2,250,231 [HANCONV]
N 137,134.88m E 576,180.17m [NAD83-18Sep90]
DATE DRILLED : Aug90
DEPTH DRILLED (GS) : 206.2-ft
MEASURED DEPTH (GS) : 206.2-ft, 27Aug93
DEPTH TO WATER (GS) : 189.9-ft, 13Aug90;
191.3-ft, 14Jun93
CASING DIAMETER : 4-in stainless steel, ~+1.0~200.2-ft;
6-in stainless steel, +3.0~0.5-ft
ELEV TOP CASING : 599.68-ft, [200E-18Sep90]
ELEV GROUND SURFACE : 596.72-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 200.2~205.8-ft, 4-in #10-slot stainless steel;
with channel pack
COMMENTS : FIELD INSPECTION, 27Aug93;
4 and 6-in stainless steel casing.
4-ft by 4-ft concrete pad, 4 posts, 1 removable.
Capped and locked, brass cap in pad with well ID.
Not in radiation zone.
OTHER:
Geologist
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not applicable
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : LERF quarterly water level measurement, 01Feb91~14Jun93;
CURRENT USER : WMC ES&M w/l monitoring and RCRA sampling,
PNL sitewide sampling 93
PUMP TYPE : Hydrostar, intake @ 203.2-ft (GS)
MAINTENANCE :



SUMMARY OF CONSTRUCTION DATA AND FIELD OBSERVATIONS
RESOURCE PROTECTION WELL - 299-E35-2

WELL DESIGNATION : 299-E35-2
CERCLA UNIT : 200 Aggregate Area Management Study
RCRA FACILITY : LERF
HANFORD COORDINATES : N 45,179.9 W 46,959.4 [200E-18Sep90]
LAMBERT COORDINATES : N 450,361 E 2,248,250 [HANCONV]
N 137,255.30m E 575,576.34m [NAD83-18Sep90]
DATE DRILLED : Aug90
DEPTH DRILLED (GS) : 202.3-ft
MEASURED DEPTH (GS) : Not documented
DEPTH TO WATER (GS) : 193.9-ft, 02Aug90;
196.6-ft, 14Jun93
CASING DIAMETER : 4-in stainless steel, +1.0-190.9-ft;
6-in stainless steel, +3.0-0.5-ft
ELEV TOP CASING : 602.10-ft, [200E-18Sep90]
ELEV GROUND SURFACE : 599.15-ft, Brass cap [200E-18Sep90]
PERFORATED INTERVAL : Not applicable
SCREENED INTERVAL : 190.9-201.5-ft, 4-in #10-slot stainless steel;
with chernel pack
COMMENTS : FIELD INSPECTION,
OTHER:
AVAILABLE LOGS : Geologist
TV SCAN COMMENTS : Not applicable
DATE EVALUATED : Not applicable
EVAL RECOMMENDATION : Not applicable
LISTED USE : LERF quarterly water level measurement, 01Feb91-14Jun93;
CURRENT USER : WMC ESEM w/l monitoring and RCRA sampling
PUMP TYPE : Hydrostar, intake @ 202.6-ft (TOC)
MAINTENANCE :

1 **5.7 INTERIM STATUS GROUNDWATER MONITORING PLAN FOR THE 200 EAST AREA**
2 **LIQUID EFFLUENT TREATMENT FACILITY, WHC-SD-EN-AP-024, REVISION 1.**

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SUPPORTING DOCUMENT		1 Total Pages <u>126</u>	
2 Title Interim Status Ground Water Monitoring Plan for the 200 East Area Liquid Effluent Retention Facility		3 Number WHC-SD- EN-AP-024	4 Rev No. 1
5 Key Words ground water monitoring LERF/Liquid Effluent Retention Facility 242-A Evaporator/Crystallizer		6 Author J. S. Schmid Name (Type or Print) <i>J. S. Schmid</i> Signature 81231/WTW23 Organization/Charge Code	
7 Abstract <p>This document presents a ground water monitoring plan for the 200 East Area Liquid Effluent Retention Facility (LERF), which will be constructed adjacent to the northeast corner of the 200 East Area of the Hanford Site in southeastern Washington State. The LERF will be used for temporary storage of liquid waste from the 242-A Evaporator/Crystallizer. An interim-status plan is required to determine existing ground water quality at the construction site and to provide means to detect any future ground water contamination caused by containment failure of the LERF.</p> <p>This document summarizes the available data on the vicinity and presents a plan to develop a ground water monitoring system around the facility. The plan is to install four new monitoring wells, one upgradient and three downgradient. These wells will be used to monitor ground water levels and water quality immediately adjacent to the LERF site, prior to and after construction and use of the facility.</p>			
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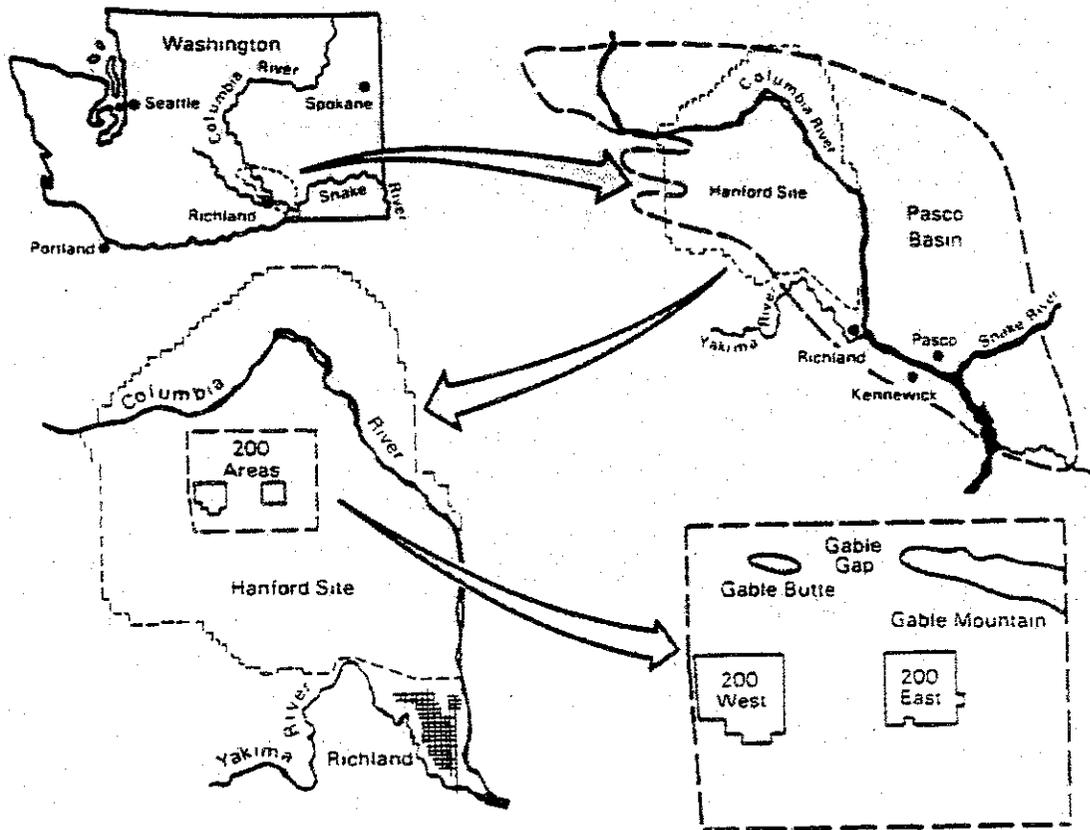
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1.0 INTRODUCTION

This document presents a ground water monitoring plan for a proposed facility, the Liquid Effluent Retention Facility (LERF). The LERF is to be located immediately east of the 200 East Area on the Hanford Site in south-eastern Washington (Figures 1-1 and 1-2). The proposed facility is composed of four contiguous, interim-storage basins designed to receive 242-A Evaporator/Crystallizer process condensate.

Figure 1-1. Map Showing the Locations of the Hanford Site and the 200 Areas.



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2.0 BACKGROUND

The U.S. Department of Energy's (DOE) Hanford Site has been used for more than four decades for nuclear reactor operations, nuclear fuel processing, radioactive waste management, and related activities. The fuel reprocessing and radioactive waste management facilities in the 200 East and 200 West areas are currently operated by Westinghouse Hanford Company (Westinghouse Hanford).

2.1 FACILITY DESCRIPTION

The proposed LERF will be composed of four contiguous, lined, surface impoundments (basins) that will be constructed to the east of the 200 East Area of the Hanford Site (see Figure 1-2). The design of the basins is fully described by WHC (1990a). Each basin will have a nominal capacity of 6.5M gal. For leak detection and containment, each basin will have a double liner with a leachate collection system installed between the two liners.

The basins will be constructed partly abovegrade and partly belowgrade, and each will be supplied with a floating cover. In addition, a leak detection system will be installed for the waste transfer piping associated with the basins. Prior to construction of the basins, land surface will be graded to 593 ft above mean sea level.

Each basin will be approximately 270 ft wide by 330 ft long. Basin dimensions allow 3 ft of freeboard when the basins are filled to nominal capacity. This will result in a maximum fluid depth of 21 ft. Design service life of the basins is 30 yr.

2.2 WASTE CHARACTERISTICS

The waste characteristics of the effluent stream that will be associated with 200 East Area LERF are described. Historical information on the stream and the facilities that hosted it is obtained from the Waste Information Data System (WIDS) general summary reports (provided as Appendix A) and Geary (1990). The WIDS database is controlled and maintained by Westinghouse Hanford.

The 242-A Evaporator, located in the 200 East Area, is a facility designed for the treatment of mixed waste. Process condensate from the facility has been disposed to the 216-A-37-1 Crib via the 207-A Retention Basins since March 1977 (Smith and Kasper 1983). The evaporator was shut down and placed on temporary standby status in April 1989, pending construction of a waste disposal alternative to supplant use of the soil column crib.

The 242-A Evaporator is the primary concentrator for Hanford Site wastes that are stored and treated in underground, double-shell tanks. The wastes are processed in different batches according to their classification by total organic content, transuranic content, and effects on the evaporation process. The process condensate consists primarily of condensed water from boiloff in the evaporator. Contaminants consist chiefly of volatile organics that boil off with the water and radionuclides that are entrained in the vapors (WHC 1990c).

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Sampling data were obtained during operations with four separate evaporator feeds. Key constituents from each feed mode are shown in Table 2-1 (WHC 1990c).

Table 2-1. Effluent Stream Sampling Data,
242-A Evaporator Process Condensate.

Key Constituents	Detection Limit ^a	Detection/Analyses	Sample Concentration 90% CI ^a	Detection Limit ^a	Detection/Analyses	Sample Concentration 90% CI ^a
	3/88 to 05/88, During CRW Feed			10/89 to 03/90, During Inactive Mode		
acetone	10	5/5	2,540	No Data		
aluminum	NA	5/5	1,290			
1-butanol	NA	5/5	75,100			
	08/85 to 02/88, During Linked Feed			01/88 to 03/89, During ASF Feed		
acetone	10	11/11	1,690	10	9/9	1,270
aluminum	NA	11/12	765	NA	9/10	1,150
2-butanone	10	07/12	58	10	9/10	46 ^b
1-butanol	NA	10/10	589 ^b	NA	9/9	46,400
	07/88, During Saltwell Feed					
acetone	10	4/4	1,040			
aluminum	NA	4/4	633			
	1977 to 1988, During Routine Operation ^c					
hydrogen-3	5,000	83/NA	6,300,000			
strontium-90	30	46/NA	760			
ruthenium-106	600	5/NA	3,500			
cesium-137	80	47/NA	540			

ASF = ammonia scrubber feed.
 CI = confidence interval.
 CRW = cladding removal waste feed.
 NA = not available.
^aUnits: chemical--parts per billion
 radionuclides--picocurie per liter.
^bConcentrations below Group A or Group C study guideline;
 values given for purposes of comparison.
^cDisposal of effluent to the 216-A-37-1 Crib began in 1983;
 thus, this data set includes some samples taken prior to 1983.

NOTES:

- Group A--Current and proposed primary and secondary drinking water standards, also known as maximum contaminant levels and derived concentration guides.
- Group C--Constituent-specific land disposal restriction limits, extraction procedure toxicity limits, and toxic characteristic leaching procedure limits.

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2.3 GEOLOGY

This section provides background information on the geology of the Hanford Site, the 200 Areas, and the proposed LERF site to support the preparation of the ground water monitoring program. The geology of the Columbia Plateau, and particularly the Pasco Basin, has been studied in detail for DOE as part of the siting studies for a deep geologic repository for nuclear waste. The *Consultation Draft, Site Characterization Plan* (DOE 1988) summarizes much of the information known about the Hanford Site, especially near the 200 West Area where the candidate repository site was located. Studies have also been done as part of the nuclear power plant licensing efforts, including those for the Washington Public Power Supply System (Supply System 1981) and the Skagit/Hanford Project (PSPL 1982). More detailed information is available in the following reports:

- structural geology and tectonics - Caggiano and Duncan (1983), Reidel et al. (1982), and Reidel and Hooper (1989)
- basalt stratigraphy and chemistry - Swanson et al. (1979) and Reidel et al. (1982)
- sedimentary units interfingered with and overlying the basalts - Bjornstad (1984, 1985); Fecht et al. (1985); Myers/Price et al. (1979); Myers and Price (1981); and Graham et al. (1984). Tallman et al. (1979) is the only in-depth study of the geology of the 200 Areas.

The Hanford Site lies within the Columbia Plateau, which is generally characterized by a thick sequence of tholeiitic basalt flows called the Columbia River Basalt Group (Swanson et al. 1979). These flows have been folded and faulted creating broad structural and topographic basins separated by asymmetric anticlinal structures (i.e., ridges). The Hanford Site lies specifically within the Pasco Basin, one of these structural basins (Figure 2-1).

Principal geologic units within the Pasco Basin include, in ascending order, the Columbia River Basalt Group (Miocene), the Ringold Formation (Miocene-Pliocene), and the Hanford formation (Pleistocene). A regionally discontinuous veneer of recent alluvium, colluvium, and/or eolian sediments overlies the principal geologic units.

2.3.1 200 Areas

The surface topography of the 200 Areas is primarily the result of Pleistocene cataclysmic flooding and Holocene eolian activity. Cataclysmic flooding, which ended about 13,000 yr ago (Mullineaux et al. 1978), created Cold Creek bar (Bretz et al. 1956), a prominent flood feature within the 200 Areas (Figure 2-2). The last cataclysmic flood(s) covered the 200 Areas with a blanket of coarse-grained deposits that become finer grained to the south. The northern boundary of the Cold Creek bar is defined by an erosional channel running east-southeast, which formed during waning stages of flooding as floodwaters drained from the basin (Bjornstad et al. 1987).

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The chemical composition of the water in the unconfined aquifer ranges between calcium-bicarbonate, sodium-bicarbonate, and calcium-sulfate types (Graham et al. 1981). Calcium-bicarbonate is the most prevalent constituent in the ground water. However, there is considerable variability in chemical composition of the ground water beneath the 200 Areas.

Discontinuous perched water tables occur in localized areas in the 200 West Area, often lying on top of a calcrete horizon in the Plio-Pleistocene unit or above markedly finer-grained sediments in the upper Ringold unit, early Palouse soil, and Hanford formation. The lateral extent of these perched water tables has not been defined in detail, but they are believed to be discontinuous and found only near areas where large quantities of water were disposed to waste facilities.

2.4.2 Proposed LERF Site

The hydrogeology of the proposed LERF site (like the geology) must be inferred from nearby monitoring facilities.

Last and Bjornstad (1989) have shown that beneath WMA-2 of the low-level burial grounds, a single hydrogeologic unit, the Hanford formation, overlies the Elephant Mountain Member of the Saddle Mountains Basalt, and that the Ringold Formation is missing. Their evidence suggests that the basalt is laterally continuous in that area, except perhaps to the north of WMA-2 in the vicinity of a paleotopographic depression in the basalt surface, where an erosional window may allow hydraulic communication between the unconfined aquifer of the Hanford formation and the confined aquifer of the Rattlesnake Ridge interbed. The unconfined aquifer is relatively thin at WMA-2 because the confining basalt surface rises toward the north. Saturated thickness ranges from 0 ft near the northern boundary of WMA-2 to about 30 ft at the southern boundary. Measured hydraulic conductivities (based on five wells) ranged from 1,400 to 6,700 ft/d, and mean effective porosity was estimated to be 10%.

Luttrell et al. (1989) have shown that the uppermost aquifer at the B Pond location is contained in unconsolidated to slightly consolidated sandy gravel to silty sandy gravel, and that the base of the aquifer may be the top of a clay-rich unit overlying the basalt. If the clay-rich unit is not laterally extensive, the Elephant Mountain Member represents the base of the aquifer. A ground water mound exists beneath B Pond because of water infiltration at the pond, and saturated thickness of the unconfined aquifer ranges from about 30 to over 70 ft.

To the west of B Pond and at the WMA-2 site, ground water flow is generally to the west, because of the influence of the ground water mound beneath B Pond. Ground water flow at the LERF site, therefore, is toward the west, and hydraulic gradient based on water elevation contours seen in Figure 2-8 is probably 1 ft/1,000 ft or less. If discharge to B Pond is discontinued and the mound is allowed to dissipate, the flow direction would be expected to reverse and become easterly (Figure 2-7). No evidence of perched water table conditions was reported for either B Pond or WMA-2, so none is expected at the LERF site.

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3.0 INDICATOR EVALUATION MONITORING PROGRAM

This plan has been developed in accordance with RCRA, as described in 40 CFR 265, Subpart F, and with Ecology requirements as described in WAC 173-303-400, to establish an interim-status indicator evaluation ground water monitoring program for the 200 East Area LERF and, if necessary, to initiate a ground water quality assessment program. All work outlined in this plan will be conducted under *Procedures for Ground-Water Investigations* (PNL 1989a) and the *RCRA Ground-Water Monitoring Project's Quality Assurance Project Plan* (PNL 1989b). Additionally, all onsite personnel must meet Occupational Safety and Health Administration medical, monitoring, and training requirements in accordance with 29 CFR 1910.120.

3.1 OBJECTIVES

The objectives are to establish a drilling and ground water monitoring program that will:

- characterize the stratigraphy and horizontal ground water flow directions beneath the LERF site; the focus will be on the uppermost confined aquifer
- determine background ground water quality
- provide means to detect any future ground water contamination from the LERF.

3.2 APPROACH

Four new monitoring wells will be installed around the LERF. These wells will provide information on the geology, hydrology, and water quality of ground water from the upper portion of the unconfined aquifer. This initial phase of characterization and ground water monitoring focuses on the uppermost portion of the aquifer. Results from this phase will be used to determine the need for wells that would penetrate and monitor deeper than the upper 20 ft of the aquifer.

Subsurface soil samples will be collected during drilling at each location. These samples will be described and classified in the field. Selected samples will be submitted to the laboratory for analyses to determine various physical and chemical parameters.

Ground water samples may be collected after reaching the water table if these samples are necessary for disposal of purge water during aquifer testing and well development. These samples may be analyzed for contamination indicator parameters before aquifer testing or well development. Aquifer tests, if conducted, are useful for providing estimates of hydraulic properties of materials beneath the site.

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Water samples will be collected and analyzed quarterly from the new monitoring wells. The first year of sample analyses will be used to establish the background water quality for each well. Statistical evaluation of subsequent analyses compared with these background concentrations will provide an indication whether hazardous constituents from the facilities are significantly affecting the ground water.

Historical ground water quality data exist for well 299-E26-1, downgradient from the LERF and from well 699-45-42, upgradient from the LERF (see well locations in Figure 1-2). These wells provide the closest available upgradient and downgradient water quality. The wells are too distant to be incorporated as part of the monitoring network for the LERF, but the water quality from these wells serves as a starting point in the evaluation of background water quality. Construction and lithologic information for these wells is provided in Appendix B, and the water chemistry data are presented in Appendix C.

3.3 GROUND WATER MONITORING SYSTEM

This section defines the uppermost confined aquifer that will be monitored, the location and justification of the monitoring wells, how the new wells will be installed, the frequency of sampling, and ground water constituents to be analyzed.

3.3.1 Uppermost Aquifer

The uppermost aquifer at the LERF site is contained within the supra-basalt sediments and is assumed to extend from the water table to the top of the Elephant Mountain Member of the Saddle Mountains Basalt. Hydrogeologic characterization activities are designed to obtain information on hydraulic and ground water flow characteristics for the uppermost aquifer.

3.3.2 Installation of New Characterization/Monitoring Wells

Four new monitoring wells will be installed around the LERF. These wells will (1) provide hydraulic data to help determine the ground water flow direction beneath the site, (2) provide upgradient and downgradient ground water quality information from the upper portion of the unconfined aquifer, (3) evaluate the hydraulic properties of the aquifer, and (4) provide geologic information on the conditions that affect contaminant migration and ground water flow.

3.3.3 Justifications for Locations of New Wells

As a minimum, one upgradient and three downgradient ground water monitoring wells will be placed around the LERF site according to the requirements of 40 CFR 265. The primary objective of this configuration is to determine the ground water quality upgradient and downgradient of the site. The well placements were based on preliminary information and professional judgement.

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3.3.3.1 Background (Upgradient) Well. The upgradient well will be located 400 ft east (the assumed upgradient direction) of the LERF, as shown in Figure 3-1. The location is close enough to provide information regarding upgradient water quality, but far enough away from the easternmost basin to be unaffected by any major leakage from that basin and consequent plume spreading in the vadose zone.

3.3.3.2 Detection (Downgradient) Wells. The three downgradient wells will be located along a north-south line approximately 100 ft west of the westernmost margin of the basins site, as shown in Figure 3-1. The wells will be located at 400-ft intervals along the north-south line, with the center well aligned on the east-west axis of the basins. Well spacing was maximized to provide a wider areal coverage of the proposed site.

The estimated depth to water table is 220 to 230 ft. Basin leakage of sufficient volume to reach the water table is estimated to exhibit a lateral spread of 200 ft or more in all directions by the time the downward-migrating plume has reached the water table. This estimated 200-ft spread is based on observations at a site 2,500 ft south of the LERF site.

Based on the assumption that the ground water flow in this vicinity is due west, the three downgradient wells are located in the flow path of the upgradient well. Water elevations from wells in the region provide the estimation of the westward flow as shown in Figure 3-2. Detailed water table elevations for the immediate vicinity of the LERF will be available after installation of the new wells.

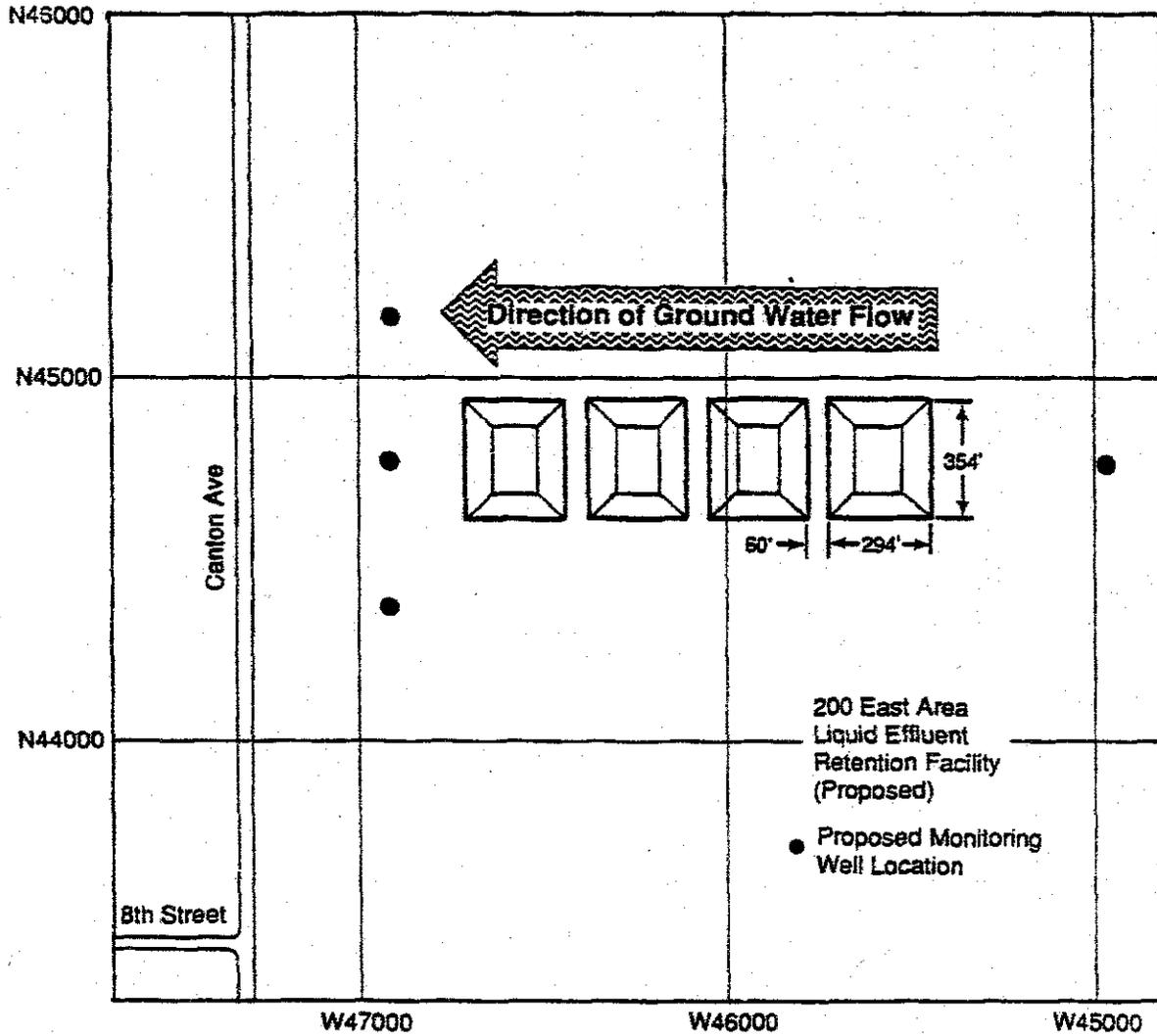
3.3.3.3 Construction Details. As suggested in Chapter 2, the uppermost aquifer is presently defined as the lower (approximately) 30 ft of the suprabasalt sediments (i.e., no basalt above the water table), and that the Elephant Mountain Member is intact in the vicinity of the basin site (i.e., no erosional window to the Rattlesnake Ridge interbed).

Two of the four wells will be drilled to a maximum of 25 ft below the water table. This overdrilling will be done in an attempt to locate the top of basalt. Overdrilling will be done at the upgradient well. Drilling will cease if the top of basalt is encountered or the well has been advanced 25 ft below the water table, whichever occurs first. Overdrilling will also be attempted at the northernmost downgradient well. If basalt is encountered within 15 ft of the water table, an alternate well will be drilled up to 25 ft below the water table or the top of basalt, whichever occurs first.

The purpose of the overdrilling is to obtain hydrogeologic information about the top of basalt. Previous studies have indicated an erosional feature in the basalt that may create intercommunication between the uppermost aquifer and the confined aquifer.

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Figure 3-1. New Monitoring Well Locations for the Proposed LERF Site.



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The wells are expected to have a total depth of 250 ft, and the lower 20 ft of each well will be screened, with 5 ft of the screened interval above water level measured at the time of well construction. All overdrilled wells that are advanced more than 15 ft into the aquifer will be backfilled to within 15 ft of the aquifer in accordance with the drilling specifications for ground water monitoring wells (WHC 1990b). The approximate location coordinates for each of the wells are:

Upgradient (background) well

North -- N44780 West -- W44975

Downgradient (detection) wells

North -- N45180 West -- W46920
 N44780 W46920
 N44380 W46920

Data sheets, as shown in Figure 3-3, will be completed and provided in the borehole data report.

3.3.4 Drilling and Well Installation

The cable-tool method of drilling will most likely be used. If another method of drilling is chosen, it will have the same advantages as the cable-tool method. These advantages include (1) drill cuttings being easily contained (important in contaminated material), (2) representative geologic samples can be collected, (3) moisture samples can be collected from above the water table, (4) disturbance to the borehole wall is minimized, and (5) a straight, plumb borehole being produced. Regardless of drilling methods, the well will meet current construction standards.

Drill cuttings will be routinely monitored for radiation and hazardous material. Where contamination is suspected, all drill cuttings will be collected until analytical results conclude that the material is not a dangerous waste. If contamination is detected, the drilling will stop until it has been determined what course of action to take. Contaminated cuttings will be handled, transported, and disposed of according to Westinghouse Hanford procedures.

To help prevent introduction of contaminants into the borehole, the drill rigs and peripheral equipment (such as drill tools, cables, and temporary casing) will be steam cleaned before arriving onsite, moving to a new site, and beginning construction of the next well. During drilling in the zone to be sampled, the addition of water to the borehole will be kept to a minimum or avoided. This will minimize well development pumping after wells are completed and minimize the changes of driving any vadose zone contaminants into the ground water.

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Figure 3-3. Example Ground Water Monitoring Well Data Sheet.

1. LOCATION: (Provide general location and coordinates.)
2. TEMPORARY CASING SIZE AND SCHEDULE:
3. APPROXIMATE WELL DEPTH: (As listed in item 6 below)
4. SPECIAL INSTRUCTIONS: (Include details such as well specification, desired order that wells are to be drilled, perched water zones, estimated number of split-spoon samples, critical start and completion dates, and any other pertinent information that may impact drilling.)
5. APPLICABLE DOCUMENTS: (Include ground water monitoring plans and work plans).
6. WELL NUMBERS, LOCATIONS, DEPTH, TYPE, AND SCREEN LENGTHS:

Temporary Well Number	Facility	Coordinates	Depth	Design Type	Screen Length

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Temporary carbon-steel casing with a minimum diameter of 8 in. will be driven to total depth as each borehole is advanced. The temporary casing will be telescoped so that no more than 150 ft of any one size of casing will be in contact with the formation. This will facilitate pulling the temporary casing out of the borehole and enable any zones of contamination or perched water to be sealed off during construction of the borehole. After the borehole has been drilled to its total depth, the final well casing and screen will be installed and the temporary carbon steel casing will be removed as the filter pack and annular seal materials are placed in the annular space.

3.3.5 Well Construction

A schematic diagram of a completed well is presented in Figure 3-4. Guidance concerning geologic sampling and inspection of well construction is provided by Last and Liikala (1987) and the procedures for ground water investigations are presented by Pacific Northwest Laboratory (PNL) (1989a). The WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells" and WHC (1990b) are used as guidance for the well design and construction materials. Quality assurance (QA) requirements of the QA project plan (PNL 1989b) also apply.

The final wells will be constructed of 4-in-ID pipe and a screen made of stainless steel, fiberglass, or other inert materials. Final screens will be 20 ft in length. The screens will extend downward so about 15 ft of screen is below the water table and 5 ft is above the water table.

Screen slot sizes will be selected in the field after sieve analysis of the sediments has been performed. The site geologist will determine the filter pack size and screen slot size based on guidelines outlined by Last and Liikala (1987). Sand filter packs will be placed in the annulus between the 8-in. telescoping screen (if used) or the temporary 8-in-diameter casing and the permanent 4-in-diameter casing and screen as the temporary casing is withdrawn. If a telescoping screen is used during tests, it will be left in the hole. The sand filter pack will be placed from approximately 1 to 3 ft below to 3 to 5 ft above the top of the screen.

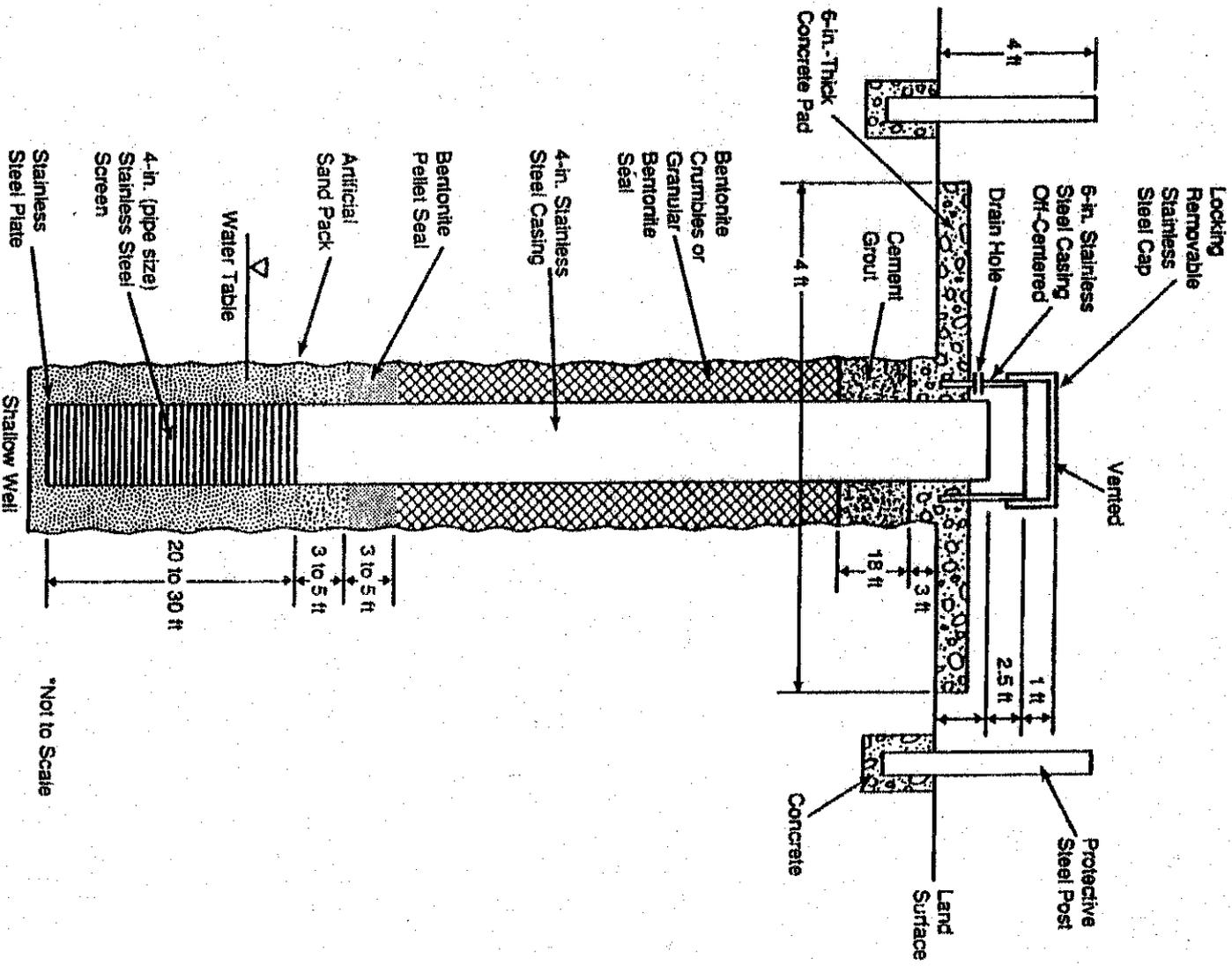
A 2- to 3-ft-thick bentonite pellet seal will be placed on top of the sand pack. The annulus above the bentonite pellet seal to 18 ft below ground surface will be filled with dry granular bentonite. Cement grout will then be installed to within 2 ft of the ground surface. The well casing will extend 1 to 2 ft above ground surface and will be protected by an outer steel casing and a locking cap. The protective casing will be set into the ground and cemented in place with a 4- by 4-ft by 6-in. concrete pad. A brass survey marker will be placed in the concrete pad and all protective casings will be permanently marked with well identification numbers.

3.3.6 Well Development

All wells will be developed following completion. Wells will be developed by the surge and bail technique, overpumping, or other reasonable techniques deemed necessary until turbidity is less than 5 NTU and sediment content is less than 8 mg/L. If the water cannot be developed to a turbidity of less than 5 NTU, an explanation will be provided and documented by the site hydrogeologist.

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Figure 3-4. Schematic Diagram of a Completed Ground Water Monitoring Well.



*Not to Scale

S8912051.11

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Other hydrochemical indicators, such as total iron and drilling fluid tracers, may be monitored to assess the adequacy of development pumping for trace constituent sampling.

All ground water discharged from the wells during development will be disposed of in accordance with Westinghouse Hanford guidelines and procedures. If it is necessary, a ground water sample will be collected and analyzed before development begins. The results could be used to determine the handling and disposal of purge water.

3.3.7 Surveying

After monitoring well installation is completed, all wells will be surveyed for location and elevation by qualified surveyors. The elevation of the top of the casing and a brass marker in the concrete pad will be determined within 0.04 ft. A mark will be placed on the casing to indicate the location that was surveyed. The areal location will be determined to the nearest 0.5 ft. All measurements will be referenced to a common datum (preferably a Hanford Site datum).

3.3.8 Monitoring Parameters

Ground water samples will be collected at least once each quarter to test constituents (Table 3-1) in conformance with 40 CFR 265, Subpart F.

While there are several other radioactive and organic constituents indicated in the effluent stream data summaries provided in Section 2.1, they should be detected as a group by the general screening or indicator parameters such as gross alpha, gross beta, total organic carbons (TOC), and total organic halogens (TOX). If increases in these parameters are detected, then more specific analyses would be performed. In addition, constituents listed in the sampling and analysis plan (Appendix D) will be analyzed once during the first year of sampling.

3.4 HYDROGEOLOGIC CHARACTERIZATION

Hydrogeologic characterization will be conducted to describe the geologic and hydrogeologic conditions and properties that control contaminant flow paths. Work performed will follow approved procedures, in accordance with the QA project plan approved by PNL and Westinghouse Hanford (PNL 1989b) and that meets EPA guidance (Stanley and Verner 1983).

Data collection and interpretation will focus on geology, geochemistry, hydrogeology, hydrochemistry, ground water monitoring, and ground water modeling. The characterization will be performed during and after construction of the planned ground water monitoring network. Information obtained from nearby facilities will be integrated into the characterization and interpretation effort. Characterization of this site is a discovery process, and data collection in these areas may expand or decrease depending on the information obtained.

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Table 3-1. Constituents Tested in Ground Water Samples.

Interim primary drinking water standards	Maximum level, mg/L
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Fluoride	1.4 to 2.4
Lead	0.05
Mercury	0.002
Nitrate (as NO ₃ ⁻)	45
Selenium	0.01
Silver	0.05
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005
2,4-D	0.1
2,4,5--TP Silvex	0.01
Radium	5 pCi/L
Gross alpha	15 pCi/L
Gross beta	4 mrem/yr
Coliform bacteria	1/100 mL
Ground water quality parameters	
Chloride	Phenols
Iron	Sodium
Manganese	Sulfate
Ground water contamination indicator parameters	
pH	TOC
Specific conductance	TOX
Site-specific Parameters (as effluent to basins becomes better defined, parameters subject to change)	
Tritium	Aluminum
Ammonium	

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3.4.1 Geologic Data

Geologic samples will be collected at 5-ft intervals, at changes in lithology, and when significant changes in moisture content are observed during drilling (EPA 1986). A general description of the borehole cuttings should be recorded by the well-site geologist to obtain a continuous lithologic record. Samples will be archived for possible future analyses. A guide to subsurface data collection and documentation during cable-tool drilling is presented by Last and Liikala (1987), and the procedures for ground water investigations are presented by PNL (1989a).

No drilling fluids will be added to the borehole unless necessary and approved by the well-site geologist. This will allow detection of perched water zones and the collection of representative moisture samples with minimal impact on water chemistry. Samples will be collected for moisture content determinations in the unsaturated sediments at 5-ft intervals and at moist or wet zones.

The well-site geologist will describe the samples in the field and document the descriptions on borehole logs. Every sample will be recorded on borehole logs as collected at the drill site. The detailed lithologic descriptions of geologic samples will include color, texture, sorting, mineralogy, roundness, relative calcium carbonate concentration, consolidation, and cementation. In addition, the drilling and well construction information, and the depths where various samples were collected, will be documented on the borehole logs.

3.4.1.1 Laboratory Analyses. Geologic samples will be analyzed in the laboratory using the following methods and criteria (see Table 3-2):

- sieve particle size
- pipette/hydrometer analyses
- permeameter testing
- calcium carbonate content
- moisture content
- petrography
- x-ray diffraction
- x-ray fluorescence
- atomic absorption analysis
- bulk mass density
- hazardous chemical analysis
- radionuclide analysis.

Some of these methods may be performed on every 5-ft sample, while other methods apply to particular types of samples or sample intervals. Table 3-2 summarizes the frequency that samples could be analyzed, the limitations, and the requirements for samples to be analyzed by the various methods.

3.4.1.2 Sediment Collection and Analysis. In addition to geologic samples, sediment samples may be collected for chemical and radiologic analysis. These samples will be collected as outlined below:

- at major lithologic changes
- at perched water zones or increased soil moisture content
- at zones where contamination is suspected based on unusual soil discoloration, odor, or detection instrumentation response above background levels.

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All samples will be collected and kept in refrigerated storage under the established chain-of-custody procedures. Samples obtained from zones identified in the last two bullets discussed in Section 3.4.1.2 will be submitted for analyses within the holding time for the constituent(s). Each sample may be analyzed for the constituents listed in Table 3-1.

Table 3-2. Laboratory Analyses to be Performed as Part of Hydrogeologic Characterization.

Laboratory analysis	Parameter measured	Sample requirements/limitations	Potential uses	Sample frequency	Method of sample collection ^a
Sieving	Particle-size distribution of sand to gravel-size particles	Individual soil particles must be disaggregated and unbroken to yield accurate results	Proxy for hydraulic parameters; ground water modeling	All samples	SS, DB, HT
Hydrometer	Particle-size distribution of mud-size particles (i.e., silt and clay)	Fine grained; undisturbed/intact soils	Characterize aquitards; ground water modeling	All fine-grained intervals	SS, DB
Permeameter	Saturated hydraulic conductivity	Undisturbed/intact soils	Determine rate of ground water movement; check for aquifer tests; ground water modeling	Selected intervals	SS
Calcium carbonate	%CaO ₃	Soils of fine sand or smaller particles	Aquifer identification; stratigraphic marker horizons	All samples	SS, DB, HT
Moisture content	%water	Undisturbed/intact soils	Elevate vadose water movement; aquifer identification; ground water modeling	All fine-grained intact intervals	SS, DB
Petrography	Mineral content/concentration	Soils with sand and larger particles	Differentiate among hydrostratigraphic units	Selected samples where major geologic contacts are suspected	SS, DB, HT
X-ray diffraction	Clay mineral identification	Soils with mud-size particles	Sorptive characteristics; hydrostratigraphic unit identification	Selected fine-grained intervals	SS, DB, HT
X-ray fluorescence	Major and trace element concentrations (except sodium and magnesium)	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soil	Selected intervals where lithology changes	SS, DB, HT
Atomic absorption	Sodium and magnesium concentrations	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Bulk mass density	Bulk porosity	Undisturbed/intact soils	Determine hydraulic parameters; ground water modeling	Selected intervals	SS
Hazardous chemicals	Concentrations of hazardous constituents in ground water	Nonturbid ground water; soil samples	Determine presence/absence of ground water contamination	All ground water bearing zones at regular intervals	Pump from completed well
Radionuclides	Concentrations of radionuclides in ground water	Nonturbid ground water; soil samples	Determine presence/absence of ground water contamination	All ground water bearing zones at regular intervals	Pump from completed well

^aSS = split-spoon drill method; DB = drive-barrel drill method; HT = hard-tool.

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3.4.1.3 Borehole Logging. After each size of temporary casing has been placed and when the monitoring wells have been drilled to final depth, the borehole will be logged with a gross gamma probe. Logging will not be necessary after the 20-ft starter casing has been placed in the borehole. A procedure for geophysical well logging that is approved by Westinghouse Hanford will be used. The primary purpose of the logging will be to provide qualitative stratigraphic interpretation and correlation (Hallenburg 1984; Fetter 1988). Specifically, the gross gamma log is useful for providing an indication of the clay content of the formation. In many cases, the presence of fine-grained sedimentary layers produces a higher gamma activity than coarse-grained sediments. Another use is to identify zones of suspected contamination by gamma ray-emitting radionuclides. After completion, each well will be viewed with a downhole video camera to ensure that the well is clean and undamaged. The neutron, density, caliper, spontaneous potential, resistivity, and magnetic probes, as well as the downhole video camera, may be used in specific instances when approved by Westinghouse Hanford. Spectral gamma logging may also be performed by Westinghouse Hanford.

3.4.1.4 Data Interpretation and Presentation. All geologic and geophysical data will be interpreted to determine the stratigraphy beneath the site. These data will be presented in cross sections, fence diagrams, contour maps, and tables, as recommended by EPA (1986). Interpretations of the stratigraphy will be used in evaluating potential contaminant flow paths, in determining hydrostratigraphic units, and, if needed, to aid in locating additional monitoring wells.

The data and interpretations will be presented in an interim site characterization report and in permitting documents. The documents will include (1) descriptions of stratigraphic units, (2) results of analyses, (3) as-built diagrams of wells, and if necessary (4) recommendations for further characterization or additional monitoring wells.

3.4.2 Hydrogeologic Data

Data that will be used to characterize the hydrogeology will be collected during and after drilling of the monitoring wells. The general types and methods of data collection are discussed below. Ground water samples will be taken following the procedures discussed in the sampling and analysis plan (Appendix C), or their revised, approved, and documented equivalents.

3.4.2.1 Aquifer Testing. The purpose of aquifer testing is to determine the hydraulic characteristics of in situ geologic materials in the uppermost confined aquifer underlying the LERF. A field testing program is essential to optimize collection of hydrologic data. However, the primary purpose of installing the wells is to monitor the ground water chemistry and not for aquifer testing. Therefore, the results must be considered in this perspective.

Aquifer testing that involves pumping ground water out of the well will be conducted only if adequate means exist for disposing of the purge water at the time the wells are ready for testing. A ground water sample may be collected and analyzed before aquifer testing begins. The results may be used to determine the handling and disposal of purge water. Slug testing will most likely be used because of the purge water issue.

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A bailer will be used to remove drilling fluids and coarse materials from the borehole. Pretest development by pumping will be conducted after bailing. The purpose of these tests is to develop the well. Pretest development by pumping can be used to determine the optimum discharge rate and, thus, the pump size for the constant-discharge test. If the pump has a check valve, then pretest development will consist of pumping at a low-flow rate followed by successively higher flow rate steps until full pump capacity or maximum drawdown has been achieved. If the pump is not equipped with a check valve, a surging technique will be used where the pump is alternately turned on and off followed by step pumping as described above. The constant-discharge test will not be performed until water levels have fully recovered from the development test.

A number of aquifer test methods may be used in the field testing program depending on the hydrologic parameter sought and existing hydraulic test conditions. Some test methods commonly used include bailer, development, constant-discharge, and recovery techniques. Constant-discharge tests could be conducted for up to 24 h in those cases where at least one observation well is available and drawdown is large enough (greater than 0.2 ft) to allow a quantitative analysis of the data. When available, data from the observation wells can be analyzed to yield estimates of transmissivity, storativity, and sometimes, hydraulic conductivity anisotropy. Results from constant-discharge tests can also be used to verify lateral continuity. Single well constant-discharge tests can normally be conducted for up to 8 h. Tests of 8-h duration can be used to estimate transmissivity.

A constant-discharge pumping test should be conducted in one upgradient and one downgradient well. If a constant-discharge pumping test is conducted, a temporary section of nominal 8-in. telescoping screen will be set in each of the wells before pumping. The length of the temporary screen will be similar to the screen lengths of the completed well. The screen will be open to the uppermost portion of the aquifer.

A submersible pump will be placed in the bottom portion of the screened interval. If the sediments in the test interval appear to have relatively high permeabilities (such as those characteristic of the Hanford formation), a large discharge range will be required. The largest pump that will fit in a nominal 8-in. telescoping screen (normally 40 hp) will be used in this case because it is expected that even a maximum discharge from this size pump (200 to 250 gal/min) will produce only a small drawdown (no more than 2 ft).

If sediments in the test interval have low permeabilities (such as those characteristic of the Ringold Formation), a much lower discharge rate will be required and a smaller pump can be installed. In some locations, the sediments in a test interval may be of such low permeability that a pumping test would not be possible. In these situations, a slug test may be conducted.

A slug test may be conducted in the following manner. The drive casing will be pulled back a few feet to expose the formation to the open hole. If heaving or caving formations are expected, a temporary section of telescoping screen will be set in the well before testing. The screen may be set as described for the constant-discharge pumping test. The borehole will be bailed to remove drilling fluids and debris before conducting the test.

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During the slug test, the hydraulic head will be changed instantaneously by suddenly introducing or removing a cylinder of known volume. The water level recovery response will then be observed over time.

A slug test will not yield representative results if the interval is of heterogeneous materials with hydraulic conductivities ranging over several orders of magnitude. In this case, split-spoon samples may be collected and laboratory tests may be used to determine hydraulic conductivity.

One or two days of continuous water level monitoring will be conducted (if scheduling permits) before/after terminating the pumping tests. These data will be used to determine whether outside influences, such as barometric effects, will have a significant impact on the tests. If so, the data will be corrected for these effects.

The conventional analysis methods by Cooper and Jacob (1946) and Theis (1935) can be used to estimate transmissivity in the unconfined aquifer (Graham et al. 1981). Modifications of these methods can be used to correct for partial penetration effects, delayed yield response, leakage effects, and borehole storage effects. Slug test methods that can be used include Hvorslev (1951), Cooper et al. (1967), and Bouwer and Rice (1976). The laboratory methods to determine hydraulic conductivity include the falling-head or constant-head permeameter tests (Klute and Dirksen 1986).

3.4.2.2 Determination of Ground Water Flow Paths. Water levels will be measured in all new wells and in all suitable nearby existing wells to determine the hydraulic head distribution used in identifying ground water flow paths. Measurements will also be made over time to evaluate temporal changes in flow paths and dynamics of the aquifer system.

3.4.2.3 Data Interpretation and Presentation. Hydrogeologic data, interpretations, and recommendations will be presented in an interim site characterization report after well installation and initial monitoring are completed. Specifically, this report will include (1) descriptions of hydrostratigraphic units, (2) water level data and water table maps, (3) test data and results of analyses, (4) as-built diagrams of wells, (5) hydrochemistry data, and if necessary, (6) recommendations for further characterization or construction of additional monitoring wells.

The data will also be used to evaluate whether the characterization was adequate and if the ground water monitoring system is appropriately designed. Recommendations will be provided for additional characterization activities or construction of additional ground water monitoring wells if necessary.

The hydrogeologic data will be integrated to form an initial conceptual model of the ground water flow system(s) in the vicinity of the LERF site. Components of the model will include the flow paths and their possible changes over time, estimates of ground water velocity, unsaturated zone conditions as they relate to the ground water monitoring system, and hydrochemical characterization.

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3.5 SAMPLING AND ANALYSIS

The wells will be sampled quarterly for 1 yr and semiannually thereafter. Sampling pumps will be installed in the new wells after construction and development is complete. The depth to water will be measured before samples are collected. The wells will be purged and samples will be collected after at least three borehole volumes have been removed and when specific conductance, temperature, and pH have stabilized. In the case of wells that pump dry because of very low permeability materials, the sample will be collected after recharge.

Sample analysis, preservation, and chain-of-custody procedures in accordance with 40 CFR 265.92 are discussed in Appendix D. The QA control protocol is also given in Appendix D. The purpose of the quality control activities is to determine and document that samples were carefully collected and transferred to an analytical laboratory, that the quality of the analytical results being produced by the laboratory are defensible, and to see the corrective actions will be taken as necessary.

Under the indicator-evaluation monitoring program, ground water surface elevation data will be evaluated at least annually to determine if the existing monitoring wells are appropriately located. If the evaluation indicates that existing wells are no longer adequately located, the ground water monitoring system will be modified to bring it into compliance with 40 CFR 265.91(a).

3.6 STATISTICAL ANALYSIS OF GROUND WATER MONITORING DATA

3.6.1 Methods for Establishing Background

Quarterly samples will be collected for 1 yr from the ground water monitoring wells in conformance with 40 CFR 265.92 for analyses of the constituents listed in Section 3.4. Additional constituents may be added to this list after evaluation of the initial results. The first set of samples will be collected after the wells have been completed, developed, and had sampling pumps installed. Depths to water will be measured before the wells are purged.

After 1 yr of quarterly monitoring, background levels for indicator parameters will be determined and compared with indicator parameters from upgradient and downgradient wells semiannually in accordance with 40 CFR 265.93. The data will be analyzed to evaluate whether ground water is being affected by the LERF.

Background summary statistics (mean, variance, and coefficient of variation) will be calculated from four quarters of data from the upgradient well. The actual method that will be used for calculating summary statistics will depend on the distribution of the data and the presence of any data reported as less than the limit of detection. Replicate summary statistics will be calculated each quarter. Background comparison summary statistics will be calculated from the quarterly summary statistics.

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Samples will then continue to be collected and analyzed semiannually from the background wells. The data will be evaluated to determine if trends are present, irregularities exist in the data, or ground water from the wells is affected by the subject facility. If any of these conditions are present, the data will be evaluated in relation to the hydrologic system to determine if the background levels need to be recalculated from a new set of quarterly sample data. The data will also be evaluated to determine whether the wells being used are suitable for that purpose or if different wells are required.

3.6.2 Evaluation of Data

Wells will be sampled at least twice each succeeding year after background concentrations have been established. A minimum of four replicate measurements will be obtained from each well for determining indicator parameters, and the arithmetic mean and variance will be calculated for the indicator parameters for each sample.

The Student's t-test, as presented in the *Technical Enforcement Guidance Document* (EPA 1986), will be used to determine statistically significant changes in the concentration of indicator parameters of downgradient wells as compared to initial background concentrations or values. This comparison will individually consider each of the wells in the monitoring system. For three of the indicator parameters (specific conductance, TOC, TOX), a single-tailed Student's t-test will be used to test at the 0.01 level of significance for significant increases over background. The difference test for pH will be a two-tailed Student's t-test at the overall 0.01 level of significance.

3.6.3 Reporting Requirements

A summary of the reports required for compliance with 40 CFR 265, Subpart F, is given in Table 3-3.

Table 3-3. Reports Required for Compliance with 40 CFR 265, Subpart F, for Ground Water Monitoring.

Submittal	Submittal period
First year of sampling: Concentrations of interim primary drinking water constituents, identifying those that exceed limits listed in Section 3-4.	Quarterly, according to the current schedule.
Concentration and statistical analyses of ground water contamination indicator parameters, noting significant differences in upgradient wells.	Annually, according to the current schedule.
Results of ground water surface elevation evaluation and description of response if appropriate.	Annually, according to the current schedule.

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4.0 GROUND WATER QUALITY ASSESSMENT PROGRAM

Criteria requiring notification to regulatory agencies and initiation of a ground water quality assessment program are described. The notifications for compliance with 40 CFR 265, Subpart F, are presented, and the contents of the ground water quality assessment program are outlined as required in 40 CFR 265.93(a).

Ground water samples from all monitoring wells will be tested quarterly for contamination indicator parameters, interim primary drinking water constituents, secondary ground water quality parameters, and site-specific parameters for the first year of sampling. Background levels of the ground water contamination indicator parameters will be statistically established after the first year of sampling using methods in the Technical Enforcement Guidance Document (EPA 1986). Once the background for the indicator parameters has been established, subsequent samplings from the LERF monitoring network will be statistically compared to the established background values to determine if there is a significant difference. If a difference is found, the wells in question will be immediately resampled. If the results are verified, Ecology will be notified in writing within 7 d of verification. A ground water quality assessment program will then be developed and its plan sent to Ecology within 15 d following the notification. An outline of this plan follows:

- INTRODUCTION
- GROUND WATER QUALITY ASSESSMENT PROGRAM
 - Investigatory Approach
 - Hydrogeology of the Site
 - Description of Background Monitoring Network
 - Existing Data and Evaluation
 - Ground Water Quality Assessment Monitoring System
 - Ground Water Quality Sampling Schedule
 - Water Table Monitoring
 - Sampling and Analytical Methods
 - Quality Assurance
 - * Laboratory, Internal Quality Control
 - * External Quality Control
 - Data Evaluation Procedures
- REFERENCES
- APPENDIX A--Preservation Techniques, Analytical Methods Used, and Current Detection Levels for Constituents Analyzed for in the Project
- APPENDIX B--As-Built Diagrams for Background Monitoring Wells
- APPENDIX C--Monthly Water Table Elevation Maps for the Surrounding Area

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The quality assessment program will include (1) number, location, and depth of wells in monitoring network, (2) sampling and analytical methods used, (3) evaluation procedures, and (4) a schedule of implementation. The quality assessment program will also provide an investigative approach to determine rate and extent of migration of hazardous waste or hazardous constituents in the ground water and their concentrations. As soon as technically feasible, these determinations will be made and a report of the findings sent to Ecology. Table 4-1 provides a schedule for reports and notifications.

Table 4-1. Reports and Notifications.

Submittal	Submittal period
Required whether or not facility might be affecting ground water	
First year of sampling only: Concentrations of interim primary drinking water standards, identifying those that exceed limits listed in Section 3.3.8.	Quarterly.
Concentration and statistical analyses of ground water contamination indicator parameters, noting significant differences in upgradient wells.	Annually, by March 30 of following year.
Results of ground water surface elevation evaluation and description of response if appropriate.	Annually, by March 30 of following year.
Required if facility might be affecting ground water	
Notification to EPA and Ecology that facility might be affecting ground water.	Within 7 d of confirmation of a statistical difference over background.
Submittal of ground water assessment plan to EPA and Ecology.	Within 15 d of the above notification.
Submittal to EPA and Ecology of written report on assessment of ground water quality, including concentrations of hazardous waste constituents and their rate and extent of migration.	Within 15 d of first determination (as soon as technically feasible).
Results of ground water quality assessment program.	Annually, by March of following year

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APPENDIX A

WASTE INFORMATION DATA SYSTEM SUMMARY REPORTS

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Waste Information Data System
General Summary Report
March 14, 1990

SITE NAME: 207-A Retention Basin
ALIAS NAMES: None

SITE TYPE: Retention Basin
WASTE CATEGORY: Hazardous Waste

OPERABLE UNIT: 200-PO-5
REGULATORY AUTHORITY: Undefined

STATUS: Active
SERVICE DATES: From 1977 to the present

COORDINATES: N41220 W46890, N41220 W47105, N40900 W47105, N40900 W46890
LOCATION: 200 East Area, directly east of the 242-A Evaporator.

REFERENCE DRAWINGS: H-2-34761, H-2-69292

SITE AREA:

ELEVATIONS and DEPTHS: Ground: 672.00 feet above MSL
Water Table: 282.00 feet below grade
Site Depth: feet below grade

WASTE VOLUME RECEIVED: liters
CONTAMINATED SOIL VOLUME: cubic meters
OVERBURDEN SOIL VOLUME: cubic meters

SITE DESCRIPTIONS:

Retention basin consisting of six rubber-lined holding basins, each 55 ft long and 10 ft wide at the bottom and 7 ft deep. A 4-in. fill line enters each basin, and a 3-in drain line exits.

WASTE DESCRIPTION:

Since March 1977, the site has been receiving two liquid waste streams from the 242-A Evaporator: (intermittently when evaporator is used)
1) Steam condensate is sent to the three north basins and then goes to 216-A-25 Pond;
2) Process condensate is sent to the three south basins and then goes to 216-A-37-1 Crib.

COMMENTS:

In operation, the basins are alternately filled, sampled, and emptied when meeting specifications. The north basins are discharged into the Gable Mountain Pond pipeline and the south basins are discharged to the 216-A-37 Crib. The facility includes the capability of returning liquid waste for reprocessing or in-tank storage if discharge specifications are not met.

RELEASE POTENTIAL:

The basin is rubber-lined.

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SITE NAME: 207-A Retention Basin

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ASSOCIATED STRUCTURES:

A 4-in. fill line for each basin, ~2 ft long (inside basin structure).
Hypalon liner for 6 basins, ~16,000 sq ft.

SURVEILLANCE INFORMATION

SITE NAME: 207-A Retention Basin

SCHEDULE: Not Applicable

LAST SURVEY DATE:

AREA POSTING: Not Applicable

POSTING TYPE: Unknown

CAVE-IN POTENTIAL:

EXISTING CAVE-INS: None

PERCENTAGE OF VEGETATION COVER:

GRASS:

OTHER:

DEEP ROOTED:

NO COVERAGE: 100%

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Waste Information Data System
General Summary Report
March 14, 1990

SITE NAME: 216-A-37-1
ALIAS NAMES: 216-A-37 Crib

SITE TYPE: Crib
WASTE CATEGORY: Low-Level Waste

OPERABLE UNIT: 200-PO-4
REGULATORY AUTHORITY: Undefined

STATUS: Active
SERVICE DATES: From March 1977 to the present

COORDINATES: N39856 W45816, N40157 W46449 (center line of crib)
LOCATION: 200 East Area, outside of the 200 East Area perimeter fence, 2,000 ft east of the 202-A Building.

REFERENCE DRAWINGS: H-2-62876, H-2-62877

SITE AREA: 7,000.00 square feet

ELEVATIONS and DEPTHS: Ground: 675.00 feet above MSL
Water Table: 278.00 feet below grade
Site Depth: feet below grade

WASTE VOLUME RECEIVED: 315,000,000 liters
CONTAMINATED SOIL VOLUME: 1,800 cubic meters
OVERBURDEN SOIL VOLUME: 3,400 cubic meters

SITE DESCRIPTIONS:

Crib with a 10-in. corrugated, galvanized, perforated pipe located horizontally, 7 ft below grade. Bottom dimensions of the excavation are 700 ft by 10 ft. It is 11 ft deep. The excavation contains 5 ft (5,300 cu ft) of gravel fill, and the site has been backfilled over. The side slope is 1:1.

WASTE DESCRIPTION:

Since 3/77, the site has been receiving process condensate from the 242-A Evaporator.

COMMENTS:

Well #299-E25-19: Beta activity (excluding H-3) shows an increase over the last seven months. Limits have not been exceeded. H-3 showed a decrease from April to October 1985. The November sample was twice as high as the previous month and shows an increase since then. NO3 remains between two and four times the drinking water standards (DWS). Well #299-E25-20 shows that a decreasing trend has been exhibited in the contaminant H-3 since February 1985. NO3 remains between three and five times the DWS. - Groundwater Monitoring Compliance Report for August 1986 (9/19/86).

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SITE NAME: 216-A-37-1

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ENVIRONMENTAL MONITORING:

Radiological surveys of the surface are performed quarterly.

RELEASE POTENTIAL:

This unit is used as a percolation crib.

ASSOCIATED STRUCTURES:

A 4-in. SCH 40 carbon steel vent riser and vent extending from the distribution pipe to 3 ft above grade.

A 3-ft by 3-ft by 1.5-ft concrete block acting as a base for the vent riser.

Two 8-in. diameter gage wells extending from the crib bottom to 3 ft above grade.

Two 2-ft by 2-ft by 1-ft concrete pads supporting the gage wells.

One concrete distribution box, 7 ft 4 in. by 5 ft 4 in.

One membrane barrier, 16,800 sq ft, between gravel and backfill.

SURVEILLANCE INFORMATION

SITE NAME: 216-A-37-1

SCHEDULE: Quarterly

LAST SURVEY DATE: 3/89

AREA POSTING: Underground Radioactive Matl.

POSTING TYPE: Unknown

RESULTS:

No surface contamination detected and no change in activity since the last survey, 1/89.

CORRECTIVE ACTION:

No action required.

CAVE-IN POTENTIAL:

EXISTING CAVE-INS: None

PERCENTAGE OF VEGETATION COVER:

GRASS: 85-90%

OTHER:

DEEP ROOTED: 10-15%

NO COVERAGE:

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3/14/90

Waste Information Data System
Radionuclide Inventory
(In Curies)

Site Name: 216-A-37-1
Operable Unit: 200-PO-4
Flagit:

Bibliography: [306]

H-3:	1580.00000	Sn-113:	.00738	U-233:
C-14:		Sb-125:		U-234:
Na-22:		I-129:	.00394	U-235:
Mn-54:		Cs-134:		Np-237:
Co-58:		Cs-137:	.09590	U-238:
Fe-59:		Ce-141:		Pu-238:
Co-60:		Ce-144:		Pu-239:
Ni-63:		Pm-147:	.06620	Pu-240:
Kr-85:		Eu-152:		Pu-241:
Sr-90:	.05530	Eu-154:		Am-241:
Zr-95:		Eu-155:		Pu-242:
Tc-99:		Th-232:		Am-243:
Ru-106:	.07630	U-233:		Cm-245:

Inventory Total U: 0.00000
Inventory Total Pu: 0.00000

Total Reported Alpha: .00831
Total Reported Beta: .55400
Total Reported Gamma:

These values are decayed through: December 31, 1988

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Historical Waste Analysis Results of 242-A Evaporator
Process Condensate. (sheet 1 of 4)

Parameter	N ^b	NDA ^c	Method ^d	Mean	StdErr ^e	Concentration ^g (ppb)	
						90%CLim ^f	Maximum
Cladding Removal Waste Feed							
Aluminum	5	0	NA ^g	1.14 E+03	9.66 E+01	1.29 E+03	1.47 E+03
Barium	5	4	DL	6.00 E+00	2.13 E-07	6.00 E+00	6.00 E+00
Calcium	5	0	NA	4.97 E+03	1.15 E+03	6.74 E+03	7.88 E+03
Chloride	5	3	DL	6.23 E+02	8.51 E+01	7.54 E+02	9.32 E+02
Magnesium	5	4	DL	5.42 E+01	4.20 E+00	6.06 E+01	7.10 E+01
Mercury	5	0	NA	5.26 E-01	5.87 E-02	6.16 E-01	6.90 E-01
Potassium	5	0	NA	6.03 E+02	3.20 E+01	6.52 E+02	6.74 E+02
Uranium	5	0	NA	3.88 E-01	2.42 E-01	7.59 E-01	1.35 E+00
Zinc	5	4	DL	5.00 E+00	1.51 E-07	5.00 E+00	5.00 E+00
Acetone	5	0	NA	2.10 E+03	2.89 E+02	2.54 E+03	2.57 E+03
Ammonia	5	0	NA	6.41 E+05	1.12 E+05	8.12 E+05	1.00 E+06
Benzyl alcohol	3	0	NA	1.47 E+01	1.76 E+00	1.80 E+01	1.80 E+01
Butanal	4	0	NA	4.42 E+01	1.31 E+01	6.57 E+01	7.60 E+01
1-Butanol (butyl alcohol)	5	0	NA	4.60 E+04	1.90 E+04	7.51 E+04	8.80 E+04
2-Butoxyethanol	5	0	NA	5.52 E+02	1.09 E+02	7.20 E+02	8.40 E+02
Butoxyglycol	5	0	NA	2.77 E+02	6.95 E+01	3.84 E+02	5.40 E+02
3,5-Dimethylpyridine	3	0	NA	2.07 E+01	2.03 E+00	2.45 E+01	2.40 E+01
2-Hexanone (methyl n-butyl ketone)	4	0	NA	9.25 E+00	1.11 E+00	1.11 E+01	1.10 E+01
Methyl ethyl ketone (2-Butanone)	5	0	NA	7.16 E+01	1.04 E+01	8.76 E+01	9.00 E+01
MIBK (hexone)	3	0	NA	4.33 E+00	3.33 E-01	4.96 E+00	5.00 E+00
2-Pentanone (methyl n-propyl ketone)	4	0	NA	8.75 E+00	1.25 E+00	1.08 E+01	1.20 E+01
2-Propanol	1	0	NA	3.90 E+01	NA	NA	3.90 E+01
Tetradecane	4	0	NA	1.92 E+01	3.61 E+00	2.52 E+01	2.60 E+01
Tetrahydrofuran	5	0	NA	1.50 E+01	1.48 E+00	1.73 E+01	1.80 E+01
Tributylphosphate	5	0	NA	3.59 E+03	1.28 E+03	5.55 E+03	6.80 E+03
Tridecane	4	0	NA	1.27 E+01	2.06 E+00	1.61 E+01	1.80 E+01
Unknown	3	0	NA	4.40 E+01	1.30 E+01	6.85 E+01	6.60 E+01
Alpha activity (pCi/L)	2	0	NA	2.15 E-01	6.30 E-02	4.09 E-01	2.78 E-01
Beta activity (pCi/L)	5	0	NA	3.86 E+02	1.88 E+02	6.73 E+02	1.09 E+03
Conductivity (µS)	5	0	NA	3.18 E+02	3.73 E+01	3.75 E+02	4.20 E+02
pH (dimensionless)	5	0	NA	1.05 E+01	5.10 E-02	1.06 E+01	1.07 E+01
Temperature (°C)	2	0	NA	3.33 E+01	3.40 E+00	4.38 E+01	3.67 E+01
TOC	5	0	NA	4.38 E+04	8.91 E+03	5.75 E+04	6.25 E+04
Linking Run Feed							
Aluminum	12	1	LH	5.99 E+02	1.22 E+02	7.65 E+02	1.65 E+03
Barium	12	11	DL	6.00 E+00	1.17 E-07	6.00 E+00	6.00 E+00
Cadmium	12	11	DL	2.25 E+00	2.50 E-01	2.59 E+00	5.00 E+00
Calcium	12	0	NA	2.04 E+03	3.45 E+02	2.51 E+03	4.37 E+03
Chloride	12	10	DL	5.94 E+02	6.50 E+01	6.83 E+02	1.17 E+03
Copper	12	8	LH	1.11 E+01	5.89 E+00	1.92 E+01	7.30 E+01
Fluoride	7	6	DL	2.21 E+01	2.14 E+00	2.52 E+01	3.50 E+01
Iron	12	7	DL	5.46 E+01	1.07 E+01	6.92 E+01	1.56 E+02
Magnesium	12	1	LH	5.17 E+02	3.28 E+02	9.64 E+02	4.03 E+03
Mercury	12	3	LH	2.22 E-01	3.36 E-02	2.68 E-01	4.80 E-01
Nickel	12	9	DL	1.12 E+01	7.26 E-01	1.22 E+01	1.70 E+01
Nitrate	12	8	LH	9.83 E+02	5.10 E+02	1.68 E+03	4.98 E+03
Potassium	12	1	LH	4.07 E+02	1.28 E+02	5.81 E+02	1.71 E+03
Sodium	12	1	LH	2.87 E+03	2.08 E+03	5.71 E+03	2.56 E+04
Sulfate	12	5	LH	2.04 E+03	1.10 E+03	3.54 E+03	1.30 E+04
Sulfide	12	10	DL	6.73 E+03	5.36 E+03	1.40 E+04	6.56 E+04
Uranium	12	2	MR	1.54 E-01	4.33 E-02	2.13 E-01	4.75 E-01

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Historical Waste Analysis Results of 242-A Evaporator
Process Condensate. (sheet 2 of 4)

Parameter	n ^b	MDA ^c	Method ^d	Mean	StdErr ^e	Concentration ^a (ppb)	
						90%CILim ^f	Maximum
Vanadium	12	11	DL	5.00 E+00	1.17 E-07	5.00 E+00	5.00 E+00
Zinc	12	6	LM	7.33 E+00	2.89 E+00	1.13 E+01	3.40 E+01
Acetone	11	0	NA	1.10 E+03	4.29 E+02	1.69 E+03	5.10 E+03
Ammonia	12	0	NA	7.55 E+04	2.25 E+04	1.06 E+05	2.50 E+05
Benzaldehyde	1	0	NA	2.30 E+01	NA	NA	2.30 E+01
Benzyl alcohol	1	0	NA	1.00 E+01	NA	NA	1.00 E+01
Butanal	4	0	NA	1.20 E+02	5.25 E+01	2.06 E+02	2.30 E+02
1-Butanol (butyl alcohol)	10	0	NA	3.99 E+02	1.37 E+02	5.89 E+02	1.13 E+03
Butoxydiglycol	1	0	NA	1.10 E+01	NA	NA	1.10 E+01
2-Butoxyethanol	10	0	NA	4.82 E+02	1.08 E+02	6.33 E+02	9.20 E+02
Butoxyglycol	6	0	NA	8.48 E+01	1.36 E+01	1.05 E+02	1.30 E+02
Dodecane	2	0	NA	4.30 E+01	3.00 E+00	5.22 E+01	4.60 E+01
Ethoxytriethylene glycol	1	0	NA	1.50 E+02	NA	NA	1.50 E+02
Heptadecane	1	0	NA	1.80 E+01	NA	NA	1.80 E+01
Hexadecane	1	0	NA	1.70 E+01	NA	NA	1.70 E+01
Hexanoic acid	1	0	NA	7.00 E+01	NA	NA	7.00 E+01
2-Hexanone (methyl n-butyl ketone)	5	0	NA	1.12 E+01	2.60 E+00	1.52 E+01	2.00 E+01
Methyl ethyl ketone (2-Butanone)	12	5	LM	4.17 E+01	1.21 E+01	5.83 E+01	1.20 E+02
Methoxydiglycol	1	0	NA	2.80 E+01	NA	NA	2.80 E+01
Methoxytriglycol	1	0	NA	3.70 E+02	NA	NA	3.70 E+02
MIBK (hexone) ^g	7	1	DL	1.46 E+01	8.95 E+00	2.75 E+01	6.80 E+01
N-Nitrosodimethylamine	12	11	DL	1.39 E+01	3.92 E+00	1.93 E+01	5.70 E+01
Pentadecane	1	0	NA	2.00 E+01	NA	NA	2.00 E+01
2-Pentanone (methyl n-propyl ketone)	4	0	NA	9.75 E+00	9.46 E-01	1.13 E+01	1.10 E+01
Phenol	12	11	DL	1.19 E+01	1.92 E+00	1.45 E+01	3.30 E+01
2-Propanol	2	0	NA	1.60 E+01	6.00 E+00	3.45 E+01	2.20 E+01
Pyridine	12	11	DL	5.04 E+02	4.17 E+00	5.10 E+02	5.50 E+02
Tetradecane	9	0	NA	1.16 E+02	5.17 E+01	1.88 E+02	4.40 E+02
Tetrahydrofuran	6	0	NA	1.98 E+01	2.94 E+00	2.42 E+01	3.00 E+01
Tributylphosphate	11	0	NA	3.30 E+03	1.81 E+03	5.79 E+03	2.06 E+04
Tridecane	9	0	NA	1.01 E+02	4.51 E+01	1.64 E+02	3.50 E+02
Triglyme	1	0	NA	9.00 E+01	NA	NA	9.00 E+01
Alpha activity (pCi/L)	10	0	LM	7.52 E-01	1.55 E-01	9.69 E-01	1.62 E+00
Beta activity (pCi/L) ^h	12	1	DL	1.29 E+03	4.51 E+02	1.90 E+03	4.34 E+03
Conductivity (uS)	12	0	NA	1.56 E+02	3.44 E+01	2.03 E+02	4.70 E+02
pH (dimensionless)	12	0	NA	9.42 E+00	2.19 E-01	9.72 E+00	1.04 E+01
Temperature (°C)	7	0	NA	2.66 E+01	3.12 E+00	3.11 E+01	3.90 E+01
TOC	12	1	LM	1.76 E+04	5.42 E+03	2.50 E+04	5.61 E+04

Ammonia Scrubber Feed

Aluminum	10	1	LM	9.44 E+02	1.44 E+02	1.15 E+03	1.77 E+03
Arsenic (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Barium	10	8	DL	6.30 E+00	2.13 E-01	6.60 E+00	8.00 E+00
Barium (EP toxic)	2	0	NA	2.31 E+02	5.00 E-01	2.33 E+02	2.32 E+02
Boron	4	3	DL	1.07 E+01	7.50 E-01	1.20 E+01	1.30 E+01
Cadmium (EP toxic)	2	2	NA	<1.00 E+01	0.00 E+00	<1.00 E+01	<1.00 E+01
Calcium	10	0	NA	3.46 E+03	6.91 E+02	4.42 E+03	8.32 E+03
Chloride	10	7	DL	7.00 E+02	1.79 E+02	9.48 E+02	2.30 E+03
Chromium (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Copper	10	9	DL	1.02 E+01	2.00 E-01	1.05 E+01	1.20 E+01
Fluoride ^h	10	4	DL	1.47 E+02	1.03 E+02	2.91 E+02	1.07 E+03
Iron	10	6	LM	2.77 E+01	5.65 E+00	3.55 E+01	6.70 E+01
Lead (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01

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Historical Waste Analysis Results of 242-A Evaporator
Process Condensate. (sheet 3 of 4)

Parameter	n ^b	MDA ^c	Method ^d	Mean	StdErr ^e	Concentration ^a (ppb)	
						90%CILim ^f	Maximum
Magnesium	10	8	DL	1.20 E+02	6.98 E+01	2.17 E+02	7.48 E+02
Manganese	10	9	DL	5.00 E+00	1.01 E-07	5.00 E+00	5.00 E+00
Mercury	10	4	LM	1.79 E-01	5.11 E-02	2.50 E-01	5.60 E-01
Mercury (EP toxic)	2	2	NA	<1.00 E+01	0.00 E+00	<1.00 E+01	<1.00 E+01
Nickel	10	9	DL	1.04 E+01	4.00 E-01	1.10 E+01	1.40 E+01
Potassium	10	0	NA	5.11 E+03	2.02 E+03	7.92 E+03	1.57 E+04
Selenium (EP toxic)	2	2	NA	<5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Silicon	4	0	NA	6.72 E+03	9.11 E+02	8.22 E+03	9.40 E+03
Silver (EP toxic)	2	2	NA	5.00 E+01	0.00 E+00	<5.00 E+01	<5.00 E+01
Sodium	10	0	NA	4.02 E+03	3.25 E+03	8.55 E+03	3.32 E+04
Strontium	10	6	DL	1.85 E+00	1.81 E+01	2.10 E+01	3.00 E+01
Sulfate	10	0	NA	2.01 E+03	2.75 E+02	2.40 E+03	3.90 E+03
Uranium	10	4	NR	5.43 E-01	2.42 E-01	8.80 E-01	2.03 E+00
Vanadium	10	7	DL	5.50 E+00	2.69 E-01	5.87 E+00	7.00 E+00
Zinc	10	5	LM	6.33 E+00	1.49 E+00	8.41 E+00	1.70 E+01
Acetone	9	0	NA	1.03 E+03	1.70 E+02	1.27 E+03	2.16 E+03
Ammonia	10	0	NA	8.20 E+05	1.82 E+05	1.07 E+06	2.19 E+06
Benzyl alcohol ^h	8	4	DL	1.19 E+01	1.09 E+00	1.34 E+01	1.70 E+01
Butanal	3	0	NA	8.67 E+00	2.33 E+00	1.31 E+01	1.30 E+01
1-Butanol (butyl alcohol)	9	0	NA	2.84 E+04	1.29 E+04	4.64 E+04	1.21 E+05
Butoxydiglycol	1	0	NA	2.70 E+01	NA	NA	2.70 E+01
2-Butoxyethanol	8	0	NA	2.89 E+02	7.74 E+01	4.03 E+02	4.90 E+02
Butoxyglycol	6	0	NA	1.88 E+02	4.48 E+01	2.54 E+02	3.60 E+02
Butoxytriethyleneglycol	1	0	NA	3.50 E+01	NA	NA	3.50 E+01
Ethanol	1	0	NA	2.00 E+00	NA	NA	2.00 E+00
2-Hexanone (methyl n-butyl alcohol)	6	3	DL	3.20 E+01	1.31 E+01	5.13 E+01	7.90 E+01
Methyl ethyl ketone (2-Butanone)	10	1	LM	3.38 E+01	7.56 E+00	4.43 E+01	9.30 E+01
2-Methylnonane	2	0	NA	1.55 E+01	1.50 E+00	2.01 E+01	1.70 E+01
2-Propanol	3	0	NA	1.90 E+01	4.51 E+00	2.75 E+01	2.40 E+01
Tetradecane	6	0	NA	1.40 E+01	2.62 E+00	1.79 E+01	2.50 E+01
Tetrahydrofuran	9	0	NA	2.92 E+01	7.85 E+00	4.02 E+01	8.10 E+01
Tributylphosphate	13	2	LM	3.95 E+03	9.39 E+02	5.22 E+03	1.01 E+04
Tridecane	6	0	NA	1.27 E+01	3.57 E+00	1.79 E+01	2.80 E+01
Unknown	9	0	NA	2.88 E+02	1.29 E+02	4.69 E+02	1.13 E+03
Unknown aliphatic HC	1	0	NA	1.20 E+01	NA	NA	1.20 E+01
Alpha activity (pCi/L)	8	6	DL	3.72 E-01	1.05 E-01	5.20 E-01	1.01 E+00
Beta activity (pCi/L)	10	0	NA	4.11 E+03	1.41 E+03	6.07 E+03	1.25 E+04
Conductivity (uS)	10	0	NA	3.19 E+02	4.49 E+01	3.82 E+02	5.90 E+02
pH (dimensionless)	10	0	NA	1.05 E+01	2.31 E-01	1.08 E+01	1.13 E+01
TDS	2	0	NA	2.25 E+04	1.50 E+03	2.71 E+04	2.40 E+04
Temperature (°C)	6	0	NA	2.76 E+01	2.31 E+00	3.10 E+01	3.49 E+01
TDC	10	0	NA	2.70 E+04	6.87 E+03	3.66 E+04	7.85 E+04
<u>Salt well Feed</u>							
Aluminum	4	0	NA	5.93 E+02	2.43 E+01	6.33 E+02	6.42 E+02
Calcium	4	0	NA	3.65 E+02	3.43 E+01	4.21 E+02	4.47 E+02
Mercury	4	0	NA	1.83 E-01	1.97 E-02	2.15 E-01	2.30 E-01
Nickel	4	3	DL	1.07 E+01	7.50 E-01	1.20 E+01	1.30 E+01
Potassium	4	0	NA	4.81 E+03	2.62 E+02	5.24 E+03	5.28 E+03
Sodium	4	0	NA	1.74 E+03	4.27 E+02	2.44 E+03	2.73 E+03
Zinc	4	1	DL	1.55 E+01	9.51 E+00	3.11 E+01	4.40 E+01
Acetone	4	0	NA	8.00 E+02	1.49 E+02	1.04 E+03	1.20 E+03
Ammonia	4	0	NA	7.97 E+04	8.04 E+03	9.29 E+04	8.89 E+04
Benzyl alcohol	1	0	NA	1.10 E+01	NA	NA	1.10 E+01
Butanal	3	0	NA	3.10 E+01	7.23 E+00	4.66 E+01	4.30 E+01

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Historical Waste Analysis Results of 242-A Evaporator
Process Condensate. (sheet 4 of 4)

Parameter	N ^b	MDA ^c	Method ^d	Mean	StdErr ^e	Concentration ^a (ppb)	
						90%CLim ^f	Maximum
1-Butanol (butyl alcohol)	4	0	NA	3.90 E+02	6.43 E+01	4.95 E+02	5.25 E+02
2-Butoxyethanol	4	0	NA	7.17 E+01	1.22 E+01	9.17 E+01	9.80 E+01
Butoxyglycol	4	0	NA	7.02 E+02	4.99 E+01	7.83 E+02	8.06 E+02
Ethoxytriethylene glycol	3	0	NA	8.20 E+01	2.57 E+01	1.30 E+02	1.20 E+02
2-Hexanone (methyl n-butyl ketone)	4	0	NA	6.25 E+00	1.31 E+00	8.40 E+00	1.00 E+01
Methoxydiglycol	1	0	NA	5.20 E+01	NA	NA	5.20 E+01
Methoxytriglycol	1	0	NA	6.50 E+01	NA	NA	6.50 E+01
Methyl ethyl ketone (2-Butanone)	4	0	NA	3.25 E+01	3.84 E+00	3.88 E+01	4.40 E+01
MIBK (hexone)	1	0	NA	8.00 E+00	NA	NA	8.00 E+00
2-Propanol	4	0	NA	2.35 E+01	5.55 E+00	3.26 E+01	3.40 E+01
Tetradecane	4	0	NA	1.38 E+02	6.60 E+01	2.46 E+02	3.20 E+02
Tetrahydrofuran	4	0	NA	1.07 E+02	2.74 E+01	1.52 E+02	1.70 E+02
Tributylphosphate	4	0	NA	3.64 E+03	9.53 E+02	5.21 E+03	6.15 E+03
Tridecane	4	0	NA	1.45 E+02	6.52 E+01	2.52 E+02	3.00 E+02
Unknown	4	0	NA	4.47 E+01	2.46 E+00	4.88 E+01	5.10 E+01
Beta activity (pCi/L)	4	0	NA	1.27 E+03	1.36 E+02	1.50 E+03	1.61 E+03
Conductivity (µS)	4	0	NA	8.32 E+01	2.17 E+00	8.68 E+01	8.70 E+01
pH (dimensionless)	4	0	NA	1.01 E+01	4.75 E-02	1.01 E+01	1.01 E+01
TOC	4	0	NA	2.36 E+04	2.22 E+03	2.72 E+04	2.97 E+04
TOX (as Cl)	4	3	DL	1.15 E+01	7.98 E+00	2.46 E+01	3.50 E+01

- ^a Concentration in ppb (parts per billion) except where noted.
- ^b N - Number of samples analyzed.
- ^c MDA - Number of samples with results below the detection limit.
- ^d Method - Replacement method for results below the detection limit:
DL -- replacement by detection limit
LM -- replacement by lognormal plotting position
MR -- replacement by normal plotting position
- ^e StdErr - Standard error.
- ^f 90%CLim - 90% confidence internal limit. Defined as upper limit of one-tailed 90% confidence interval.
- ^g NA - Not applicable.
- ^h At least one reported measurement is less than the reported detection limit for data set.

(Geary 1990, p. 3-3 to 3-9)

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APPENDIX B

GEOLOGIC AND WELL CONSTRUCTION DIAGRAMS

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WELL CONSTRUCTION AND COMPLETION SUMMARY		
Drilling Method: Cable tool Fluid Used: Water Driller's Name: Rodda Drilling Company: Bach Drilling Date Started: 28Apr48	Sample Method: Hard tool (nom) Additives Used: Not documented WA State Lic Nr: Not documented Company Location: Not documented Date Complete: 25May48	WELL NUMBER: 299-E26-1 TEMPORARY WELL NO: 361-B-11 Location: Hanford Coordinates: N/S <u>44,774</u> E/W <u>48,025</u> State: _____ Coordinates: N <u>449,953</u> E <u>2,247,185</u> Start Card #: Not documented T <u> </u> R <u> </u> S <u> </u> Elevation: _____ Ground surface (ft): 615.5 Estimated
Depth to water: 205.5 ft Jun89 (Ground Surface) GENERALIZED STRATIGRAPHY Driller's Log		Elevation of reference point: [617.25 ft] (top of casing) Height of reference point above ground surface: [1.75 ft] : : Y Depth of surface seal: [ND] Type of surface seal: <u>None documented</u> I.D. of surface casing (if present): [ND] I.D. of riser pipe: [8-in] Type of riser pipe: <u>Carbon steel</u> Diameter of borehole: [9-in nom] Type of filler: <u>Not documented</u> Elevation/depth top of seal: _____ Type of seal: <u>Not documented</u> Depth top of perforations: [217 ft] <u>5 holes/ft</u> Depth bottom of perforations: [227 ft] Depth bottom of casing: [229 ft] Depth bottom of borehole: [248 ft]
0-2: Sandy LOAM 2-15: SAND and GRAVEL 15-30: GRAVEL and BOULDERS 30-40: SAND, GRAVEL and BOULDERS 40-45: SAND 45-60: SAND, GRAVEL and BOULDERS 60-65: SAND and GRAVEL 65-80: SAND, GRAVEL and BOULDERS 80-85: Coarse SAND and GRAVEL 85-95: SAND, GRAVEL and BOULDERS 95-131: SAND and CLAY 131-138: Coarse SAND and fine GRAVEL 138-140: Hard fine SAND 140-145: SAND, GRAVEL and BOULDERS 145-155: SAND 155-165: SAND and GRAVEL 165-175: SAND, GRAVEL and BOULDERS 175-180: SAND and GRAVEL 180-185: GRAVEL and BOULDERS 185-190: Fine SAND 190-195: SAND and GRAVEL 195-201: SAND, GRAVEL and BOULDERS 201-205: SAND and GRAVEL 205-209: SAND 209-210: SAND, GRAVEL and BOULDERS 210-218: SAND 218-225: Coarse SAND and fine GRAVEL 225-231: Red-brown volcanic ASH 231-240: Dark BED ROCK 240-245: Black SAND and fine ground ROCK 245-248: BASALT		
Drawing By: <u>RKL\2#E26-01.ASB</u> Date: <u>02May90</u> Reference: <u>field inspection Report, 07Feb90</u> <u>Golder 8831752\14114</u>		

WELL CONSTRUCTION AND COMPLETION SUMMARY	
<p>Drilling Operator: <u>Circle Well</u> Well No: _____ Field Name: <u>WIC-SD</u> Well No: _____ Name: <u>WIC-SD</u> Drilling Company: <u>Int. Development</u> Service: <u>Drilling</u></p> <p>Depth to water: <u>199 ft above sea level</u> Type of service: _____ Completions: <u>Drilling</u> Stratigrapher: <u>149</u></p> <p>0-16in SAND and SOLENOIDS 16-25: SAND and GRAVEL 25-42: SAND 42-52: SAND and small GRAVEL 52-60: SAND, GRAVEL, with some CLAY 60-65: SAND with some CLAY 65-120: SAND and SILL 120-125: SAND, GRAVEL, and SILL 125-132: SAND 132-142: SOLENOIDS 142-143: SAND and SOLENOIDS 143-144: SAND and SOLENOIDS 144-145: SAND and GRAVEL 145-150: SAND and GRAVEL 150-160: SAND and CLAYED GRAVEL 160-165: SAND, CLAY and GRAVEL 165-180: SAND and SILL 180-185: SOLENOIDS 185-190: SOLENOIDS and SAND 190-195: SOLENOIDS and SAND 195 : BROWN GRAVEL</p>	<p>Service Method: <u>Hand Drill</u> Activities: _____ Log: <u>Not documented</u> Log Scale: _____ Log W/L: <u>Not documented</u> Drilling: _____ Company: <u>Int. Development</u> Service: <u>Drilling</u></p> <p>Well Name: <u>WIC-SD</u> Number: <u>480-45-42</u> Coordinates: <u>N 45.27N</u> <u>E/W</u> <u>N 42.09W</u> State: _____ County: <u>N</u> <u>480.448</u> <u>N</u> <u>2.25E.149</u> Elevation: _____ Elevation: _____ Elevation: _____</p> <p>Elevation of reference point: (572.25 ft) (Top of casing) Height of reference point above ground surface: (0) Depth of surface well: (0) Type of surface well: <u>Not documented</u> I.D. of surface casing: (30) (if present) I.D. of riser pipe: (30) Type of riser pipe: _____ Casing size: _____ Diameter of borehole: (30 in. max) Type of filter: _____ Mud description: _____ Elevation/Depth top of well: _____ Type of seal: <u>Not documented</u> Depth top of perforations: (199 ft) A. Inches: _____</p> <p>Depth bottom of perforations: (199 ft) Depth bottom of casing: (199 ft) Depth bottom of borehole: (199 ft)</p>
<p>NOTE: Remediation works by Huttons. Cemented well to 199 ft and installed cement plug to 199 ft.</p>	
<p>Created by: <u>Int. Development</u> Date: <u>08/07/04</u> Revised by: <u>Int. Development</u> Date: <u>08/07/04</u></p>	

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APPENDIX C

WATER-CHEMISTRY DATA LISTINGS AND SUMMARIES

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This appendix presents all water-chemistry data available from the existing wells in the vicinity of the 200 East Area Liquid Effluent Retention Facility. The results of the analyses of the ground water from these wells are listed in Table C-1. Less than flags indicate levels below detection limits.

Regulatory agency guidelines are based on the following:

- U.S. Environmental Protection Agency (EPA) - maximum contaminant levels given in 40 CFR 141 (July 1987) *National Primary Drinking Water Regulations* as amended by 52 FR 25690.
- EPA - *Proposed Maximum Containment Goals* in 50 FR 46936.
- U.S. Department of Energy (DOE) - DOE derived concentration guides, DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1990).

Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 1 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	3/30/87	Cesium-137	PCI/L		6.20	20.00	200.00	EPA
2-E26-1	3/30/87	Cobalt-60	PCI/L			22.50	100.00	EPA
2-E26-1	3/30/87	Nitrate	PPB	<	500.00	500.00	45000.00	EPA
2-E26-1	3/30/87	Ruthenium-106	PCI/L	<	17.60	172.50	30.00	EPA
2-E26-1	3/30/87	Tritium	PCI/L		10300.00	500.00	20000.00	EPA
2-E26-1	6/16/87	1,1,1-trichloroethane	PPB	<	10.00	5.00	200.00	EPA
2-E26-1	6/16/87	1,1,2-trichloroethane	PPB	<	10.00	5.00		
2-E26-1	6/16/87	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,2-dichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	1,3-dichlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Alkalinity			94200.00	20000.00		
2-E26-1	6/16/87	Aluminum, filtered	PPB	<	150.00	150.00		
2-E26-1	6/16/87	Ammonium ion	PPB	>	63.00	50.00		
2-E26-1	6/16/87	Antimony, filtered	PPB	>	100.00	100.00		
2-E26-1	6/16/87	Arsenic, filtered	PPB	>	5.00	5.00	50.00	EPA
2-E26-1	6/16/87	Barium, filtered	PPB	>	23.00	6.00	1000.00	EPA
2-E26-1	6/16/87	Beryllium, filtered	PPB	>	5.00	5.00		
2-E26-1	6/16/87	Cadmium, filtered	PPB	>	2.00	2.00	10.00	EPA
2-E26-1	6/16/87	Calcium, filtered	PPB	>	29000.00	50.00		
2-E26-1	6/16/87	Carbon Tetrachloride by GC/MS	PPB	>	10.00	5.00	5.00	EPA
2-E26-1	6/16/87	Chloride	PPB	>	6900.00	500.00	250000.00	EPAS
2-E26-1	6/16/87	Chloroform	PPB	>	10.00	5.00	100.00	EPA
2-E26-1	6/16/87	Chromium, filtered	PPB	>	10.00	10.00	50.00	EPA
2-E26-1	6/16/87	Copper, filtered	PPB	>	10.00	10.00	1300.00	EPAP
2-E26-1	6/16/87	Cyanide	PPB	>	10.00	10.00		
2-E26-1	6/16/87	Fluoride	PPB	>	500.00	500.00	4000.00	EPA
2-E26-1	6/16/87	Gross alpha	PCI/L		1.09	4.00	15.00	EPA
2-E26-1	6/16/87	Gross beta	PCI/L		9.14	8.00	50.00	EPA
2-E26-1	6/16/87	Hexachlorobenzene	PPB	>	10.00	10.00		
2-E26-1	6/16/87	Hexachlorophene	PPB	>	10.00	10.00		
2-E26-1	6/16/87	Hydrazine, Low Detection Level	PPB	>	30.00	30.00		
2-E26-1	6/16/87	Iron, filtered	PPB	>	50.00	30.00	300.00	EPAS
2-E26-1	6/16/87	Kerosene	PPB	>	10000.00	10000.00		
2-E26-1	6/16/87	Lead, filtered	PPB	>	5.00	5.00	50.00	EPA
2-E26-1	6/16/87	Magnesium, filtered	PPB	>	8820.00	50.00		
2-E26-1	6/16/87	Manganese, filtered	PPB	>	5.00	5.00	50.00	EPAS
2-E26-1	6/16/87	Mercury, filtered	PPB	>	0.10	0.10	2.00	EPA
2-E26-1	6/16/87	Methyl ethyl ketone	PPB	>	10.00	10.00		
2-E26-1	6/16/87	Methylene Chloride	PPB	>	10.00	5.00		
2-E26-1	6/16/87	Naphthalene	PPB	>	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 2 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	6/16/87	Nickel, filtered	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Nitrate	PPB	<	5090.00	500.00	45000.00	EPA
2-E26-1	6/16/87	Osmium, filtered	PPB	<	300.00	300.00		
2-E26-1	6/16/87	Pentachlorobenzene	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Phenol	PPB	<	10.00	10.00		
2-E26-1	6/16/87	Phosphate	PPB	<	1000.00	1000.00		
2-E26-1	6/16/87	Potassium, filtered	PPB	<	5880.00	100.00		
2-E26-1	6/16/87	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
2-E26-1	6/16/87	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
2-E26-1	6/16/87	Sodium, filtered	PPB	<	9450.00	200.00		
2-E26-1	6/16/87	Strontium, filtered	PPB	<	300.00	10.00		
2-E26-1	6/16/87	Sulfate	PPB	<	29900.00	500.00	250000.00	EPAS
2-E26-1	6/16/87	Tetrachloroethylene	PPB	<	10.00	5.00		
2-E26-1	6/16/87	Total Organic Halogen, Low Det. Level	PPB	<	6.30	10.00		
2-E26-1	6/16/87	Total organic carbon	PPB	<	302.00	2000.00		
2-E26-1	6/16/87	Trichloroethylene	PPB	<	10.00	5.00	5.00	EPA
2-E26-1	6/16/87	Tritium	PCI/L	<	16600.00	500.00	20000.00	EPA
2-E26-1	6/16/87	Vanadium, filtered	PPB	<	11.00	5.00		
2-E26-1	6/16/87	Xylene-m	PPB	<	10.00	5.00	440.00	EPAP
2-E26-1	6/16/87	Xylene-o,p	PPB	<	10.00	5.00	440.00	EPAP
2-E26-1	6/16/87	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
2-E26-1	6/16/87	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
2-E26-1	6/16/87	pH, Laboratory Measurement			7.72	0.01	8.50	EPAS
2-E26-1	8/05/87	Cesium-137	PCI/L	<	3.52	20.00	200.00	EPAR
2-E26-1	8/05/87	Cobalt-60	PCI/L	<	1.02	22.50	100.00	EPAR
2-E26-1	8/05/87	Ruthenium-106	PCI/L	<	2.77	172.50	30.00	EPAR
2-E26-1	8/05/87	Tritium	PCI/L	<	17200.00	500.00	20000.00	EPA
2-E26-1	3/01/88	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	3/01/88	Tritium	PCI/L	<	16700.00	300.00	20000.00	EPA
2-E26-1	8/29/88	Iodine-129 (Drinking Water Standard)	PCI/L	<	0.28	1.00	1.00	EPAR
2-E26-1	8/29/88	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	8/29/88	Tritium	PCI/L	<	15200.00	500.00	20000.00	EPA
2-E26-1	11/07/88	Alkalinity			75100.00	20000.00		
2-E26-1	11/07/88	Ammonium ion	PPB	<	50.00	50.00		
2-E26-1	11/07/88	Chloride	PPB	<	6100.00	500.00	250000.00	EPAS
2-E26-1	11/07/88	Cyanide	PPB	<	10.00	10.00		
2-E26-1	11/07/88	Fluoride	PPB	<	500.00	500.00	4000.00	EPA
2-E26-1	11/07/88	Nitrate	PPB	<	500.00	500.00	45000.00	EPA
2-E26-1	11/07/88	Phosphate	PPB	<	1000.00	1000.00		
2-E26-1	11/07/88	Specific conductance	UMHO		173.00	1.00	700.00	WDOE
2-E26-1	11/07/88	Sulfate	PPB	<	18900.00	500.00	250000.00	EPAS
2-E26-1	11/07/88	Total carbon	PPB	<	16100.00	1000.00		
2-E26-1	11/07/88	Total organic carbon	PPB	<	300.00	2000.00		
2-E26-1	11/07/88	pH, Field Measurement			8.30	0.10	8.50	EPAS
2-E26-1	11/07/88	pH, Laboratory Measurement			8.30	0.01	8.50	EPAS

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 3 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
2-E26-1	6/06/89	Iodine-129 (Drinking Water Standard)	PCI/L		0.40	1.00	1.00	EPAR
2-E26-1	6/06/89	Nitrate, High Detection Level	PPB	<	2500.00	2500.00	45000.00	EPA
2-E26-1	6/06/89	Tritium	PCI/L		12700.00	500.00	20000.00	EPA
6-45-42	2/28/87	Cesium-137	PCI/L	<	3.85	20.00	200.00	EPAR
6-45-42	2/28/87	Cobalt-60	PCI/L	<	2.10	22.50	100.00	EPAR
6-45-42	2/28/87	Nitrate	PPB		7970.00	500.00	45000.00	EPA
6-45-42	2/28/87	Ruthenium-106	PCI/L		72.00	172.50	30.00	EPAR
6-45-42	2/28/87	Tritium	PCI/L		51800.00	500.00	20000.00	EPA
6-45-42	6/11/87	Cesium-137	PCI/L	<	1.13	20.00	200.00	EPAR
6-45-42	6/11/87	Cobalt-60	PCI/L			22.50	100.00	EPAR
6-45-42	6/11/87	Nitrate	PPB		7350.00	500.00	45000.00	EPA
6-45-42	6/11/87	Ruthenium-106	PCI/L		63.40	172.50	30.00	EPAR
6-45-42	6/11/87	Tritium	PCI/L		53000.00	500.00	20000.00	EPA
6-45-42	8/04/87	Cesium-137	PCI/L	<	3.79	20.00	200.00	EPAR
6-45-42	8/04/87	Cobalt-60	PCI/L	<	1.70	22.50	100.00	EPAR
6-45-42	8/04/87	Nitrate, High Detection Level	PPB		6510.00	2500.00	45000.00	EPA
6-45-42	8/04/87	Ruthenium-106	PCI/L	<	3.01	172.50	30.00	EPAR
6-45-42	8/04/87	Tritium	PCI/L		54100.00	500.00	20000.00	EPA
6-45-42	9/15/87	Cesium-137	PCI/L	<	9.83	20.00	200.00	EPAR
6-45-42	9/15/87	Cobalt-60	PCI/L	<	2.10	22.50	100.00	EPAR
6-45-42	9/15/87	Gross alpha	PCI/L		1.71	4.00	15.00	EPA
6-45-42	9/15/87	Gross beta	PCI/L		4.01	8.00	50.00	EPA
6-45-42	9/15/87	Natural uranium	UG/L		1.85	0.73		
6-45-42	9/15/87	Plutonium-238	PCI/L		0.02	17.00	1.60	DOE
6-45-42	9/15/87	Plutonium-239/40	PCI/L	<	0.01	17.00	1.20	DOE
6-45-42	9/15/87	Ruthenium-106	PCI/L	<	72.30	172.50	30.00	EPAR
6-45-42	9/15/87	Strontium-90	PCI/L	<	0.10	5.00	8.00	EPA
6-45-42	9/15/87	Tritium	PCI/L		52600.00	500.00	20000.00	EPA
6-45-42	9/15/87	Uranium-234	PCI/L		1.14	0.10	20.00	DOE
6-45-42	9/15/87	Uranium-235	PCI/L		0.04	0.10	24.00	DOE
6-45-42	9/15/87	Uranium-238	PCI/L		0.86	0.10	24.00	DOE
6-45-42	10/14/87	Cesium-137	PCI/L	<	2.56	20.00	200.00	EPAR
6-45-42	10/14/87	Cobalt-60	PCI/L	<	4.05	22.50	100.00	EPAR
6-45-42	10/14/87	Gross alpha	PCI/L		1.81	4.00	15.00	EPA
6-45-42	10/14/87	Gross beta	PCI/L		4.75	8.00	50.00	EPA
6-45-42	10/14/87	Natural uranium	UG/L		2.54	0.73		
6-45-42	10/14/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/14/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/14/87	Ruthenium-106	PCI/L	<	5.37	172.50	30.00	EPAR
6-45-42	10/14/87	Strontium-90	PCI/L	<	0.27	5.00	8.00	EPA
6-45-42	10/14/87	Tritium	PCI/L		52900.00	500.00	20000.00	EPA
6-45-42	10/14/87	Uranium-234	PCI/L		1.07	0.10	20.00	DOE
6-45-42	10/14/87	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	10/14/87	Uranium-238	PCI/L		0.88	0.10	24.00	DOE
6-45-42	11/15/87	1,1,1,2-tetrachlorethane	PPB	<	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 4 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	1,1,1-trichloroethane	PPB	<	5.00	5.00	200.00	EPA
6-45-42	11/15/87	1,1,2,2-tetrachloroethane	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,1,2-trichloroethane	PPB	<	5.00	5.00		
6-45-42	11/15/87	1,1-dichloroethane	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,1-dichloroethylene	PPB	<	10.00	10.00	7.00	EPA
6-45-42	11/15/87	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	11/15/87	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	11/15/87	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAP
6-45-42	11/15/87	1,2-diphenylhydrazine	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,3-dichloropropene	PPB	<	10.00	5.00		
6-45-42	11/15/87	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	11/15/87	1,4-naphthoquinone	PPB	<	10.00	10.00		
6-45-42	11/15/87	1-chloro-2,3-epoxypropane	PPB	<	10.00	10.00		EPAP
6-45-42	11/15/87	1-naphthylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,3,4,6-tetrachlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4,5-trichlorophenol	PPB	<	50.00	10.00		
6-45-42	11/15/87	2,4,6-trichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dimethylphenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,4-dinitrophenol	PPB	<	50.00	10.00		
6-45-42	11/15/87	2,4-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,6-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2,6-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-acetylaminofluorene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	11/15/87	2-chloronaphthalene	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-chlorophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-cyclohexyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methyl-2-(methylthio) propionaldehyde	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methylaziridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-methylacetonitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-naphthylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-picoline	PPB	<	10.00	10.00		
6-45-42	11/15/87	2-sec-butyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	3,3'-dichlorobenzidine	PPB	>	20.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 5 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	3,3'-dimethoxybenzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	3,3'-dimethylbenzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	3-methylcholanthrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	4,4'-methylenebis(2-chloroaniline)	PPB	<	10.00	10.00		
6-45-42	11/15/87	4,6-dinitro-o-cresol and salts	PPB	<	10.00	10.00		
6-45-42	11/15/87	4-aminobiphenyl	PPB	<	10.00	10.00		
6-45-42	11/15/87	4-bromophenyl phenyl ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	5-(aminomethyl)-3-isoxazolol	PPB	<	10.00	10.00		
6-45-42	11/15/87	5-nitro-o-toluidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	7,12-dimethylbenz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	11/15/87	7H-dibenzo[c,g]carbazole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	11/15/87	Acetophenone	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acrolein	PPB	<	10.00	10.00		
6-45-42	11/15/87	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	11/15/87	Alkalinity			103000.00	20000.00		
6-45-42	11/15/87	Alpha, alpha-dimethylphenethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Aluminum	PPB	<	150.00	150.00		
6-45-42	11/15/87	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	11/15/87	Amitrole	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ammonium ion	PPB	<	50.00	50.00		
6-45-42	11/15/87	Aniline	PPB	<	10.00	10.00		
6-45-42	11/15/87	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	11/15/87	Aranite	PPB	<	10.00	10.00		
6-45-42	11/15/87	Arsenic	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Arsenic, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Auramine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Barium	PPB	<	38.00	6.00	1000.00	EPA
6-45-42	11/15/87	Barium, filtered	PPB	<	38.00	6.00	1000.00	EPA
6-45-42	11/15/87	Benz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benz[a]acridine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Benzene, dichloromethyl	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzenethiol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[a]pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[b]fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzo[j]fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Benzyl chloride	PPB	<	10.00	10.00		
6-45-42	11/15/87	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	11/15/87	Bis(2-chloroethoxy) methane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-chloroethyl) ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-chloroisopropyl) ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(2-ethylhexyl) phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Bis(chloromethyl) ether	PPB	<	10.00	5.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 6 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Bromoacetone	PPB	<	10.00	5.00		
6-45-42	11/15/87	Bromoform	PPB	<	10.00	5.00	100.00	EPA
6-45-42	11/15/87	Butyl benzyl phthalate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cadmium	PPB	<	2.00	2.00	10.00	EPA
6-45-42	11/15/87	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	11/15/87	Calcium	PPB	<	25200.00	50.00		
6-45-42	11/15/87	Calcium, filtered	PPB	<	20600.00	50.00		
6-45-42	11/15/87	Carbon Tetrachloride by GC/MS	PPB	<	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Carbon disulfide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cesium-137	PCI/L	<	7.28	20.00	200.00	EPAR
6-45-42	11/15/87	Chloride	PPB	<	5960.00	500.00	25000.00	EPAS
6-45-42	11/15/87	Chloronaphazine	PPB	>	10.00	10.00		
6-45-42	11/15/87	Chloroalkyl ethers	PPB	>	10.00	10.00		
6-45-42	11/15/87	Chlorobenzene	PPB	<	10.00	5.00	60.00	EPAP
6-45-42	11/15/87	Chloroform	PPB	<	5.00	5.00	100.00	EPA
6-45-42	11/15/87	Chloromethyl methyl ether	PPB	<	10.00	10.00		
6-45-42	11/15/87	Chromium	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Chrysene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Cobalt-60	PCI/L	<	20.30	22.50	100.00	EPAR
6-45-42	11/15/87	Copper	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	11/15/87	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	11/15/87	Cresols	PPB	>	10.00	10.00		
6-45-42	11/15/87	Crotonaldehyde	PPB	>	10.00	10.00		
6-45-42	11/15/87	Cyanide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Di-n-butyl phthalate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Di-n-octyl phthalate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Di-n-propylnitrosamine	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenz[a, h]acridine	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenz[a, h]anthracene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenz[a, j]acridine	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a, e]pyrene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a, h]pyrene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibenzo[a, i]pyrene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dibromomethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Dichlorodifluoromethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Diethyl phthalate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Diethylarsine	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dihydroxofrole	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dimethyl phthalate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dinitrobenzene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Dioxane	PPB	<	500.00	500.00		
6-45-42	11/15/87	Diphenylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ethyl methacrylate	PPB	<	10.00	10.00		
6-45-42	11/15/87	Ethyl methanesulfonate	PPB	<	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 7 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	11/15/87	Ethyleneimine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Fluoranthene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Fluoride	PPB		634.00	500.00	4000.00	EPA
6-45-42	11/15/87	Fluoride, Low Detection Level	PPB		595.00	20.00	4000.00	EPA
6-45-42	11/15/87	Formalin	PPB	<	500.00	500.00		
6-45-42	11/15/87	Gross alpha	PCI/L		1.89	4.00	15.00	EPA
6-45-42	11/15/87	Gross alpha	PCI/L		2.09	4.00	15.00	EPA
6-45-42	11/15/87	Gross beta	PCI/L		2.95	8.00	50.00	EPA
6-45-42	11/15/87	Gross beta	PCI/L		8.07	8.00	50.00	EPA
6-45-42	11/15/87	Hexachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorobutadiene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorocyclopentadiene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachloroethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachlorophene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hexachloropropene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Hydrogen sulfide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Indeno(1,2,3-cd)pyrene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Iodomethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Iron	PPB		886.00	30.00	300.00	EPAS
6-45-42	11/15/87	Iron, filtered	PPB	>	30.00	30.00	300.00	EPAS
6-45-42	11/15/87	Isosafrole	PPB	>	10.00	10.00		
6-45-42	11/15/87	Kerosene	PPB	>	10000.00	10000.00		
6-45-42	11/15/87	Lead (graphite furnace)	PPB	>	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Lead, filtered	PPB	>	5.00	5.00	50.00	EPA
6-45-42	11/15/87	Magnesium	PPB		10400.00	50.00		
6-45-42	11/15/87	Magnesium, filtered	PPB		10200.00	50.00		
6-45-42	11/15/87	Maleic hydrazide	PPB	>	500.00	500.00		
6-45-42	11/15/87	Malononitrile	PPB	>	10.00	10.00		
6-45-42	11/15/87	Manganese	PPB		12.00	5.00	50.00	EPAS
6-45-42	11/15/87	Manganese, filtered	PPB		6.00	5.00	50.00	EPAS
6-45-42	11/15/87	Melphalan	PPB	>	10.00	10.00		
6-45-42	11/15/87	Mercury	PPB	>	0.10	0.10	2.00	EPA
6-45-42	11/15/87	Mercury, filtered	PPB	>	0.10	0.10	2.00	EPA
6-45-42	11/15/87	Methacrylonitrile	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methanethiol	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methapyrene	PPB	>	10.00	10.00		
6-45-42	11/15/87	Metholonyl	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl Isobutyl Ketone	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl bromide	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl chloride	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl ethyl ketone	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl methacrylate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methyl methanesulfonate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Methylene Chloride	PPB	>	10.00	5.00		

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WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Methylthiouracil	PPB	<	10.00	10.00		
6-45-42	11/15/87	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitroso-N-methylurethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodi-n-butylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodiethanolamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodimethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosodimethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomethylethylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomethylvinylamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosomorpholine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrososarcosine	PPB	<	10.00	10.00		
6-45-42	11/15/87	N-nitrosopiperidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Naphthalene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Natural uranium	UG/L	<	1.98	0.73		
6-45-42	11/15/87	Nickel	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nicotinic acid	PPB	<	100.00	100.00		
6-45-42	11/15/87	Nitrate	PPB	<	7470.00	500.00	45000.00	EPA
6-45-42	11/15/87	Nitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Nitrosopyrrolidine	PPB	<	10.00	10.00		
6-45-42	11/15/87	O,O,O-triethyl phosphorothioate	PPB	<	10.00	10.00		
6-45-42	11/15/87	O-toluidine hydrochloride	PPB	<	10.00	10.00		
6-45-42	11/15/87	p-benzoquinone	PPB	<	10.00	10.00		
6-45-42	11/15/87	p-chloro-m-cresol	PPB	<	10.00	10.00		
6-45-42	11/15/87	p-chloroaniline	PPB	<	10.00	10.00		
6-45-42	11/15/87	p-dimethylaminoazobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	p-nitroaniline	PPB	<	50.00	10.00		
6-45-42	11/15/87	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachloronitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pentachlorophenol	PPB	<	50.00	50.00	220.00	EPAP
6-45-42	11/15/87	Phenacetin	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phenol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phenylenediamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Phosphate	PPB	>	1000.00	1000.00		
6-45-42	11/15/87	Phthalic acid esters	PPB	>	10.00	10.00		
6-45-42	11/15/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	11/15/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	11/15/87	Potassium	PPB	<	4590.00	100.00		
6-45-42	11/15/87	Potassium, filtered	PPB	<	4390.00	100.00		
6-45-42	11/15/87	Propanide	PPB	<	10.00	10.00		
6-45-42	11/15/87	Pyridine	PPB	<	500.00	500.00		
6-45-42	11/15/87	Radium	PPB	<	0.02	1.00	5.00	EPA
6-45-42	11/15/87	Raserpine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Resorcinol	PPB	>	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 9 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	11/15/87	Ruthenium-106	PCI/L	<	19.40	172.50	30.00	EPAR
6-45-42	11/15/87	Safrol	PPB	<	10.00	10.00		
6-45-42	11/15/87	Selenium	PPB	<	5.00	5.00	10.00	EPA
6-45-42	11/15/87	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
6-45-42	11/15/87	Silver	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	11/15/87	Sodium	PPB		19300.00	200.00		
6-45-42	11/15/87	Sodium, filtered	PPB		18500.00	200.00		
6-45-42	11/15/87	Specific conductance	UMHO		229.00	1.00	700.00	WDOE
6-45-42	11/15/87	Strontium, filtered	PPB		193.00	10.00		
6-45-42	11/15/87	Strontium-90	PCI/L	<	0.19	5.00	8.00	EPA
6-45-42	11/15/87	Strychnine	PPB	<	50.00	50.00		
6-45-42	11/15/87	Sulfate	PPB		34800.00	500.00	250000.00	EPAS
6-45-42	11/15/87	Sym-trinitrobenzene	PPB	<	10.00	10.00		
6-45-42	11/15/87	Tetrachloroethylene	PPB	<	5.00	5.00		
6-45-42	11/15/87	Thiofanox	PPB	<	10.00	10.00		
6-45-42	11/15/87	Thiuram	PPB	<	10.00	10.00		
6-45-42	11/15/87	Toluene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	11/15/87	Toluenediamine	PPB	<	10.00	10.00		
6-45-42	11/15/87	Total Organic Halogen, Low Det. Level	PPB	<	6.10	10.00		
6-45-42	11/15/87	Total carbon	PPB		21800.00	1000.00		
6-45-42	11/15/87	Total organic carbon	PPB	>	355.00	2000.00		
6-45-42	11/15/87	Trans-1,2-dichloroethene	PPB	>	10.00	5.00	70.00	EPAP
6-45-42	11/15/87	Tributylphosphoric Acid	PPB	>	10.00	10.00		
6-45-42	11/15/87	Trichloroethylene	PPB	>	5.00	5.00	5.00	EPA
6-45-42	11/15/87	Trichloromethanethiol	PPB	>	10.00	10.00		
6-45-42	11/15/87	Trichloromonofluoromethane	PPB	>	10.00	10.00		
6-45-42	11/15/87	Trichloropropane	PPB	>	10.00	10.00		
6-45-42	11/15/87	Tris(2,3-dibromopropyl) phosphate	PPB	>	10.00	10.00		
6-45-42	11/15/87	Tritium	PCI/L		51100.00	500.00	20000.00	EPA
6-45-42	11/15/87	Uranium-234	PCI/L		1.24	0.10	20.00	DOE
6-45-42	11/15/87	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	11/15/87	Uranium-238	PCI/L		0.99	0.10	24.00	DOE
6-45-42	11/15/87	Vanadium	PPB		31.00	5.00		
6-45-42	11/15/87	Vanadium, filtered	PPB		32.00	5.00		
6-45-42	11/15/87	Vinyl chloride	PPB	>	10.00	10.00	2.00	EPA
6-45-42	11/15/87	Warfarin	PPB	>	10.00	10.00		
6-45-42	11/15/87	Xylene-m	PPB	>	5.00	5.00	440.00	EPAP
6-45-42	11/15/87	Xylene-o,p	PPB	>	5.00	5.00	440.00	EPAP
6-45-42	11/15/87	Zinc	PPB		8.00	5.00	5000.00	EPAS
6-45-42	11/15/87	Zinc, filtered	PPB		7.00	5.00	5000.00	EPAS
6-45-42	11/15/87	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	11/15/87	p-Nitrophenol	PPB	>	50.00	10.00		
6-45-42	11/15/87	pH, Field Measurement			7.60	0.10	8.50	EPAS
6-45-42	11/15/87	pH, Laboratory Measurement			8.00	0.01	8.50	EPAS

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WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	12/03/87	Cesium-137	PCI/L	<	5.64	20.00	200.00	EPAR
6-45-42	12/03/87	Cobalt-60	PCI/L	<		22.50	100.00	EPAR
6-45-42	12/03/87	Gross alpha	PCI/L	<	1.67	4.00	15.00	EPA
6-45-42	12/03/87	Gross beta	PCI/L	<	4.07	8.00	50.00	EPA
6-45-42	12/03/87	Natural uranium	UG/L	<	2.48	0.73		
6-45-42	12/03/87	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	12/03/87	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	12/03/87	Ruthenium-106	PCI/L	<	62.90	172.50	30.00	EPAR
6-45-42	12/03/87	Strontium-90	PCI/L	<	0.22	5.00	8.00	EPA
6-45-42	12/03/87	Tritium	PCI/L	<	51200.00	500.00	20000.00	EPA
6-45-42	12/03/87	Uranium-234	PCI/L	<	1.02	0.10	20.00	DOE
6-45-42	12/03/87	Uranium-235	PCI/L	<	0.03	0.10	24.00	DOE
6-45-42	12/03/87	Uranium-238	PCI/L	<	0.80	0.10	24.00	DOE
6-45-42	1/08/88	1,1,1,2-tetrachloroethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,1,1-trichloroethane	PPB	<	5.00	5.00	200.00	EPA
6-45-42	1/08/88	1,1,2,2-tetrachloroethane	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,1,2-trichloroethane	PPB	<	5.00	5.00		
6-45-42	1/08/88	1,1-dichloroethane	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,1-dichloroethylene	PPB	<	10.00	10.00	7.00	EPA
6-45-42	1/08/88	1,2,3,4-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	1/08/88	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	1/08/88	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAR
6-45-42	1/08/88	1,2-diphenylhydrazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,3-dichloropropane	PPB	<	10.00	5.00		
6-45-42	1/08/88	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	1/08/88	1,4-naphthoquinone	PPB	<	10.00	10.00		
6-45-42	1/08/88	1-chloro-2,3-epoxypropane	PPB	<	10.00	10.00		EPAP
6-45-42	1/08/88	1-naphthylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,3,4,6-tetrachlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4,5-trichlorophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	2,4,6-trichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dimethylphenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,4-dinitrophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	2,4-dinitrotoluene	PPB	<	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 11 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	2,6-dichlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2,6-dinitrotoluene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-acetylaminofluorene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	1/08/88	2-chloronaphthalene	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-chlorophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-cyclohexyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methyl-2-(methylthio) propionaldehyde	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methylaziridine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-methylactonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-naphthylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-picoline	PPB	<	10.00	10.00		
6-45-42	1/08/88	2-sec-butyl-4,6-dinitrophenol	PPB	<	10.00	10.00		
6-45-42	1/08/88	3,3'-dichlorobenzidine	PPB	<	20.00	10.00		
6-45-42	1/08/88	3,3'-dimethoxybenzidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	3,3'-dimethylbenzidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	3-methylcholanthrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	4,4'-methylenebis(2-chloroaniline)	PPB	<	10.00	10.00		
6-45-42	1/08/88	4,6-dinitro-o-cresol and salts	PPB	<	10.00	10.00		
6-45-42	1/08/88	4-aminobiphenyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	4-bromophenyl phenyl ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	5-(aminomethyl)-3-isoxazolol	PPB	<	10.00	10.00		
6-45-42	1/08/88	5-nitro-o-toluidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	7,12-dimethylbenz[a]anthracene	PPB	<	10.00	10.00		
6-45-42	1/08/88	7H-dibenzo[c,g]carbazole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	1/08/88	Acetophenone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acrolein	PPB	<	10.00	10.00		
6-45-42	1/08/88	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	Alkalinity		>	101000.00	20000.00		
6-45-42	1/08/88	Alpha, alpha-dimethylphenethylamine	PPB	>	10.00	10.00		
6-45-42	1/08/88	Aluminum	PPB	>	150.00	150.00		
6-45-42	1/08/88	Aluminum, filtered	PPB	>	150.00	150.00		
6-45-42	1/08/88	Amitrole	PPB	>	10.00	10.00		
6-45-42	1/08/88	Ammonium Ion	PPB	>	50.00	50.00		
6-45-42	1/08/88	Aniline	PPB	>	10.00	10.00		
6-45-42	1/08/88	Antimony, filtered	PPB	>	100.00	100.00		
6-45-42	1/08/88	Aramite	PPB	>	10.00	10.00		
6-45-42	1/08/88	Arsenic	PPB	>	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Arsenic, filtered	PPB	>	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Auxamine	PPB	>	10.00	10.00		
6-45-42	1/08/88	Barium	PPB	>	32.00	6.00	1000.00	EPA
6-45-42	1/08/88	Barium, filtered	PPB	>	34.00	6.00	1000.00	EPA
6-45-42	1/08/88	Benz[a]anthracene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Benz[c]acridine	PPB	>	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 12 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Benzene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Benzene, dichloromethyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzenethiol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benidina	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[a]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[b]fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzo[j]fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Benzyl chloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	1/08/88	Bis(2-chloroethoxy) methane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-chloroethyl) ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-chloroisopropyl) ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(2-ethylhexyl) phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Bis(chloromethyl) ether	PPB	<	10.00	5.00		
6-45-42	1/08/88	Bromoacetone	PPB	<	10.00	5.00		
6-45-42	1/08/88	Bromoform	PPB	<	10.00	5.00	100.00	EPA
6-45-42	1/08/88	Butyl benzyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cadmium	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/08/88	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/08/88	Calcium	PPB	<	24200.00	50.00		
6-45-42	1/08/88	Calcium, filtered	PPB	<	26300.00	50.00		
6-45-42	1/08/88	Carbon Tetrachloride by GC/MS	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Carbon disulfide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cesium-137	PCI/L	<	5.22	20.00	200.00	EPAR
6-45-42	1/08/88	Chloride	PPB	<	5670.00	500.00	250000.00	EPAS
6-45-42	1/08/88	Chloronaphazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chloroalkyl ethers	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chlorobenzene	PPB	<	10.00	5.00	60.00	EPAP
6-45-42	1/08/88	Chloroform	PPB	<	5.00	5.00	100.00	EPA
6-45-42	1/08/88	Chloromethyl methyl ether	PPB	<	10.00	10.00		
6-45-42	1/08/88	Chromium	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Chrysene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cobalt-60	PCI/L	<	4.34	22.50	100.00	EPAR
6-45-42	1/08/88	Copper	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	1/08/88	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	1/08/88	Cresols	PPB	<	10.00	10.00		
6-45-42	1/08/88	Crotonaldehyde	PPB	<	10.00	10.00		
6-45-42	1/08/88	Cyanide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-butyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-octyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Di-n-propylnitrosamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a, h]acridine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a, h]anthracene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenz[a, j]acridine	PPB	<	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 13 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Dibenzo[a, a]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenzo[a, h]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibenzo[a, i]pyrene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dibromomethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dichlorodifluoromethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Diethyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Diethylarsine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dihydroxofrole	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dimethyl phthalate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dinitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Dioxane	PPB	<	500.00	500.00		
6-45-42	1/08/88	Diphenylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethyl methacrylate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethyl methanesulfonate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	1/08/88	Ethyleneimine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Fluoranthene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Fluoride	PPB	<	667.00	500.00	4000.00	EPA
6-45-42	1/08/88	Formalin	PPB	>	500.00	500.00		
6-45-42	1/08/88	Gross alpha	PCI/L	<	1.85	4.00	15.00	EPA
6-45-42	1/08/88	Gross beta	PCI/L	<	3.19	8.00	50.00	EPA
6-45-42	1/08/88	Hexachlorobenzene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hexachlorobutadiene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hexachlorocyclopentadiene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hexachloroethane	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hexachlorophane	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hexachloropropene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Hydrogen sulfide	PPB	>	10.00	10.00		
6-45-42	1/08/88	Indeno(1,2,3-cd)pyrene	PPB	>	10.00	10.00		
6-45-42	1/08/88	Iodomethane	PPB	>	10.00	10.00		
6-45-42	1/08/88	Iron	PPB	>	428.00	30.00	300.00	EPAS
6-45-42	1/08/88	Iron, filtered	PPB	>	60.00	30.00	300.00	EPAS
6-45-42	1/08/88	Isonafrole	PPB	>	10.00	10.00		
6-45-42	1/08/88	Kerosene	PPB	>	10000.00	10000.00		
6-45-42	1/08/88	Lead (graphite furnace)	PPB	>	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Lead, filtered	PPB	>	5.00	5.00	50.00	EPA
6-45-42	1/08/88	Magnesium	PPB	>	10100.00	50.00		
6-45-42	1/08/88	Magnesium, filtered	PPB	>	10500.00	50.00		
6-45-42	1/08/88	Maleic hydrazide	PPB	>	500.00	500.00		
6-45-42	1/08/88	Malononitrile	PPB	>	10.00	10.00		
6-45-42	1/08/88	Manganese	PPB	>	5.00	5.00	50.00	EPAS
6-45-42	1/08/88	Manganese, filtered	PPB	>	10.00	5.00	50.00	EPAS
6-45-42	1/08/88	Melphalan	PPB	>	10.00	10.00		
6-45-42	1/08/88	Mercury	PPB	>	0.10	0.10	2.00	EPA
6-45-42	1/08/88	Mercury, filtered	PPB	>	0.10	0.10	2.00	EPA

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 14 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Methacrylonitrile	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methanethiol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methapyrilene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Metholonyl	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl isobutyl ketone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl bromide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl chloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl ethyl ketone	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl methacrylate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methyl methanesulfonate	PPB	<	10.00	10.00		
6-45-42	1/08/88	Methylene Chloride	PPB	<	10.00	5.00		
6-45-42	1/08/88	Methylthiouracil	PPB	<	10.00	10.00		
6-45-42	1/08/88	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitroso-N-methylurethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodi-n-butylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodiethanolamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodiethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosodimethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomethylethylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomethylvinylamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosomorpholine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosornicotine	PPB	<	10.00	10.00		
6-45-42	1/08/88	N-nitrosopiperidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Naphthalene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Natural uranium	UG/L	<	2.17	0.73		
6-45-42	1/08/88	Nickel	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nicotinic acid	PPB	<	100.00	100.00		
6-45-42	1/08/88	Nitrate	PPB	<	8860.00	500.00	45000.00	EPA
6-45-42	1/08/88	Nitrate, High Detection Level	PPB	<	6910.00	2500.00	45000.00	EPA
6-45-42	1/08/88	Nitrobenzine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Nitrosopyrrolidine	PPB	<	10.00	10.00		
6-45-42	1/08/88	O,O,O-triethyl phosphorothioate	PPB	<	10.00	10.00		
6-45-42	1/08/88	O-toluidine hydrochloride	PPB	<	10.00	10.00		
6-45-42	1/08/88	P benzoquinone	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-chloro-m-cresol	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-chloroaniline	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-dimethylaminoazobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	P-nitroaniline	PPB	<	50.00	10.00		
6-45-42	1/08/88	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachloronitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pentachlorophenol	PPB	<	50.00	50.00	220.00	EPAP
6-45-42	1/08/88	Phenacetin	PPB	<	10.00	10.00		
6-45-42	1/08/88	Phenol	PPB	<	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 15 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Phenylenediamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	1/08/88	Phthalic acid esters	PPB	<	10.00	10.00		
6-45-42	1/08/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	1/08/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	1/08/88	Potassium	PPB	<	4420.00	100.00		
6-45-42	1/08/88	Potassium, filtered	PPB	<	4320.00	100.00		
6-45-42	1/08/88	Pronamide	PPB	<	10.00	10.00		
6-45-42	1/08/88	Pyridine	PPB	<	500.00	500.00		
6-45-42	1/08/88	Radium	PCI/L	<	0.04	1.00	5.00	EPA
6-45-42	1/08/88	Reserpine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Resorcinol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Ruthenium-106	PCI/L	<	56.60	172.50	30.00	EPAR
6-45-42	1/08/88	Safrol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Selenium	PPB	<	5.00	5.00	10.00	EPA
6-45-42	1/08/88	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
6-45-42	1/08/88	Silver	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/08/88	Sodium	PPB	<	18000.00	200.00		
6-45-42	1/08/88	Sodium, filtered	PPB	<	18400.00	200.00		
6-45-42	1/08/88	Specific conductance	UMHO	<	219.00	1.00	700.00	WDOE
6-45-42	1/08/88	Strontium, filtered	PPB	<	192.00	10.00		
6-45-42	1/08/88	Strontium-90	PCI/L	<	0.02	5.00	8.00	EPA
6-45-42	1/08/88	Strychnine	PPB	<	50.00	50.00		
6-45-42	1/08/88	Sulfate	PPB	<	35200.00	500.00	25000.00	EPAS
6-45-42	1/08/88	Sym-trinitrobenzene	PPB	<	10.00	10.00		
6-45-42	1/08/88	Tetrachloroethylene	PPB	<	5.00	5.00		
6-45-42	1/08/88	Thiofanox	PPB	<	10.00	10.00		
6-45-42	1/08/88	Thiuram	PPB	<	10.00	10.00		
6-45-42	1/08/88	Toluene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	1/08/88	Toluenediamine	PPB	<	10.00	10.00		
6-45-42	1/08/88	Total Organic Halogen, Low Det. Level	PPB	>	1.10	10.00		
6-45-42	1/08/88	Total carbon	PPB	<	22600.00	1000.00		
6-45-42	1/08/88	Total organic carbon	PPB	<	368.00	2000.00		
6-45-42	1/08/88	Trans-1,2-dichloroethene	PPB	<	10.00	5.00	70.00	EPAP
6-45-42	1/08/88	Tributylphosphoric Acid	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloroethylene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	1/08/88	Trichloromethanethiol	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloromonofluoromethane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Trichloropropane	PPB	<	10.00	10.00		
6-45-42	1/08/88	Tris (2,3-dibromopropyl) phosphate	PPB	>	10.00	10.00		
6-45-42	1/08/88	Tritium	PCI/L	<	52300.00	500.00	20000.00	EPA
6-45-42	1/08/88	Uranium-234	PCI/L	<	1.11	0.10	20.00	DOE
6-45-42	1/08/88	Uranium-235	PCI/L	<	0.04	0.10	24.00	DOE
6-45-42	1/08/88	Uranium-238	PCI/L	<	0.86	0.10	24.00	DOE

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 16 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/08/88	Vanadium	PPB		28.00	5.00		
6-45-42	1/08/88	Vanadium, Filtered	PPB		30.00	5.00		
6-45-42	1/08/88	Vinyl chloride	PPB	<	10.00	10.00	2.00	EPA
6-45-42	1/08/88	Warfarin	PPB	<	10.00	10.00		
6-45-42	1/08/88	Xylene-m	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	1/08/88	Xylene-o,p	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	1/08/88	Zinc	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	1/08/88	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	1/08/88	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	1/08/88	p-Nitrophenol	PPB	<	50.00	10.00		
6-45-42	1/08/88	pH, Field Measurement			7.50	0.10	8.50	EPAS
6-45-42	1/08/88	pH, Laboratory Measurement			7.74	0.01	8.50	EPAS
6-45-42	2/04/88	Cesium-137	PCI/L	<	3.18	20.00	200.00	EPAR
6-45-42	2/04/88	Cobalt-60	PCI/L	<	3.60	22.50	100.00	EPAR
6-45-42	2/04/88	Gross alpha	PCI/L		1.55	4.00	15.00	EPA
6-45-42	2/04/88	Gross beta	PCI/L		4.22	8.00	50.00	EPA
6-45-42	2/04/88	Natural uranium	UG/L		2.32	0.73		
6-45-42	2/04/88	Nitrate, High Detection Level	PPB		6140.00	2500.00	45000.00	EPA
6-45-42	2/04/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	2/04/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	2/04/88	Ruthenium-106	PCI/L	<	27.10	172.50	30.00	EPAR
6-45-42	2/04/88	Strontium-90	PCI/L	<	0.14	5.00	8.00	EPA
6-45-42	2/04/88	Tritium	PCI/L		50100.00	500.00	20000.00	EPA
6-45-42	2/04/88	Uranium-234	PCI/L		1.16	0.10	20.00	DOE
6-45-42	2/04/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	2/04/88	Uranium-238	PCI/L		0.87	0.10	24.00	DOE
6-45-42	3/17/88	Cesium-137	PCI/L	>	1.38	20.00	200.00	EPAR
6-45-42	3/17/88	Cobalt-60	PCI/L	>	2.02	22.50	100.00	EPAR
6-45-42	3/17/88	Gross alpha	PCI/L		1.87	4.00	15.00	EPA
6-45-42	3/17/88	Gross beta	PCI/L		4.78	8.00	50.00	EPA
6-45-42	3/17/88	Natural uranium	UG/L		1.92	0.73		
6-45-42	3/17/88	Nitrate, High Detection Level	PPB		5210.00	2500.00	45000.00	EPA
6-45-42	3/17/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	3/17/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	3/17/88	Ruthenium-106	PCI/L	<	13.30	172.50	30.00	EPAR
6-45-42	3/17/88	Strontium-90	PCI/L	<	0.17	5.00	8.00	EPA
6-45-42	3/17/88	Tritium	PCI/L		49700.00	500.00	20000.00	EPA
6-45-42	3/17/88	Uranium-234	PCI/L		0.87	0.10	20.00	DOE
6-45-42	3/17/88	Uranium-235	PCI/L	<	0.01	0.10	24.00	DOE
6-45-42	3/17/88	Uranium-238	PCI/L		0.57	0.10	24.00	DOE
6-45-42	4/07/88	Cesium-137	PCI/L	>	2.05	20.00	200.00	EPAR
6-45-42	4/07/88	Cobalt-60	PCI/L	>	0.56	22.50	100.00	EPAR
6-45-42	4/07/88	Gross alpha	PCI/L		2.62	4.00	15.00	EPA
6-45-42	4/07/88	Gross beta	PCI/L		5.78	8.00	50.00	EPA
6-45-42	4/07/88	Natural uranium	UG/L		1.88	0.73		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 17 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	4/07/88	Nitrate, High Detection Level	PPB		5960.00	2500.00	45000.00	EPA
6-45-42	4/07/88	Plutonium-238	PCI/L	>	0.01	17.00	1.60	DOE
6-45-42	4/07/88	Plutonium-239/40	PCI/L	>		17.00	1.20	DOE
6-45-42	4/07/88	Ruthenium-106	PCI/L	>	29.20	172.50	30.00	EPAR
6-45-42	4/07/88	Strontium-90	PCI/L	>	0.27	5.00	8.00	EPA
6-45-42	4/07/88	Tritium	PCI/L		50200.00	500.00	20000.00	EPA
6-45-42	4/07/88	Uranium-234	PCI/L		0.94	0.10	20.00	DOE
6-45-42	4/07/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	4/07/88	Uranium-238	PCI/L		0.79	0.10	24.00	DOE
6-45-42	5/04/88	Cesium-137	PCI/L	>	2.76	20.00	200.00	EPAR
6-45-42	5/04/88	Cobalt-60	PCI/L	>	6.92	22.50	100.00	EPAR
6-45-42	5/04/88	Gross alpha	PCI/L		1.48	4.00	15.00	EPA
6-45-42	5/04/88	Gross beta	PCI/L		4.04	8.00	50.00	EPA
6-45-42	5/04/88	Natural uranium	UG/L		2.07	0.73		
6-45-42	5/04/88	Nitrate, High Detection Level	PPB		6610.00	2500.00	45000.00	EPA
6-45-42	5/04/88	Plutonium-238	PCI/L	>		17.00	1.60	DOE
6-45-42	5/04/88	Plutonium-239/40	PCI/L	>		17.00	1.20	DOE
6-45-42	5/04/88	Ruthenium-106	PCI/L	>	21.60	172.50	30.00	EPAR
6-45-42	5/04/88	Strontium-90	PCI/L	>	0.06	5.00	8.00	EPA
6-45-42	5/04/88	Tritium	PCI/L		49400.00	500.00	20000.00	EPA
6-45-42	5/04/88	Uranium-234	PCI/L		1.00	0.10	20.00	DOE
6-45-42	5/04/88	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	5/04/88	Uranium-238	PCI/L		0.82	0.10	24.00	DOE
6-45-42	5/04/88	Cesium-137	PCI/L	>	2.32	20.00	200.00	EPAR
6-45-42	6/06/88	Cobalt-60	PCI/L	>	4.27	22.50	100.00	EPAR
6-45-42	6/06/88	Gross alpha	PCI/L		2.23	4.00	15.00	EPA
6-45-42	6/06/88	Gross beta	PCI/L		6.29	8.00	50.00	EPA
6-45-42	6/06/88	Natural uranium	UG/L		2.03	0.73		
6-45-42	6/06/88	Nitrate, High Detection Level	PPB		7730.00	2500.00	45000.00	EPA
6-45-42	6/06/88	Plutonium-238	PCI/L	>		17.00	1.60	DOE
6-45-42	6/06/88	Plutonium-239/40	PCI/L	>		17.00	1.20	DOE
6-45-42	6/06/88	Ruthenium-106	PCI/L	>	2.79	172.50	30.00	EPAR
6-45-42	6/06/88	Strontium-90	PCI/L	>	0.41	5.00	8.00	EPA
6-45-42	6/06/88	Tritium	PCI/L		50200.00	500.00	20000.00	EPA
6-45-42	6/06/88	Uranium-234	PCI/L		1.08	0.10	20.00	DOE
6-45-42	6/06/88	Uranium-235	PCI/L		0.06	0.10	24.00	DOE
6-45-42	6/06/88	Uranium-238	PCI/L		0.89	0.10	24.00	DOE
6-45-42	6/15/88	1,1,1,2-tetrachloroethane	PPB	>	10.00	10.00		
6-45-42	6/15/88	1,1,1-trichloroethane	PPB	>	5.00	5.00	200.00	EPA
6-45-42	6/15/88	1,1,2,2-tetrachloroethane	PPB	>	10.00	5.00		
6-45-42	6/15/88	1,1,2-trichloroethane	PPB	>	5.00	5.00		
6-45-42	6/15/88	1,1-dichloroethane	PPB	>	10.00	5.00		
6-45-42	6/15/88	1,1-dichloroethylene	PPB	>	10.00	10.00	7.00	EPA
6-45-42	6/15/88	1,2,3,4-tetrachlorobenzene	PPB	>	10.00	10.00		
6-45-42	6/15/88	1,2,3,5-tetrachlorobenzene	PPB	>	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 18 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	1,2,3-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,3-trichloropropane	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,4,5-tetrachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2,4-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dibromo-3-chloropropane	PPB	<	10.00	10.00		EPAP
6-45-42	6/15/88	1,2-dibromoethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,2-dichloroethane	PPB	<	10.00	5.00	5.00	EPA
6-45-42	6/15/88	1,2-dichloropropane	PPB	<	10.00	5.00	6.00	EPAP
6-45-42	6/15/88	1,3,5-trichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,3-dichlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	1,3-dichloropropane	PPB	<	10.00	5.00		
6-45-42	6/15/88	1,4-dichloro-2-butene	PPB	<	10.00	10.00		
6-45-42	6/15/88	2-chloroethyl vinyl ether	PPB	<	10.00	5.00		
6-45-42	6/15/88	Acetonitrile	PPB	<	3000.00	10.00		
6-45-42	6/15/88	Acrolein	PPB	<	10.00	10.00		
6-45-42	6/15/88	Acrylonitrile	PPB	<	10.00	10.00		
6-45-42	6/15/88	Alkalinity		<	103000.00	2000.00		
6-45-42	6/15/88	Aluminum, filtered	PPB	>	150.00	150.00		
6-45-42	6/15/88	Ammonium ion	PPB	>	50.00	50.00		
6-45-42	6/15/88	Antimony, filtered	PPB	>	100.00	100.00		
6-45-42	6/15/88	Arsenic, filtered	PPB	>	6.00	5.00	50.00	EPA
6-45-42	6/15/88	Barium, filtered	PPB	>	35.00	6.00	1000.00	EPA
6-45-42	6/15/88	Benzene	PPB	>	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Beryllium, filtered	PPB	>	5.00	5.00		
6-45-42	6/15/88	Bis(chloromethyl) ether	PPB	>	10.00	5.00		
6-45-42	6/15/88	Bromoacetone	PPB	>	10.00	5.00		
6-45-42	6/15/88	Bromoform	PPB	>	10.00	5.00	100.00	EPA
6-45-42	6/15/88	Cadmium, filtered	PPB	>	2.00	2.00	10.00	EPA
6-45-42	6/15/88	Calcium, filtered	PPB	>	26900.00	50.00		
6-45-42	6/15/88	Carbon Tetrachloride by GC/MS	PPB	>	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Carbon disulfide	PPB	>	10.00	10.00		
6-45-42	6/15/88	Chloride	PPB	>	5650.00	500.00	250000.00	EPAS
6-45-42	6/15/88	Chlorobenzene	PPB	>	10.00	5.00	60.00	EPAP
6-45-42	6/15/88	Chloroform	PPB	>	5.00	5.00	100.00	EPA
6-45-42	6/15/88	Chloromethyl methyl ether	PPB	>	10.00	10.00		
6-45-42	6/15/88	Chromium, filtered	PPB	>	10.00	10.00	50.00	EPA
6-45-42	6/15/88	Copper, filtered	PPB	>	10.00	10.00	1300.00	EPAP
6-45-42	6/15/88	Crotonaldehyde	PPB	>	10.00	10.00		
6-45-42	6/15/88	Cyanide	PPB	>	151.00	10.00		
6-45-42	6/15/88	Dibromomethane	PPB	>	10.00	10.00		
6-45-42	6/15/88	Dichlorodifluoromethane	PPB	>	10.00	10.00		
6-45-42	6/15/88	Diethylarsine	PPB	>	10.00	10.00		
6-45-42	6/15/88	Dioxane	PPB	>	500.00	500.00		
6-45-42	6/15/88	Ethyl methacrylate	PPB	>	10.00	10.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 19 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	Ethylene oxide	PPB	<	3000.00	10.00		
6-45-42	6/15/88	Fluoride	PPB	<	1200.00	500.00	4000.00	EPA
6-45-42	6/15/88	Fluoride, Low Detection Level	PPB	<	488.00	20.00	4000.00	EPA
6-45-42	6/15/88	Formalin	PPB	<	500.00	500.00		
6-45-42	6/15/88	Gross alpha	PCI/L	<	1.77	4.00	15.00	EPA
6-45-42	6/15/88	Gross beta	PCI/L	<	7.25	0.00	50.00	EPA
6-45-42	6/15/88	Hexachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Hexachlorophene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Hydrogen sulfide	PPB	<	10.00	10.00		
6-45-42	6/15/88	Iodomethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Iron, filtered	PPB	<	53.00	30.00	300.00	EPAS
6-45-42	6/15/88	Kerosene	PPB	<	10000.00	10000.00		
6-45-42	6/15/88	Lead, filtered	PPB	<	5.00	5.00	50.00	EPA
6-45-42	6/15/88	Magnesium, filtered	PPB	<	10800.00	50.00		
6-45-42	6/15/88	Manganese, filtered	PPB	<	7.00	5.00	50.00	EPAS
6-45-42	6/15/88	Mercury, filtered	PPB	<	0.10	0.10	2.00	EPA
6-45-42	6/15/88	Methacrylonitrile	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methanethiol	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl Isobutyl Ketone	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl bromide	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl chloride	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl ethyl ketone	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methyl methacrylate	PPB	<	10.00	10.00		
6-45-42	6/15/88	Methylene Chloride	PPB	<	10.00	5.00		
6-45-42	6/15/88	N,N-diethylhydrazine	PPB	<	10.00	10.00		
6-45-42	6/15/88	Naphthalene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	6/15/88	Nitrate	PPB	<	7270.00	500.00	45000.00	EPA
6-45-42	6/15/88	Pentachlorobenzene	PPB	<	10.00	10.00		
6-45-42	6/15/88	Pentachloroethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Phenol	PPB	<	10.00	10.00		
6-45-42	6/15/88	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	6/15/88	Potassium, filtered	PPB	<	3920.00	100.00		
6-45-42	6/15/88	Pyridine	PPB	<	500.00	500.00		
6-45-42	6/15/88	Selenium, filtered	PPB	<	5.00	5.00	10.00	EPA
6-45-42	6/15/88	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	6/15/88	Sodium, filtered	PPB	<	17300.00	200.00		
6-45-42	6/15/88	Strontium, filtered	PPB	<	196.00	10.00		
6-45-42	6/15/88	Sulfate	PPB	<	34200.00	500.00	250000.00	EPAS
6-45-42	6/15/88	Tetrachloroethylene	PPB	<	5.00	5.00		
6-45-42	6/15/88	Toluene	PPB	<	5.00	5.00	2000.00	EPAP
6-45-42	6/15/88	Total Organic Halogen, Low Det. Level	PPB	<	5.55	10.00		
6-45-42	6/15/88	Total carbon	PPB	<	23300.00	1000.00		
6-45-42	6/15/88	Total organic carbon	PPB	<	622.00	2000.00		
6-45-42	6/15/88	Trans-1,2-dichloroethene	PPB	<	10.00	5.00	70.00	EPAP

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 20 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	6/15/88	Tributylphosphoric Acid	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloroethylene	PPB	<	5.00	5.00	5.00	EPA
6-45-42	6/15/88	Trichloromethanethiol	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloromonofluoromethane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Trichloropropane	PPB	<	10.00	10.00		
6-45-42	6/15/88	Vanadium, filtered	PPB	<	34.00	5.00		
6-45-42	6/15/88	Vinyl chloride	PPB	<	10.00	10.00	2.00	EPA
6-45-42	6/15/88	Xylene-m	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	6/15/88	Xylene-o,p	PPB	<	5.00	5.00	440.00	EPAP
6-45-42	6/15/88	Zinc, filtered	PPB	<	5.00	5.00	5000.00	EPAS
6-45-42	6/15/88	p-Dichlorobenzene	PPB	<	10.00	10.00	75.00	EPA
6-45-42	6/15/88	pH, Laboratory Measurement			7.90	0.01	8.50	EPAS
6-45-42	8/12/88	Cesium-137	PCI/L	<	6.14	20.00	200.00	EPAR
6-45-42	8/12/88	Cobalt-60	PCI/L	<	0.17	22.50	100.00	EPAR
6-45-42	8/12/88	Gross alpha	PCI/L		1.89	4.00	15.00	EPA
6-45-42	8/12/88	Gross beta	PCI/L		4.50	8.00	50.00	EPA
6-45-42	8/12/88	Natural uranium	UG/L		2.10	0.73		
6-45-42	8/12/88	Nitrate, High Detection Level	PPB		5170.00	2500.00	45000.00	EPA
6-45-42	8/12/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	8/12/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	8/12/88	Ruthenium-106	PCI/L	<	10.70	172.50	30.00	EPAR
6-45-42	8/12/88	Strontium-90	PCI/L	>	0.17	5.00	8.00	EPA
6-45-42	8/12/88	Tritium	PCI/L		46000.00	500.00	20000.00	EPA
6-45-42	8/12/88	Uranium-234	PCI/L		1.02	0.10	20.00	DOE
6-45-42	8/12/88	Uranium-235	PCI/L		0.04	0.10	24.00	DOE
6-45-42	8/12/88	Uranium-238	PCI/L		0.82	0.10	24.00	DOE
6-45-42	8/15/88	Alkalinity			101000.00	20000.00		
6-45-42	8/15/88	Aluminum, filtered	PPB	>	150.00	150.00		
6-45-42	8/15/88	Antimony, filtered	PPB	>	100.00	100.00		
6-45-42	8/15/88	Barium, filtered	PPB	>	16.00	6.00	1000.00	EPA
6-45-42	8/15/88	Beryllium, filtered	PPB	>	5.00	5.00		
6-45-42	8/15/88	Cadmium, filtered	PPB	>	2.00	2.00	10.00	EPA
6-45-42	8/15/88	Calcium, filtered	PPB	>	29700.00	50.00		
6-45-42	8/15/88	Cesium-137	PCI/L	<	0.11	20.00	200.00	EPAR
6-45-42	8/15/88	Chloride	PPB	>	4830.00	500.00	250000.00	EPAS
6-45-42	8/15/88	Chromium, filtered	PPB	>	10.00	10.00	50.00	EPA
6-45-42	8/15/88	Cobalt-60	PCI/L	<	3.76	22.50	100.00	EPAR
6-45-42	8/15/88	Copper, filtered	PPB	<	10.00	10.00	1300.00	EPAP
6-45-42	8/15/88	Cyanide	PPB	>	10.00	10.00		
6-45-42	8/15/88	Fluoride	PPB	>	500.00	500.00	4000.00	EPA
6-45-42	8/15/88	Fluoride, Low Detection Level	PPB	>	550.00	20.00	4000.00	EPA
6-45-42	8/15/88	Gross alpha	PCI/L		0.43	4.00	15.00	EPA
6-45-42	8/15/88	Gross beta	PCI/L		5.81	8.00	50.00	EPA
6-45-42	8/15/88	Iron, filtered	PPB	>	30.00	30.00	300.00	EPAS
6-45-42	8/15/88	Magnesium, filtered	PPB		10400.00	50.00		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 21 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	8/15/88	Manganese, filtered	PPB	<	5.00	5.00	50.00	EPAS
6-45-42	8/15/88	Natural uranium	UG/L		2.82	0.73		
6-45-42	8/15/88	Nickel, filtered	PPB	<	10.00	10.00		
6-45-42	8/15/88	Nitrate	PPB		6650.00	500.00	45000.00	EPA
6-45-42	8/15/88	Nitrate, High Detection Level	PPB		6870.00	2500.00	45000.00	EPA
6-45-42	8/15/88	Phosphate	PPB	<	1000.00	1000.00		
6-45-42	8/15/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	8/15/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	8/15/88	Potassium, filtered	PPB		4460.00	100.00		
6-45-42	8/15/88	Ruthenium-106	PCI/L	<	12.60	172.50	30.00	EPAR
6-45-42	8/15/88	Silver, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	8/15/88	Sodium, filtered	PPB		18000.00	200.00		
6-45-42	8/15/88	Specific conductance	UMHO		262.00	1.00	700.00	WDOE
6-45-42	8/15/88	Strontium, filtered	PPB		183.00	10.00		
6-45-42	8/15/88	Strontium-90	PCI/L	<	0.22	5.00	8.00	EPA
6-45-42	8/15/88	Sulfate	PPB		30900.00	500.00	250000.00	EPAS
6-45-42	8/15/88	Total carbon	PPB		23900.00	1000.00		
6-45-42	8/15/88	Total organic carbon	PPB	<	480.00	2000.00		
6-45-42	8/15/88	Tritium	PCI/L		45600.00	500.00	20000.00	EPA
6-45-42	8/15/88	Uranium-234	PCI/L		1.01	0.10	20.00	DOE
6-45-42	8/15/88	Uranium-235	PCI/L		0.06	0.10	24.00	DOE
6-45-42	8/15/88	Uranium-238	PCI/L		0.73	0.10	24.00	DOE
6-45-42	8/15/88	Vanadium, filtered	PPB		20.00	5.00		
6-45-42	8/15/88	Zinc, filtered	PPB		82.00	5.00	5000.00	EPAS
6-45-42	8/15/88	pH, Field Measurement			7.80	0.10	8.50	EPAS
6-45-42	8/15/88	pH, Laboratory Measurement			7.90	0.01	8.50	EPAS
6-45-42	9/09/88	Cesium-137	PCI/L	>	1.83	20.00	200.00	EPAR
6-45-42	9/09/88	Cobalt-60	PCI/L	>	1.32	22.50	100.00	EPAR
6-45-42	9/09/88	Gross alpha	PCI/L		1.07	4.00	15.00	EPA
6-45-42	9/09/88	Gross beta	PCI/L		4.38	8.00	50.00	EPA
6-45-42	9/09/88	Natural uranium	UG/L		2.13	0.73		
6-45-42	9/09/88	Nitrate, High Detection Level	PPB		6700.00	2500.00	45000.00	EPA
6-45-42	9/09/88	Plutonium-238	PCI/L	>		17.00	1.60	DOE
6-45-42	9/09/88	Plutonium-239/40	PCI/L	>		17.00	1.20	DOE
6-45-42	9/09/88	Ruthenium-106	PCI/L	>	28.10	172.50	30.00	EPAR
6-45-42	9/09/88	Strontium-90	PCI/L	>	0.37	5.00	8.00	EPA
6-45-42	9/09/88	Tritium	PCI/L		47100.00	500.00	20000.00	EPA
6-45-42	9/09/88	Uranium-234	PCI/L		1.02	0.10	20.00	DOE
6-45-42	9/09/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	9/09/88	Uranium-238	PCI/L		0.70	0.10	24.00	DOE
6-45-42	10/06/88	Cesium-137	PCI/L	>	1.56	20.00	200.00	EPAR
6-45-42	10/06/88	Cobalt-60	PCI/L	>	0.39	22.50	100.00	EPAR
6-45-42	10/06/88	Gross alpha	PCI/L		1.61	4.00	15.00	EPA
6-45-42	10/06/88	Gross beta	PCI/L		4.17	8.00	50.00	EPA
6-45-42	10/06/88	Natural uranium	UG/L		2.28	0.73		

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 22 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	10/06/88	Nitrate, High Detection Level	PPB		6560.00	2500.00	45000.00	EPA
6-45-42	10/06/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/06/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/06/88	Ruthenium-106	PCI/L	<	14.10	172.50	30.00	EPAR
6-45-42	10/06/88	Strontium-90	PCI/L	<	0.06	5.00	8.00	EPA
6-45-42	10/06/88	Tritium	PCI/L		49500.00	500.00	20000.00	EPA
6-45-42	10/06/88	Uranium-234	PCI/L		1.00	0.10	20.00	DOE
6-45-42	10/06/88	Uranium-235	PCI/L		0.07	0.10	24.00	DOE
6-45-42	10/06/88	Uranium-238	PCI/L		0.79	0.10	24.00	DOE
6-45-42	10/31/88	Cesium-137	PCI/L	<	6.07	20.00	200.00	EPAR
6-45-42	10/31/88	Cobalt-60	PCI/L	<	4.26	22.50	100.00	EPAR
6-45-42	10/31/88	Gross alpha	PCI/L		1.66	4.00	15.00	EPA
6-45-42	10/31/88	Gross beta	PCI/L		3.18	8.00	50.00	EPA
6-45-42	10/31/88	Natural uranium	UG/L		2.16	0.73		
6-45-42	10/31/88	Nitrate, High Detection Level	PPB		6400.00	2500.00	45000.00	EPA
6-45-42	10/31/88	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/31/88	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/31/88	Ruthenium-106	PCI/L	<	20.20	172.50	30.00	EPAR
6-45-42	10/31/88	Strontium-90	PCI/L	<	0.30	5.00	8.00	EPA
6-45-42	10/31/88	Tritium	PCI/L		46300.00	500.00	20000.00	EPA
6-45-42	10/31/88	Uranium-234	PCI/L		0.85	0.10	20.00	DOE
6-45-42	10/31/88	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	10/31/88	Uranium-238	PCI/L		0.53	0.10	24.00	DOE
6-45-42	12/13/88	Cesium-137	PCI/L	>	5.65	20.00	200.00	EPAR
6-45-42	12/13/88	Cobalt-60	PCI/L	>	1.37	22.50	100.00	EPAR
6-45-42	12/13/88	Gross alpha	PCI/L		1.23	4.00	15.00	EPA
6-45-42	12/13/88	Gross beta	PCI/L		4.44	8.00	50.00	EPA
6-45-42	12/13/88	Natural uranium	UG/L		2.20	0.73		
6-45-42	12/13/88	Nitrate, High Detection Level	PPB		7100.00	2500.00	45000.00	EPA
6-45-42	12/13/88	Plutonium-238	PCI/L	>	0.01	17.00	1.60	DOE
6-45-42	12/13/88	Plutonium-239/40	PCI/L	>		17.00	1.20	DOE
6-45-42	12/13/88	Ruthenium-106	PCI/L	<	6.03	172.50	30.00	EPAR
6-45-42	12/13/88	Strontium-90	PCI/L	>	0.22	5.00	8.00	EPA
6-45-42	12/13/88	Tritium	PCI/L		48000.00	500.00	20000.00	EPA
6-45-42	12/13/88	Uranium-234	PCI/L		0.85	0.10	20.00	DOE
6-45-42	12/13/88	Uranium-235	PCI/L		0.03	0.10	24.00	DOE
6-45-42	12/13/88	Uranium-238	PCI/L		0.67	0.10	24.00	DOE
6-45-42	1/13/89	Cesium-137	PCI/L	>	2.47	20.00	200.00	EPAR
6-45-42	1/13/89	Cobalt-60	PCI/L	>	2.27	22.50	100.00	EPAR
6-45-42	1/13/89	Gross alpha	PCI/L		2.52	4.00	15.00	EPA
6-45-42	1/13/89	Gross beta	PCI/L		3.50	8.00	50.00	EPA
6-45-42	1/13/89	Natural uranium	UG/L		2.51	0.73		
6-45-42	1/13/89	Nitrate, High Detection Level	PPB		7000.00	2500.00	45000.00	EPA
6-45-42	1/13/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	1/13/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 23 of 24).

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WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/13/89	Ruthenium-106	PCI/L	<	11.00	172.50	30.00	EPAR
6-45-42	1/13/89	Strontium-90	PCI/L	<	0.35	5.00	8.00	EPA
6-45-42	1/13/89	Tritium	PCI/L	<	44500.00	500.00	20000.00	EPA
6-45-42	1/13/89	Uranium-234	PCI/L	<	1.13	0.10	20.00	DOE
6-45-42	1/13/89	Uranium-235	PCI/L	<	0.03	0.10	24.00	DOE
6-45-42	1/13/89	Uranium-238	PCI/L	<	0.06	0.10	24.00	DOE
6-45-42	1/16/89	Alkalinity		<	102000.00	20000.00		
6-45-42	1/16/89	Aluminum, filtered	PPB	<	150.00	150.00		
6-45-42	1/16/89	Antimony, filtered	PPB	<	100.00	100.00		
6-45-42	1/16/89	Barium, filtered	PPB	<	34.00	6.00	1000.00	EPA
6-45-42	1/16/89	Beryllium, filtered	PPB	<	5.00	5.00		
6-45-42	1/16/89	Boron, filtered	PPB	<	14.00	10.00		
6-45-42	1/16/89	Bromide	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Cadmium, filtered	PPB	<	2.00	2.00	10.00	EPA
6-45-42	1/16/89	Calcium, filtered	PPB	<	26600.00	50.00		
6-45-42	1/16/89	Chloride	PPB	<	5400.00	500.00	250000.00	EPAS
6-45-42	1/16/89	Chromium, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/16/89	Chromium, filtered	PPB	<	20.00	20.00		
6-45-42	1/16/89	Cobalt, filtered	PPB	<	12.00	10.00	1300.00	EPAP
6-45-42	1/16/89	Copper, filtered	PPB	<	10.00	10.00		
6-45-42	1/16/89	Cyanide	PPB	<	500.00	500.00	4000.00	EPA
6-45-42	1/16/89	Fluoride	PPB	<	30.00	30.00	300.00	EPAS
6-45-42	1/16/89	Iron, filtered	PPB	<	10.00	10.00		
6-45-42	1/16/89	Lithium, filtered	PPB	<	10200.00	50.00		
6-45-42	1/16/89	Magnesium, filtered	PPB	<	5.00	5.00	50.00	EPAS
6-45-42	1/16/89	Manganese, filtered	PPB	<	40.00	40.00		
6-45-42	1/16/89	Molybdenum, filtered	PPB	<	10.00	10.00		
6-45-42	1/16/89	Nickel, filtered	PPB	<	6900.00	500.00	45000.00	EPA
6-45-42	1/16/89	Nitrate	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Nitrite	PPB	<	1000.00	1000.00		
6-45-42	1/16/89	Phosphate	PPB	<	4530.00	100.00		
6-45-42	1/16/89	Potassium, filtered	PPB	<	21700.00	50.00		
6-45-42	1/16/89	Silicon, filtered	PPB	<	10.00	10.00	50.00	EPA
6-45-42	1/16/89	Silver, filtered	PPB	<	19300.00	200.00		
6-45-42	1/16/89	Sodium, filtered	PPB	<	292.00	1.00	700.00	WDOE
6-45-42	1/16/89	Specific conductance	UMHO	<	198.00	10.00		
6-45-42	1/16/89	Strontium, filtered	PPB	<	36000.00	500.00	250000.00	EPAS
6-45-42	1/16/89	Sulfate	PPB	<	30.00	30.00		
6-45-42	1/16/89	Tin, filtered	PPB	<	60.00	60.00		
6-45-42	1/16/89	Titanium, filtered	PPB	<	22000.00	1000.00		
6-45-42	1/16/89	Total carbon	PPB	<	400.00	2000.00		
6-45-42	1/16/89	Total organic carbon	PPB	<	27.00	5.00		
6-45-42	1/16/89	Vanadium, filtered	PPB	<	10.00	5.00	5000.00	EPAS
6-45-42	1/16/89	Zinc, filtered	PPB	<	50.00	50.00		
6-45-42	1/16/89	Zirconium, filtered	PPB	<	7.70	0.10	0.50	EPAS
6-45-42	1/16/89	pH, Field Measurement						

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Table C-1. Water-Chemistry Data from Wells Near LERF Site (page 24 of 24).

WELL NAME	COLLECTION DATE	CONSTITUENT NAME	ANALYSIS UNITS	LESS THAN FLAG	ANALYSIS VALUE	DETECTION LIMIT	REGULATORY LIMIT	REGULATING AGENCY
6-45-42	1/16/89	pH, Laboratory Measurement			8.00	0.01	8.50	EPAS
6-45-42	2/08/89	Alpha, High Detection Level	PCI/L		1.81	4.00	15.00	EPA
6-45-42	2/08/89	Cesium-137	PCI/L	<	3.13	20.00	200.00	EPAR
6-45-42	2/08/89	Cobalt-60	PCI/L	<	2.35	22.50	100.00	EPAR
6-45-42	2/08/89	Gross beta	PCI/L		2.95	8.00	50.00	EPA
6-45-42	2/08/89	Natural uranium	UG/L		2.47	0.73		
6-45-42	2/08/89	Nitrate, High Detection Level	PPB		7100.00	2500.00	45000.00	EPA
6-45-42	2/08/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	2/08/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	2/08/89	Ruthenium-106	PCI/L	<	30.10	172.50	30.00	EPAR
6-45-42	2/08/89	Strontium-90	PCI/L	<	0.17	5.00	8.00	EPA
6-45-42	2/08/89	Tritium	PCI/L		42500.00	500.00	20000.00	EPA
6-45-42	2/08/89	Uranium-234	PCI/L		1.19	0.10	20.00	DOE
6-45-42	2/08/89	Uranium-235	PCI/L		0.02	0.10	24.00	DOE
6-45-42	2/08/89	Uranium-238	PCI/L		1.19	0.10	24.00	DOE
6-45-42	3/02/89	Alpha, High Detection Level	PCI/L	<	0.04	4.00	15.00	EPA
6-45-42	3/02/89	Cesium-137	PCI/L	<	1.77	20.00	200.00	EPAR
6-45-42	3/02/89	Cobalt-60	PCI/L	<	2.46	22.50	100.00	EPAR
6-45-42	3/02/89	Gross beta	PCI/L		2.85	8.00	50.00	EPA
6-45-42	3/02/89	Natural uranium	UG/L		2.68	0.73		
6-45-42	3/02/89	Nitrate, High Detection Level	PPB		6500.00	2500.00	45000.00	EPA
6-45-42	3/02/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	3/02/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	3/02/89	Ruthenium-106	PCI/L	<	20.80	172.50	30.00	EPAR
6-45-42	3/02/89	Strontium-90	PCI/L	<	0.18	5.00	8.00	EPA
6-45-42	3/02/89	Tritium	PCI/L		39100.00	500.00	20000.00	EPA
6-45-42	3/02/89	Uranium-234	PCI/L		1.27	0.10	20.00	DOE
6-45-42	3/02/89	Uranium-235	PCI/L	<		0.10	24.00	DOE
6-45-42	3/02/89	Uranium-238	PCI/L		0.93	0.10	24.00	DOE
6-45-42	10/09/89	Alpha, High Detection Level	PCI/L		3.00	4.00	15.00	EPA
6-45-42	10/09/89	Cesium-137	PCI/L	<	3.60	20.00	200.00	EPAR
6-45-42	10/09/89	Cobalt-60	PCI/L	<	0.83	22.50	100.00	EPAR
6-45-42	10/09/89	Gross beta	PCI/L		5.19	8.00	50.00	EPA
6-45-42	10/09/89	Natural uranium	UG/L		2.14	0.73		
6-45-42	10/09/89	Nitrate, High Detection Level	PPB		6000.00	2500.00	45000.00	EPA
6-45-42	10/09/89	Plutonium-238	PCI/L	<		17.00	1.60	DOE
6-45-42	10/09/89	Plutonium-239/40	PCI/L	<		17.00	1.20	DOE
6-45-42	10/09/89	Ruthenium-106	PCI/L	<	1.04	172.50	30.00	EPAR
6-45-42	10/09/89	Strontium-90	PCI/L	<	0.24	5.00	8.00	EPA
6-45-42	10/09/89	Tritium	PCI/L		41400.00	500.00	20000.00	EPA
6-45-42	10/09/89	Uranium-234	PCI/L		0.93	0.10	20.00	DOE
6-45-42	10/09/89	Uranium-235	PCI/L	<		0.10	24.00	DOE
6-45-42	10/09/89	Uranium-238	PCI/L		0.75	0.10	24.00	DOE

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APPENDIX D

SAMPLING AND ANALYSIS PLAN

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APPENDIX D

SAMPLING AND ANALYSIS PLAN

This appendix introduces the procedures that will be used for sample collection (including well evaluation and sample withdrawal methods); chain of custody; analytical methods, including sample preservation, shipment, and chemical analysis; and quality assurance/quality control (Tables D-1 and D-2).

All sampling activities are currently performed under contract by Pacific Northwest Laboratory (PNL).

SAMPLE COLLECTION PROCEDURES

The procedures for ground water sample collection, water level measurements, and field measurements are contained in *Procedures for Ground-Water Investigations* (PNL 1989a). Specific applicable procedures include the following:

- GC-1--"Ground-Water Sample Collection Procedure"
- GC-2--"In-Line Sample Filtration Procedure"
- GC-3--"Disposal of Purge Water from Monitoring Wells"
- FA-1--"Temperature Measurement Procedure"
- FA-2--"Calibration of Conductivity Meter and Measurement of Field Conductivity"
- FA-3--"Calibration of pH Meter and Measurement of Field pH"
- WL-1--"Water-Level Measurement Procedure"
- WL-2--"Procedure for Standardizing Steel Tapes"
- AD-1--"Change Control Procedure"
- AD-2--"Ground-Water Sample Chain of Custody"
- AD-4--"Sediment Sample Chain of Custody"
- DO-1--"Collection and Documentation of Borehole Samples and Well Construction Data"
- DO-2--"Split-Barrel Auger Sediment Sampling."

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CHAIN-OF-CUSTODY PROCEDURES

Chain-of-custody procedures are contained in *Procedures for Ground-Water Investigations* (PNL 1989a). The specific applicable procedure is AD-2, "Ground-Water Sample Chain-of-Custody Procedure." The history of the custody of each sample will be documented according to this procedure.

QUALITY ASSURANCE/QUALITY CONTROL

Quality Assurance

Quality assurance (QA) will be conducted in accordance with the PNL QA manual. A QA plan describing the manner in which specific QA requirements are to be met has been prepared in accordance with that manual (PNL 1989b).

Quality Control

The purpose of quality control (QC) is to determine and document the quality of the analytical results being produced by the laboratory and to bring potential problems with analyses to attention for corrective actions as needed. The QC effort has two main components (1) routine internal checks performed by the contract laboratory and (2) external checks conducted by PNL. The scope of these efforts is described in the following sections.

Internal Quality Control. Internal QC includes general practices applicable to a wide range of analyses as well as specific procedures stipulated for particular analyses. The QC and QA programs are documented in QC and QA manuals. A quarterly QC report will be provided to PNL that includes blank, matrix, spike, and surrogate data.

External Quality Control. Pacific Northwest Laboratory will use inter-laboratory comparisons, replicate, blank, and blind samples to evaluate the accuracy of results. The purpose and scope of each of these are as follows.

Interlaboratory comparisons using field samples are conducted to determine if the results obtained are comparable to those obtained from other laboratories. Comparisons are currently being conducted for anions, selected volatile organic constituents, metals, cyanide, gross alpha, gross beta, and tritium. Each month, replicate samples from selected wells are delivered to four different PNL laboratories. The results from these PNL laboratories are then compared to the results of the contract laboratory. Samples sent to PNL laboratories are from the same sampling set as those to be analyzed in duplicate by the contract laboratory.

Replicate analyses of field samples are conducted to establish how much variability might be expected in the laboratory measurements performed on nearly identical samples and as a check for gross errors. Blanks for a wide range of analyses are submitted to the contract laboratory monthly to check for container or laboratory contamination.

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Trip (transport) blanks or transfer blanks are submitted to determine whether environmental conditions encountered during collection and transportation of samples have affected the results obtained by analysis. One set of trip blanks and transfer blanks are submitted each sample period per sample area at a rate of at least one for 1 to 20 wells. These blanks are analyzed for volatile organic constituents.

Blind samples are submitted to estimate the bias of analytical laboratory procedures and to determine when this bias exceeds control limits. Blind standard samples prepared by PNL containing metals, anions, herbicides, pesticides, and volatile organic compounds have been submitted quarterly since January 1986. Most blind samples are now prepared with materials supplied by the U.S. Environmental Protection Agency (EPA), including the previous list of analytes plus ammonium ion, cyanide, semivolatile compounds, PCBs, and an expanded number of pesticides and volatile organic compounds. Samples containing constituents not available in EPA performance samples are prepared from high-quality chemicals. These include constituents from the enhanced thiourea and phosphorous pesticides group analyses, plus ethylene glycol, sulfide, perchlorate, and hydrazine dioxin (TCDD).

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Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 1 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION(a,b)	ANALYSIS METHODS(C)	DETECTION LIMIT, PPB(d)
Metals Analyzed by the Inductively Coupled Plasma Method--Unfiltered/Filtered			
beryllium	P, HNO ₃ to pH<2	SW-846, (e) #6010	3
strontium			10
zinc			5
calcium			50
barium			6
cadmium			5
chromium			10
silver			10
sodium			200
nickel			10
copper			10
vanadium			5
antimony			100
aluminum			150
manganese			5
potassium			100
iron			30
magnesium			50
boron			10
cobalt			20
lithium			10
molybdenum			40
silicon	50		
tin	30		
titanium	60		
zirconium	50		
Metals - Unfiltered/Filtered			
arsenic	P, HNO ₃ to pH<2	SW-846, #7060	5
mercury	G, HNO ₃ to pH<2	SW-846, #7470	0.1
selenium	P, HNO ₃ to pH<2	SW-846, #7740	5
lead	P, HNO ₃ to pH<2	SW-846, #7421	5
Anions by Ion Chromatography			
nitrate	P, none		500
sulfate			500
fluoride			500

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Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 2 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION (a,b)	ANALYSIS METHODS (c)	DETECTION LIMIT, PPB (d)
chloride phosphate bromide nitrite		(f)	500 1000 1000 1000
Pesticides			
endrin methoxychlor toxaphene lindane (four isomers)	G, none	SW-846, #8080	0.1 3 1 0.1
Herbicides			
2,4-D 2,4,5-TP silvex 2,4,5-T	G, none	SW-846, #8150	2 2 2
Volatile Organic Analyses (VOA)			
carbon tetra- chloride benzene methyl ethyl ketone toluene 1,1,1-trichloro- ethane 1,1,2-trichloro- ethane trichloroethylene tetrachloroethylene xylene-o,p chloroform 1,1-dichloroethane 1,2-dichloroethane trans-1,2- dichloroethylene methylene chloride vinyl chloride xylene-m	G, no headspace	SW-846, #8240	5 5 10 5 5 5 5 5 5 5 5 5 5 5 5 10 5

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Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 3 of 4)

CONSTITUENT	COLLECTION AND PRESERVATION ^(a,b)	ANALYSIS METHODS ^(c)	DETECTION LIMIT, PPB ^(d)
methyl isobutyl ketone			10
acetone by VOA			10
tetrahydrofuran			10
p-dichlorobenzene			5
Radiological			
radium	P, HNO ₃ to pH<2	SW-846, #9315 ^(g)	1 pCi/L
gross alpha	P, HNO ₃ to pH<2	SW-846, #9310	4 pCi/L
gross beta	P, HNO ₃ to pH<2	SW-846, #9310	8 pCi/L
tritium	P, none	ASTM D2476-81	500 pCi/L
uranium	P, HNO ₃ to pH<2	ASTM D2907-83 ^(h)	0.5 pCi/L
gamma scan	P, HNO ₃ to pH<2	(i)	
technetium-99	P, HNO ₃ to pH<2	(j)	15 pCi/L
iodine-129 (LDL)	P, none	(k)	1 pCi/L
strontium-90	P, HNO ₃ to pH<2	(l)	5 pCi/L
plutonium-239/240	P, HNO ₃ to pH<2	ASTM D3865-82	17 pCi/L
Other			
coliform bacteria	P, none	SW-846, #9131 ^(m)	2.2 ⁽ⁿ⁾
coliform, MFT	P, none	SW-846, 9132 ^(o)	1/100 mL
temperature	field measurement	(p)	--
conductivity, laboratory	P, none	(p)	1 μohm
pH, laboratory measurement	P, none	(p)	0.01
total organic halogen, low detection level	G, H ₂ SO ₄ to pH<2 No headspace	SW-846, #9020	10
total organic carbon	G, HCl or H ₂ SO ₄ to pH<2	SW-846, #9060	2000
total carbon	G, none	SW-846, #9060	2000
ammonium ion	P, H ₂ SO ₄ to pH<2	ASTM D1426-D ^(q)	50
phenol	G, none	SW-846, #8040	10
cyanide	P, NaOH to pH>12	SW-846, #9010	10
hydrazine	G, HCl	ASTM D1385	30
total dissolved solids	P, none	Std. Methods 209B ^(r)	5000

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Table D-1. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Listed Constituents as of January 1, 1989. (Sheet 4 of 4)

- *P, plastic; G, glass.
- ^bAll samples will be cooled to 4°C upon collection.
- ^cConstituents grouped together are analyzed by the same method.
- ^dDetection limit units except where indicated.
- *EPA 1986.
- ¹Analytical method adapted from Method 300.0, EPA 1984.
- ²The method also references ASTM 1988 and Krieger and Whittaker 1980.
- ³Method A/B, adopted from *Techniques of Water Resources Investigations of the U.S. Geological Survey*, as amended, U.S. Government Printing Office, Washington, D.C. and from NCRP 1985.
- ⁴Method 901, from Krieger and Whittaker 1980 and Volchok and dePlanque 1983.
- ⁵Method from procedures manual.
- ⁶Adapted from Method E-I-02, Volchok and dePlanque 1983.
- ⁷Method 905, Krieger and Whittaker 1980.
- ⁸Multiple tube fermentation.
- ⁹Most probable number.
- ⁰Membrane filter technique.
- ¹PNL 1989.
- ²By ion selective electrode.
- ³APHA 1985.

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 1 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
Metals Analyzed by the Inductively Coupled Plasma Method			
thallium	P, HNO ₃ to pH<2	SW-846, #7840	5
Thiourea Group--Enhanced Additions			
thiourea	G, none	SW-846, #8330 (modified)	200
1-acetyl-2-thiourea			200
1-(o-chlorophenyl) thiourea			200
diethylstilbestrol			200
ethylenethiourea			200
1-naphthyl-2-thiourea			200
N-phenylthiourea			500
Pesticides--Enhanced Additions			
aldrin	G, none	SW-846, #8080	0.1
chlordane			1
4,4' DDD ^(f)			0.1
4,4' DDE ^(g)			0.1
4,4' DDT ^(h)			0.1
endosulfan I			0.1
endosulfan II			0.1
endosulfan sulfate			0.5
heptachlor			0.1
heptachlor epoxide			0.1
kepone			1
dieldrin			0.1
chlorobenzilate			300
Phosphorous Pesticides			
carbophenothion			2
tetraethylpyro-phosphate			2
disulfoton			2

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 2 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
dimethoate methyl parathion parathion phorate	G, none	SW-846, #8140	2 2 2 2
Direct Aqueous Injection			
paraaldehyde acrylamide allyl alcohol 3-chloropropioni- trile ethyl carbamate ethyl cyanide ethylene glycol isobutyl alcohol N-propylamine 2-propyn-1-ol 1-butanol 2-propanol ethanol monobutylphosphate dibutylphosphate ethylene glycol 1-butynol	G, none	GC/FID ^(f)	10,000 10,000 10,500 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000 10,000
Dioxins PCDDs ^(j) PCDFs ^(k) 2,3,7,8 TCDD ^(l)	G, none	SW-846, #8280	0.01 0.01 0.01
Volatile Organic Analyses--Enhanced Additions			
dioxane pyridine acrolein acrylonitrile bis(chloromethyl) ether bromoacetone			500 5 10 10 5 5

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 3 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
methyl bromide			10
carbon disulfide			10
chlorobenzene			5
2-chloroethyl vinyl ether			5
methyl chloride			10
chloromethyl methyl ether	G, no headspace	SW-846, #8240	10
crotonaldehyde			10
1,2-dibromo-3-chloropropane			10
1,2-dibromoethane			10
dibromomethane			10
1,4-dichloro-2-butene			10
dichlorodifluoromethane			10
1,1-dichloro ethylene			10
1,2-dichloropropane			5
N-N-diethylhydrazine			10
1,1-dimethylhydrazine			10
1,2-dimethylhydrazine			10
iodomethane			10
methacrylonitrile			10
methanethiol			10
pentachloroethane			10
1,1,1,2-tetrachlorethane			10
1,1,2,2-tetrachlorethane			5
bromoform			5
trichloromethanethiol			10
trichloromonofluoromethane			10
1,2,3-trichloropropane			10
acetonitrile			10
formalin	G, no headspace	SW-846, #8240	500
ethylene oxide			10

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 4 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
ethyl methacrylate			10
ethylbenzene			5
styrene			5
chlorobromodimethane			5
dibromochloromethane			5
2-hexanone			50
allyl chloride			100
chloroethane			10
propionitrile			5
vinyl acetate			5
SEMIVOLATILE ORGANIC ANALYSIS (Acid/Base/Neutral)			
1,2-dichlorobenzene	G, none	SW-846, #8270	10
1,3-dichlorobenzene			10
p-dichlorobenzene			10
hexachlorobenzene			10
pentachlorobenzene			10
1,2,4,5-tetrachlorobenzene			10
1,2,4-trichlorobenzene			10
hexachlorophene			10
naphthalene			10
1,2,3-trichlorobenzene			10
phenol			10
1,3,5-trichlorobenzene			10
1,2,3,4-tetrachlorobenzene			10
1,2,3,5-tetrachlorobenzene			10
kerosene			10,000
chlorobenzene by ABN			10
cresols			10
pentachlorophenol			50

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 5 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
	G, none	SW-846, #8270	
tributylphospahte			10
strychnine			50
maleic hydrizide			500
nicotinic acid			100
acetophenone			10
warfarin			10
2-acetyl-amino-fluorene			10
4-aminobyphenyl			10
5-(aminomethyl)-3-isoxazolol			10
amitrole			10
aniline			10
aramite			10
auramine			10
benz[c]acridine			10
benz[a]anthracene			10
benzene, dichloromethyl			10
benzenethoil			10
benzidine			10
benzo[b]fluoranthene			10
benzo[j]fluoranthene			10
p benzoquinone			10
benzyl chloride			10
bis(2-chloroethoxy)methane			10
bis(2-choroethyl) ether			10
bis(2-ethylhexyl) phthalate			10
4-bromophenyl phenyl ether			10
butyl benzyl phthalate			10
2-sec-butyl-4,6-dinitrophenol			10
chloroalkyl ethers			10
p-chloroaniline			20
p-chlorom-cresol			20

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 6 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
1-chloro-2,3-epoxypropane			10
2-chloronaphthalene			10
2-chlorophenol			10
chrysene			10
2-cyclohexyl-4,6-dinitrophenol			10
dibenz[a,h]acridine			10
dibenz[a,j]acridine			10
dibenz[a,h]anthracene			10
7H-dibenzo[c,g]carbazole			10
dibenzo[a,e]pyrene			10
dibenzo[a,h]pyrene			10
dibenzo[a,i]pyrene			10
di-n-butyl phthalate			10
3,3'-dichlorobenzidine			20
2,4-dichlorophenol			10
2,6-dichlorophenol			10
diethyl phthalate			10
dihydrosafrole			10
3,3'-dimethoxybenzidine			10
p-dimethylaminoazobenzene			10
7,12-dimethylbenz[a]anthracene			10
3,3'-dimethylbenzidine			10
thiofanox			10
alpha, alpha-dimethylphenethylamine			10
dimethyl phthalate			10
dinitrobenzene			10
4,6-dinitro-o-cresol and salts			50
2,4-dinitrophenol			50
2,4-dinitrotoluene			10
2,6-dinitrotoluene			10

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 7 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
di-n-octyl phthalate			10
diphenylamine			10
1,2-diphenylhydrazine			10
di-n-propylnitrosamine			10
ethyleneimine			10
ethyl methanesulfonate			10
fluoranthene			10
hexachlorobutadiene			10
hexachlorocyclopentadiene			10
hexachloroethane			10
indeno(1,2,3-cd)pyrene			10
isosafrole			10
malononitrile			10
melphalan			10
methapyrilene			10
methionyl			10
2-methylaziridine			10
3-methylcholanthrene			10
4,4'-methylenebis(2-chloroaniline)			10
2-methylactonitrile			10
methyl methacrylate			10
methyl methanesulfonate			10
2-methyl-2-(methylthio)propionaldehyde			10
methylthiouracil			10
1,4-naphthoquinone			10
1-naphthylamine			10
2-naphthylamine			10
p-nitroaniline			10
nitrobenzine			10
p-nitrophenol			50
N-nitrosodi-n-butylamine			10

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 8 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPR ^(e)
N-nitrosodiethanolamine			10
N-nitrosodiethylamine			10
N-nitrosodimethylamine			10
N-nitrosomethyl-ethylamine			10
N-nitroso-n-methylurethane			10
N-nitrosomethylvinylamine			10
N-nitrosomorpholine			10
N-nitrosoronicotine			10
N-nitrosopiperidine			10
nitrosopyrrolidine			10
pentachloronitrobenzene			10
phenacetin			10
phenylenediamine			10
phthalic acid esters			10
2-picoline			10
pronamide			10
reserpine			10
resorcinol			10
safrol			10
2,3,4,6-tetrachlorophenol			10
thiuram			10
toluenediamine			10
O-toluidine hydrochloride			10
2,4,5-trichlorophenol			10
O,O,O-triethylphosphorothioate			10
sym-trinitrobenzene			10
tris(2,3-dibromopropyl) phosphate			10
benzo[a]pyrene			10
chlornaphazine			10

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^(a). (Sheet 9 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
bis(2-chloroisopropyl)ether			10
hexachloropropene			10
isophorone			10
acenaphthene			10
fluorene			10
anthracene			10
pyrene			10
o-nitrophenol			10
2-methylnaphthalene			10
phenanthrene			10
benzyl alcohol			10
benzo(k)fluoranthene			10
benzo(ghi)perylene			10
dinoseb			10
diallate			10
N-nitrosodiphenylamine			10
dibenzofuran			10
acenaphthylene			10
bis (1-chloro-1-methylethyl) ether			10
O,O-diethyl-O,2-pyrazinylphosorothionate			10
isodrin			10
o-nitroaniline (2-nitroaniline)			50
m-nitroaniline (3-nitroaniline)			50
4-nitroquinoline-1-oxide			10
acetone by ABN			10
OTHER			
polychlorinated biphenyls	G, none	SW-846, #8080	1
perchlorate	P, none	70-IC ^(m)	500

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Table D-2. Preservation Techniques, Analytical Methods Used, and the Current Detection Levels for Additional Constituents on the 9905 and Appendix IX Lists^a. (Sheet 10 of 10)

CONSTITUENT	COLLECTION AND PRESERVATION ^(b,c)	ANALYSIS METHODS ^(d)	DETECTION LIMIT, PPB ^(e)
sulfide	P, NaOH/zinc acetate	SW-846, #9030	1000
citrus red no. 2	G, none	AOAC #34.015B ⁽ⁿ⁾	1000

^aMAC 173-303-9905, "Dangerous Waste Constituent List"; and 40 CFR 264, Appendix IX, "Ground-Water Monitoring List."

^bP, plastic; G, glass.

^cAll samples will be cooled to 4°C upon collection.

^dConstituents grouped together are analyzed by the same method.

^eDetection limit units except where indicated.

^fDDD = dichlorodiphenyldichloroethane.

^gDDE = dichlorodiphenyldichloroethylene.

^hDDT = dichlorodiphenyltrichloroethane.

ⁱDirect aqueous injection.

^jPCDD = polychlorinated dibenzo-p-dioxin.

^kPCDF = polychlorinated dibenzofuran.

^lTCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin.

^mAnalytical method adapted from Method 300.0, EPA 1984.

ⁿAOAC 1980.

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