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:	11 OF 15
DOCUMENT #:	WA7890008967 Rev 8
TITLE:	Hanford Facility RCRA Permit, Dangerous Waste Portion, Rev 008, 9/04

ATTACHMENT 41

1301-N and 1325-N Liquid Waste Disposal Facilities

Contents

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Contents

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

JR 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)

*The date construction of the Hanford Facility commenced

☐ 2. **New Facility** (Complete item below.)

MO	DAY	YEAR

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

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.

1. Amount – Enter the amount.
2. 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
..ers	L	Tons Per Hour	D	Hectare-Meter	F
..bic 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	D	8	1	4,320,000		U					
2											
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.

D81

The 1301-N Liquid Waste Disposal Facility (LWDF) was used from 1963 to September 1985. The LWDF received mixed waste process and cooling waste water from N Reactor. The LWDF also received dangerous waste generated from laboratories, and may have received waste from spills within the N Reactor Building, which were discharged through the mixed waste drain system. The dangerous waste discharges consisted of less than 0.002% of the total volume of the waste discharged to the LWDF. The 1301-N LWDF was a percolation unit designed for the disposal of liquid waste through the soil column. The process design capacity for the LWDF was 16,352,900 liters (4,320,000 gallons) a day. The process design capacity reflects the maximum volume of water discharged on a daily basis rather than the physical capacity of the unit. The influent pipes up to the face of the 105-N building facility are considered to be included within the treatment, storage, and disposal unit boundary.

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 odes 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:

1. 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.
2. 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.
3. 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	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)*				D. Processes 2. Process Description *(if a code is not entered in D(1))*
1	F	0	0	3	6,200		P		D81				Percolation
2	D	0	0	2	20,600		P		D81				Percolation
3	D	0	0	6	100		P		D81				Percolation
4	D	0	0	7	10,000		P		D81				Percolation
5	D	0	0	8	150		P		D81				Percolation
6	D	0	0	9	6,200		P		D81				Percolation
7	W	C	0	2	4,000		P		D81				Percolation
8	W	T	0	2	15,000		P		D81				Included with above
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IV. DESCRIPTION OF DANGEROUS WASTE (continued)

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

The 1301-N LWDF was used for the disposal of liquid waste from N reactor. The waste consisted of waste from nonspecific sources and listed waste (F003), toxicity characteristic waste (D006, D007, D008, and D009), characteristic waste (D002), state-only carcinogenic waste (WC02), and state-only toxic waste (WT02).

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	John D. Wagoner	2/25/97

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.

[signature] 2/25/97

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

Date

[signature] 3/7/97

Co-operator
R. Michael Little, President
Bechtel Hanford, Inc.

Date

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/State I.D.. No.

W	A	7	8	9	0	0	0	8	9	6	7

FOR 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)

*The date construction of the Hanford Facility commenced

☐ **2. New Facility** (Complete item below.)

MO	DAY	YEAR

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

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.

1. Amount – Enter the amount.
2. 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	D	8	1	4,320,000		U					
2											
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.

D81

The 1325-N Liquid Waste Disposal Facility (LWDF) was used from 1985 to April 1991. The LWDF received nonregulated mixed process and cooling waters from N Reactor. The LWDF also received dangerous waste generated from laboratories and may have received waste from spills from within the N Reactor Building, which was discharged through the mixed waste drain system. The dangerous waste discharges consisted of less than 0.002% of the total volume of the waste discharged to the LWDF. The LWDF was a percolation unit designed for the disposal of liquid waste through the soil column. The process design capacity for the 1325-N LWDF was 16,353,000 liters (4,320,000 gallons) per day. The process design capacity reflects the maximum volume of water discharged daily basis rather than the physical capacity of the LWDF. The influent pipes between the 1325-N and the 1301-N LWDFs are considered to be included within the treatment, storage, and disposal unit boundary.

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 odes 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

3. 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).

4. 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:

4. 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.

5. 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.

6. 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	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))*
1	F	0	0	3	6,200		P		D81				Percolation
2	D	0	0	2	20,600		P		D81				Percolation
3	D	0	0	6	100		P		D81				Percolation
4	D	0	0	8	150		P		D81				Percolation
5	D	0	0	9	6,200		P		D81				Percolation
6	W	C	0	2	4,000		P		D81				Percolation
7	W	T	0	2	15,000		P		D81				Included with above
8													
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. DESCRIPTION OF DANGEROUS WASTE (continued)

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

The 1325-N LWDF was used for the disposal of liquid waste from N reactor. The waste consisted of waste from nonspecific sources and listed waste (F003), toxicity characteristic waste (D006, D008, and D009), characteristic waste (D002), state-only carcinogenic waste (WC02), and state-only toxic waste (WT02).

V. FACILIITY 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	John D. Wagoner	2/25/97

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.

John D. Wagoner — 2/25/97

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

R M Little — 2/7/97

Co-operator — Date
R. Michael Little, President
Bechtel Hanford, Inc.

Contents

Figures

Tables

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2.0 UNIT DESCRIPTION

The closure plan for the 1301-N Liquid Waste Disposal Facility (1301-N), also known by the designation 116-N-1, and for the 1325-N Liquid Waste Disposal Facility (1325-N), also known by the designation 116-N-3. The 1301-N and 1325-N terminology will be used throughout this appendix because the Liquid Waste Disposal Facilities are identified as such in their interim status Part A Permit Applications. These radioactive dangerous waste units operated as soil column disposal units, most recently under the authority of the *Washington Administrative Code* (WAC) 173-303. Closure of these units will commence pursuant to WAC 173-303-610 and the Hanford Facility Dangerous Waste Permit (Permit). Modification of the Permit to include this closure plan is scheduled to occur in calendar year 1999. However, because of the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) milestone that requires one document be submitted to address the four treatment, storage, and disposal units this closure plan will be incorporated into the Permit Modification in December 1998.

This closure plan is part of the 100-NR-1 Treatment, Storage, and Disposal Corrective Measures Study (DOE/RL-96-39, Rev. 1A). Approval of this closure plan will be obtained through the Permit modification process. Contaminated groundwater associated with 1301-N and 1325-N TSD operations is defined as the 100-NR-2 Operable Unit (OU). Remedial alternatives associated with contaminated groundwater are defined in the 100-NR-1/NR-2 Treatment, Storage, and Disposal Corrective Measures Study. Chosen remedial actions for 100-NR-2 groundwater will be defined in a separate ROD and, again, incorporated into the Permit through Permit modification. Actual closure activities necessary to close these units are not known at this time because the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) alternative selection process has not been completed. Therefore, this closure plan contains closure activities that may be required for the range of 1301-N and 1325-N remedial alternatives presented in Permit Attachment 41, Chapter 5.0. This range includes two closure options available to dangerous waste units under WAC 173-303 and the Permit: modified closure or landfill closure.

2.1 REGULATORY BACKGROUND

The 1301-N and 1325-N units are operated by the U.S. Department of Energy (DOE), Richland Operations Office (RL), and co-operated by Bechtel Hanford, Inc. Although the U.S. Government holds legal title to this facility, the RL, for purposes of regulation under WAC 173-303, is considered the legal owner of the facility under existing U.S. Environmental Protection Agency (EPA) interpretive regulations (51 Federal Register 7722).

The Part A, Form 3, dangerous waste permit application documentation for 1301-N originally was submitted to the Washington State Department of Ecology (Ecology) and the EPA in August 1986. Documentation for the 1325-N Liquid Waste Disposal Facility originally was submitted in February 1987.

The Part A identifies the listed waste spent solvent, methanol (F003), as being disposed to 1301-N and 1325-N. Any media or debris that came into contact with wastewaters disposed to these units may also, by definition, be considered to be a listed dangerous waste in lieu of an approved contained-in determination. The reason this is not stated definitively is because, federally, F003 spent solvents are no longer listed if they do not exhibit the characteristic of ignitability (40 CFR 261.3[a][2][iii]), however, a similar 'exclusion' does not exist in State regulation.

Soil samples taken from the 1325-N Trench resulted in non-detectable levels of methanol. The values reported for the nondetects range from 5.0 to 5.4 mg/kg and are well below the Model Toxics Control Act Method B cleanup of 400 mg/kg. Sampling of the 1301-N Crib was not conducted since it is considered to be analogous with the 1325-N Trench. In December 2000, Washington State Department of Ecology granted a contained-in determination for the soils located within the 1325-N and 1301-N Liquid Waste Disposal Facilities.

2.2 CLOSURE PLAN AND CORRECTIVE MEASURES STUDY INTEGRATION

Closure of the 1301-N and 1325-N units will occur under the authority of WAC 173-303. These units are also defined under the 100-NR-1 OU and are part of DOE/RL-96-39, Rev. 1A. Integrated TSD and OU closure actions will be necessary to remediate contaminated soil and groundwater. Actions taken to remediate these TSDs will comply with the provisions of both CERCLA and RCRA. The CERCLA public involvement, including public notice and opportunity to comment, has been enhanced to concurrently satisfy the RCRA closure process. The remedy selected under CERCLA will be incorporated into the Hanford Facility RCRA Permit as the RCRA closure action after issuance of the public notice and comment process.

The CERCLA ROD was issued subsequent to the Hanford Facility RCRA Permit modification. Should the CERCLA ROD contain provisions inconsistent with the approved RCRA modifications, the Hanford Facility RCRA Permit will be again modified to reconcile these differences during the next permit modification cycle.

Closure options available under WAC 173-303-610 and the Permit are as follows:

Clean closure - requires that groundwater be uncontaminated by dangerous waste constituents (as evidenced through compliance with WAC 173-303-645) and that soils contain concentrations of dangerous waste constituents below *Model Toxics Control Act* (MTCA) Method B direct soil exposure and groundwater protection levels (WAC 173-303-610[2][b][I] and Permit Condition II.K.1). This closure option is compatible with both exposure scenarios presented in DOE/RL-96-39, Rev. 1A, rural-residential and the modified CRCIA Ranger/Industrial Scenario because it allows for unrestricted use of the units after closure. Because it is unclear at this time whether the groundwater under 1301-N and 1325-N has been contaminated with dangerous waste constituents from past operation of these units, as defined under WAC 173-303-645, this closure option has not been identified as available to 1301-N and 1325-N in this closure plan. Should a clean soil column be attained and future groundwater monitoring indicate levels of dangerous waste constituents are below MTCA Method B levels, this option will be revisited through Permit modification.

Modified closure - requires that soil concentrations of dangerous waste constituents not exceed MTCA Method C direct soil exposure and groundwater protection levels. Groundwater may or may not be contaminated by dangerous waste constituents (Permit Condition II.K.3). This closure option is only compatible with modified CRCIA ranger/industrial uses of the land (as defined for the purposes of Permit Attachment 41) because institutional controls would be required in order to limit access to the contaminated media.

Landfill closure - required when soils contain concentrations of dangerous waste constituents above MTCA Method C direct soil exposure and groundwater protection levels. Groundwater may or may not be contaminated by dangerous waste constituents (Permit Condition II.K.4). This closure option is only compatible with modified CRCIA ranger/industrial uses of the land because capping and other institutional controls would be required in order to limit access to the contaminated media.

Closure option decisions at 1301-N and 1325-N will be driven by decisions made pursuant to a CERCLA ROD for these units. Remedial alternatives compared in Permit Attachment 41 encompass modified and landfill closure options available under WAC 173-303-610 and the Permit. Therefore, information is contained in Permit Attachment 41 that address compliance with all potential closure options. Remedial alternatives compared are presented below:

- No Action under a rural residential or modified CRCIA ranger/industrial exposure scenario (RRES-1), (MCRIS-1)

- Remove/Treat if Required/Dispose/Backfill under a residential or modified CRCIA ranger/industrial exposure scenario (RRES-6), (MCRIS-6)
- Remove to 3.0 m (10 ft) below ground surface (bgs)/Treat if Required/Dispose/Backfill/Cap for Groundwater Protection under a modified CRCIA ranger/industrial exposure scenario (MCRIS-7)
- Remove to 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify for Groundwater Protection/Backfill under a modified CRCIA ranger/industrial exposure scenario (MCRIS-8).

The RRES-1 and MCRIS-1 Alternatives are presented in DOE/RL-96-39, Rev. 1A for baseline comparison but are not considered viable alternatives for 1301-N and 1325-N. MCRIS-6 and MCRIS-8 Alternatives may result in a modified closure decision, depending upon the concentrations of dangerous waste constituents left in the units after excavation is completed. Landfill closure is precluded by the RRES-6, MCRIS-6, and MCRIS-8 Alternatives because they do not include placement of a final cover over the units. The MCRIS-7 Alternative may result in a modified closure or landfill closure decision depending upon the concentrations of dangerous waste constituents left after excavation. Although unlikely, a modified closure option may still be viable for the MCRIS-7 Alternative because capping of these units may be required for purposes unrelated to closure of these units under WAC 173-303-610, i.e., protection of the groundwater from radiological contaminants remaining in soils below 3.0 m (10 ft).

2.3 CLOSURE PERFORMANCE STANDARDS

The closure performance standards of WAC 173-303-610(2) require that the owner/operator of a TSD unit close the unit in a manner that (1) minimizes the need for further maintenance; (2) controls, minimizes, or eliminates postclosure escape of dangerous waste to the extent necessary to protect human health and the environment; and (3) returns the land to the appearance and use of surrounding land areas.

2.3.1 Minimize the Need for Further Maintenance

The extent of future site maintenance depends on the closure option chosen for 1301-N and 1325-N (i.e., modified, or landfill closure). Maintenance, monitoring, and inspections necessary to minimize the need for further maintenance of the units under a modified or landfill closure option are defined in Permit Attachment 41, Chapter 5.0.

2.3.2 Control Dangerous Waste Escape to Protect Human Health and the Environment

Closure activities defined in Permit Attachment 41, Chapter 4.0 will ensure the control of dangerous waste during closure activities. Because these activities cannot be fully defined until a remedial alternative is chosen through a ROD and remedial design is defined, these activities describe a range of activities that may be undertaken in order to achieve modified or landfill closure. Closure activities will meet the remedial action objectives for soils as defined in Permit Attachment 41, Chapter 3.0. Remedial action objectives for contaminated groundwater associated with 1301-N and 1325-N operations are defined in Permit Attachment 41, Chapter 4.0. These objectives are designed to protect both human health and the environment.

2.3.3 Return Land to Appearance and Use of Surrounding Area

The appearance and use of 1301-N and 1325-N after closure will be consistent with the future use of the 100-N Area. Permit Attachment 41 defines two possible exposure scenarios: rural-residential and modified CRCIA ranger/industrial. All alternatives include the commitment to revegetate the surface soils.

2.4 GENERAL DESCRIPTION OF UNITS

This section provides a general description of the 1301-N and 1325-N Liquid Waste Disposal Facilities. This description is Intended to provide an overview of these units.

The 1301-N and 1325-N surface soils and subsoils, including the UPR-100-N-31 spill, and associated structures and piping that have been contaminated by dangerous waste constituents from these units are subject to this WAC 173-303 closure action.

The 1301-N and 1325-N units were the primary Liquid Waste Disposal Facilities for the N Reactor. Wastes disposed included reactor coolant, spent fuel storage basin, and periphery cooling systems bleed off. Also included were reactor primary coolant loop decontamination rinse solution and discharges from building drains containing radioactive wastes generated in reactor support facilities. The 1301-N unit was operated from December 1963 until September 1985. The 1325-N unit was operated from October 1983 until April 1991. From October 1983 to September 1985, both units were in operation.

For a general discussion on the N Reactor facility background and more in-depth description of these units, refer to DOE/RL-96-39, Rev. 1A, Section 2.0.

2.4.1 Topographical Maps

General topographical maps for the area surrounding the 1301-N and 1325-N units are provided in Figures 2.1 and 2.2.

2.4.2 Floodplain

The U.S. Army Corp of Engineers has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to a maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 41 million L/s (1.4 million ft^3/s). The floodplain associated with the probable maximum flood is shown in Permit Attachment 33 (DOE/RL-91-28), General Information Portion, §2.2.1.4, Flood Plain Area. The 1301-N and 1325-N units would not be affected by the probable maximum flood.

2.4.3 Traffic

The majority of traffic inside the Hanford Site boundaries consists of light-duty vehicles used to transport employees to work areas. The 1301-N and 1325-N units are located within the Hanford Controlled Access Area where roadways cannot be accessed by the general public. These facilities are isolated from the nearest public highway, State Highway 24, by approximately 6 km (4 mi). Vehicle traffic around the units is restricted and is minimal, as the area is enclosed by a fenced with locked gates and is posted as a radiation zone. DOE/RL-96-39, Rev. 1A, Section 2.4 provides additional details about the current postings on the perimeter fence.

2.4.4 General Hydrogeologic Conditions

DOE/RL-96-39, Rev. 1A, Section 2.3.2 provides information on the geology and hydrogeology underlying the 1301-N and 1325-N units.

2.4.5 Physical Dimensions of the Units

The 1301-N unit consists of a 16-m by 3.7-m (52- by 12-ft) weir box inside a 38- by 88-m (125-by 290-ft) rectangular basin (crib). A zigzag extension trench, approximately 490 m (1,600 ft) long, 15 m (50 ft) wide, and 3.7 m (12 ft) deep, was added to the crib.

The 1325-N unit includes a concrete header box inside a 73- by 76-m (240- by 250-ft) rectangular basin (crib). A straight extension trench, approximately 914 m (3,000 ft) long, 16.8 m (55 ft) wide, and 3.0 m (10 ft) deep, was also added to this crib.

2.4.6 Design Capacity

Both the 1301-N and 1325-N Liquid Waste Disposal Facilities were designed with a discharge capacity of 11,400 L/min (3,000 gal/min). The average flow rate was approximately 6,400 L/min (1,700 gal/min).

2.4.7 Ancillary Equipment

The 1301-N and 1325-N units are passive liquid waste disposal facilities that do not rely on active systems for operations support. The units consist of transfer piping, concrete effluent distribution structures, and soils to distribute liquid wastes.

2.4.8 Containment Systems

The 1301-N and 1325-N units do not include any containment systems.

2.4.9 Structures and Piping Requiring Removal or Characterization as Clean

The structures in the 1301-N and 1325-N Liquid Waste Disposal Facilities include concrete structures and earthen basins and trenches. The 1301-N unit consists of a 16- by 3.7-m (52- by 12-ft) weir box, a 38- by 88-m (125- by 290-ft) rectangular basin (crib), and a zigzag extension trench, approximately 490 m (1,600 ft) long, 15 m (50 ft) wide, and 3.7 m (12 ft) deep.

The 1325-N unit includes a concrete header box, a 73- by 76-m (240- by 250-ft) rectangular basin (crib), a tie-in structure, and a straight extension trench, approximately 914 m (3,000 ft) long, 16.8 m (55 ft) wide, and 3.0 m (10 ft) deep.

Figure 2.1 shows the pipelines to be removed or characterized as clean between the 1722-N Building and 1301-N and between 1310-N and 1301-N. Figure 2.2 shows the piping between the 1301-N Crib and the 1325-N Crib.

Refer to Permit Attachment 41, Chapter 4.0, Closure Activities, for a more in-depth discussion on the removal of structures.

2.4.10 Security

The entire Hanford Site is a controlled-access area. The Hanford Site maintains around-the-clock surveillance to restrict unauthorized access for the protection of the public and of government property, classified information, and special nuclear materials. The Hanford Patrol maintains a continuous presence of protective force personnel to provide Hanford Site security.

Within the Hanford Site are operational areas, including 100-N, to which access is restricted. There is a staffed checkpoint at the Wye Barricade through which access to the 100-N Area is allowed only to authorized personnel. Authorized personnel are those individuals with a DOE-issued security identification badge indicating the appropriate authorization. Such personnel are subject to a search of items carried into or out of controlled areas.

2.5 WASTE CHARACTERISTICS

2.5.1 Liquid Waste Discharges

The wastes disposed in 1301-N and 1325-N were generated from N Reactor operations. The waste streams included the following:

- Reactor coolant system bleed off
- Spent fuel storage basin cooling water overflow
- Reactor periphery cooling systems bleed off
- Reactor primary coolant loop decontamination rinse solution
- Building drains serving reactor support facilities.

The combination of these waste streams resulted in an average flow of approximately 6,400 L/min (1,700 gal/min). Results of influent sampling and analysis (Table 2.1) did not indicate the characteristics of a dangerous waste.

Reactor primary coolant system. The reactor primary coolant system was supplied by demineralized water with chemicals added for water quality control (QC). Ammonium hydroxide was used for pH control and was injected at a concentration of approximately 40 ppm to maintain a pH of 10.2 to 10.4 standard units. Hydrazine was introduced for oxygen control at a concentration of 0.04 ppm.

Fuel storage basin cooling water. The spent fuel storage basin was supplied by filtered water with chlorine added as an algaecide. A trace amount of residual chlorine was maintained to ensure complete treatment.

Reactor periphery cooling systems. Reactor periphery cooling systems that discharged bleed-off wastes to 1301-N and 1325-N include the following:

- Graphite and shield cooling
- Reactor control rod cooling
- Reactor secondary coolant loop.

As with other reactor, cooling systems, bleed off and spillage from the periphery cooling systems resulted in small continuous discharge.

Graphite and Shield Cooling. The graphite and shield cooling system was supplied by demineralized water with chemicals added for water QC. Ammonium hydroxide was injected at a concentration of approximately 40 ppm to maintain a pH of 10.0 to 10.2 standard units. Hydrazine was injected for oxygen control at a concentration of 0.04 ppm.

Reactor Control Rod Cooling. The reactor control rod cooling system was supplied by demineralized water with chemicals added for water QC. Ammonium hydroxide was injected at a concentration of approximately 40 ppm to maintain a pH of 7.0 standard units. Hydrazine is injected for oxygen control at a concentration of 0.15 ppm.

Reactor Secondary Coolant Loop. The reactor secondary coolant loop was supplied by demineralized water with chemicals added for water QC. Morpholine was injected at a concentration of approximately 4 ppm to maintain a pH of 8.6 to 9.2 standard units. Hydrazine was injected for oxygen control at a concentration of 1 ppm or less.

Reactor primary coolant loop decontamination. The reactor primary coolant loop was decontaminated every 2 to 4 years. The decontamination solution consisted of 79,500 L (21,000 gal) TURCO 4512-A™ (70% phosphoric acid) and 136 to 181 kg (300 to 400 lb) of diethylthiourea. This solution was diluted to an 8 wt% phosphoric acid solution as it entered the reactor coolant loop.

After the pH of the rinsate was verified between 6.0 and 9.0 standard units, the final rinse solution containing approximately 378,500 L (100,000 gal) of demineralized water was discharged. The calculated phosphoric acid released per decontamination was 5.7 L (1.5 gal), and the calculated amount of diethylthiourea was 2.3 g (0.0051 lb).

Building drains. The radioactive drain system collected radioactive water from throughout the 109-N and 105-N Buildings. Pump leakage, system bleed off from the reactor primary and periphery cooling systems, laboratories, decontamination activities, and other routine activities were drained to 1301-N and 1325-N via this system.

Three of the waste streams exhibited characteristics of a dangerous waste at the point of generation. These were leaks and spills from the auxiliary power battery lockers, hydrazine mixing spills, and laboratory wastes. Each of these wastes contained contaminants that are designated dangerous wastes under WAC 173-303-090. However, sampling of the 1301-N and 1325-N influent (Table 2.1) did not identify characteristics of a dangerous waste at the point of discharge into 1301-N and 1325-N.

Wastes from Chemical Analyses. Chemical analyses were performed in laboratories to determine hydrazine, ammonia, chloride, and fluoride concentrations in reactor coolant. Waste characterization indicated that approximately 9,800 L/yr (2,600 gal/yr) contained constituents designated as dangerous wastes under WAC 173-303-090.

Auxiliary Power Battery Lockers. Spills and leaks from the auxiliary power battery lockers contributed 300 to 450 L/yr (80 to 120 gal/yr) of waste from nickel-cadmium and lead-acetate batteries. It is estimated that approximately 40% of the spilled material was from nickel-cadmium batteries and 60% from lead-acetate batteries.

Hydrazine Mixing and Injection Area Floor Drains. Hydrazine spills from mixing and injection activities entered the radioactive drain system. Spills were very small in volume and, in the case of the mixed solution, were extremely dilute. Approximately 160 kg (350 lb) of hydrazine was spilled yearly in this manner.

2.5.2 Liquid Waste Discharge Chronology

A chronology of liquid waste discharges to 1301-N and 1325-N is provided in Table 2.2.

Table 2.1. 1301-N and 1325-N Effluent Analysis

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	6.58	6.56	6.97	6.70
Conductivity (micromhos)	148	155	190	164
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.0018	0.002	0.002	0.0019
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.027	0.027	0.028
Cadmium (.002 ppm)	ND	ND	ND	ND
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	1.831	1.819	1.781	1.810
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	ND	ND	ND	ND
Manganese (.005 ppm)	ND	ND	ND	ND
Potassium (.1 ppm)	0.647	0.608	0.606	0.620
Iron (.05 ppm)	0.081	0.077	0.050	0.069
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND
Calcium (.05 ppm)	14.40	13.97	14.05	14.14
Nitrate (.5 ppm)	ND	ND	ND	ND
Sulphate (.5 ppm)	12.41	11.53	11.97	11.97
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	1.57	1.48	1.53	1.53
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	---	0.023	0.009	0.016
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND

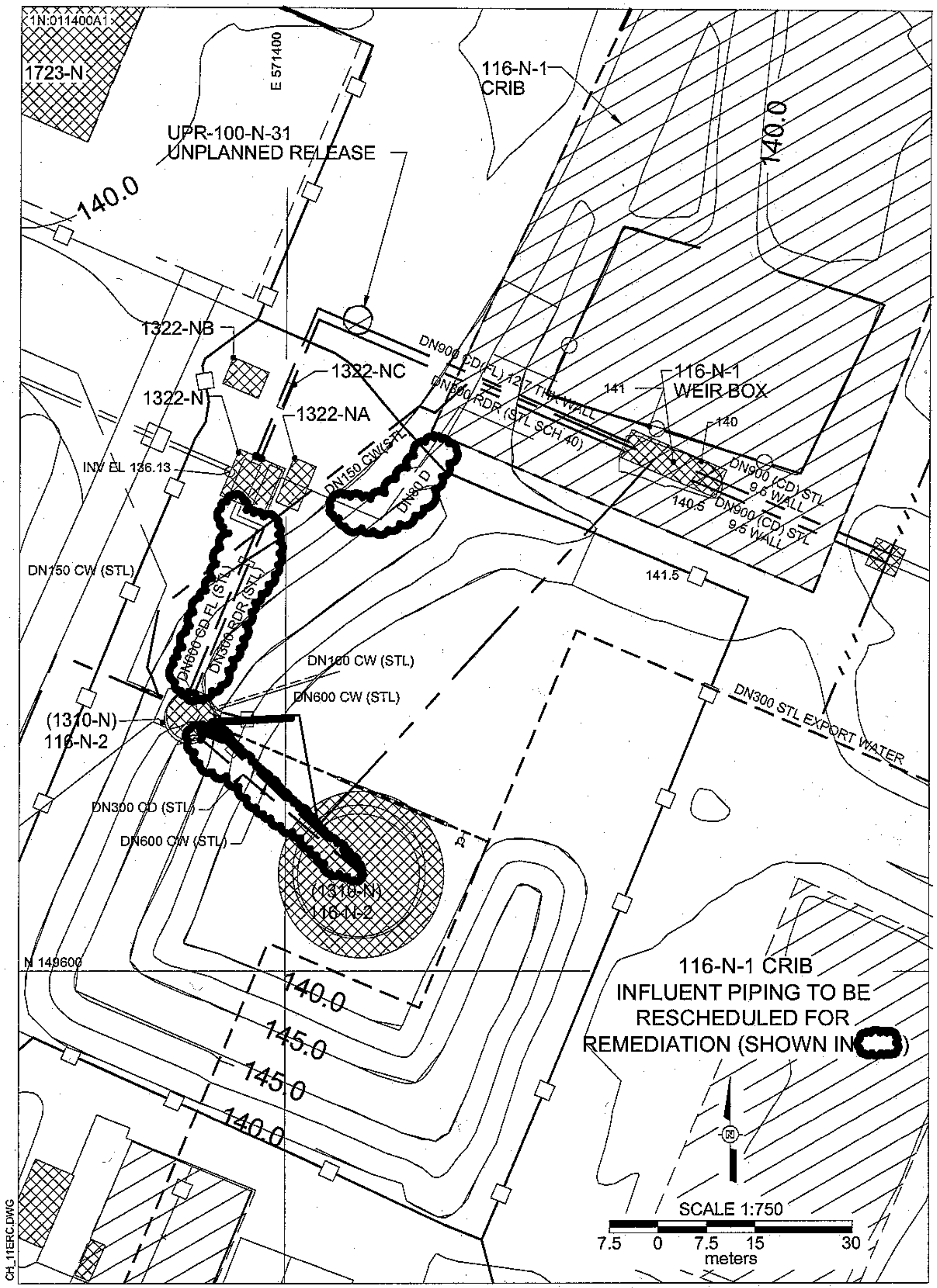
ND = Not Detected MDL = Minimum Detection Limit Data obtained from samples taken August 1985 Diediker and Hall. (1987)

Table 2.2. Chronology of Liquid Waste Discharges

Year	**Liquid Waste Discharge to 1301-N** Liquid Waste Disposal Facility **(L/day)**	**Liquid Waste Discharge to 1325-N** Liquid Waste Disposal Facility **(L/day)**
1964	9,462,500*	0
1965	9,462,500*	0
1966	9,462,500*	0
1967	9,462,500*	0
1968	9,462,500*	0
1969	9,462,500*	0
1970	9,462,500*	0
1971	9,462,500*	0
1972	9,462,500*	0
1973	8,702,000	0
1974	9,500,000	0
1975	9,500,000	0
1976	9,900,000	0
1977	14,500,000	0
1978	12,500,000	0
1979	13,500,000	0
1980	12,500,000	0
1981	10,500,000	0
1982	10,500,000	0
1983	6,942,000	1,960,000
1984	8,100,000	1,900,000
1985	7,200,000	2,800,000
1986	0	7,250,000
1987	0	2,100,000
1988	0	1,660,000
1989	0	1,660,000
1990	0	1,660,000
1991+	0	0

[1]WHC-SD-ER-TA-001, Rev. 0 (WHC 1991).*There are no reliable data available for average flow rates and effluent discharge rates for 1301-N. Estimates based on discharge volumes from 1973 to 1976 were used for 1964 through 1972. Data for 1973 through 1989 were taken from the yearly effluent release reports. LWDF = liquid waste disposal facility

Figure 2.1. 116-N-1 Crib Influent Piping to be Rescheduled for Remediation



Contents

Figures

Tables

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3.0 GROUNDWATER MONITORING

3.1 AQUIFER IDENTIFICATION

The unconfined aquifer in the 100-N Area is located primarily in the upper part of the Ringold Formation (sands and gravels) and is approximately 12 to 15 m (40 to 50 ft) thick. The base of the aquifer is believed to be a laterally continuous clay-rich unit containing a series of paleosols. Lithologies in this unit range from clay and silt to sand. Most of the wells in the 100-N Area did not penetrate through the clay layer; therefore, the thickness of the clay-rich unit is unknown at most locations.

The water table is approximately 21 to 23 m (69 to 75 ft) below land surface near 1301-N and approximately 23 m (75 ft) below land surface near 1325-N. Water levels have returned to these "pre-Hanford" levels after years of groundwater mounding caused by artificial recharge from the units and other effluent disposal in the 100-N Area.

A representative range of transmissivity estimates for the unconfined aquifer in the 100-N Area is 93 to 560 m^2/day (1,000 to 6,030 ft^2/day) throughout most of that area. Wells in the northwest portion seem to show a higher transmissivity (up to 1,900 m^2/day [20,500 ft^2/day]). These values correspond to horizontal hydraulic conductivity of 6 to 37 m/day (20 to 121 ft/day), and 120 m/day (394 ft/day) in the northwest portion. Specific yield is estimated at 0.1 to 0.3.

Hartman and Lindsey (1993) describe the hydrogeology of the 100-N Area in more detail.

3.2 INTERIM STATUS GROUNDWATER MONITORING

Groundwater monitoring began at 1301-N and 1325-N in December 1987. The original monitoring networks were modified over the years as water levels declined and new wells were installed to replace dry wells.

After the first year of groundwater monitoring at 1301-N, specific conductance in one downgradient well was found to be elevated above background (i.e., upgradient) levels. A groundwater quality assessment program was initiated (Gilmore and Jensen 1989). The assessment program found no evidence that dangerous waste or dangerous waste constituents from 1301-N had entered the groundwater (Hartman 1992). Rather, the elevated specific conductance was caused by sulfate/sodium-contaminated groundwater coming from the nearby 1324-N/NA site. In 1992, the groundwater monitoring program at 1301-N reverted to an indicator parameter monitoring program, as described in 40 CFR 265.93(d)(6). An additional upgradient well was added to the network to reflect the influence of 1324-N/NA. New critical mean values were established for indicator parameters, and the site remains in indicator evaluation status.

Some contamination has been detected in the groundwater under or near the 1301-N and 1325-N units. Two dangerous waste constituents, nitrate and chromium, were found to be at levels above the MCL (Hartman and Dresel, 1997). Nitrate levels above the MCL of 44 mg/L were observed in well 199-N-3 and 199-N-32 in 1996. Well 199-N-3 monitors the 1301-N unit and well 199-N-32 monitors the 1325-N unit. Nitrate values from nearby wells monitoring the same interval are not above the MCL. Chromium concentrations above the MCL of 0.1 mg/L have been observed in wells 199-N-33 and well 199-N-80 in 1996. Well 199-N-33 monitors the 1325-N unit. The 1996 data from well 199-N-33 is considered anomalous. Well 199-N-80 monitors the bottom zone of the unconfined aquifer and is located downgradient from 1301-N. Wells monitoring the upper part of the unconfined aquifer for 1301-N do not have values of chromium above the MCLs. Although contamination has been detected as described, the interim status groundwater monitoring configuration did not identify these constituents as releases attributable to operation of, or residual contamination in, the 1301-N and 1325-N units through statistical analysis of upgradient versus downgradient wells.

The 1325-N unit has been monitored under an indicator evaluation program throughout its history of *Resource Conservation and Recovery Act of 1976* (RCRA) monitoring. Wells were added or deleted from the network to reflect changing conditions.

Groundwater is monitored under several programs in addition to the RCRA in the 100-N Area. The most significant programs in terms of numbers of wells and analytes are those of the RCRA, sitewide surveillance, and CERCLA. Sampling and analysis for RCRA, CERCLA, and sitewide surveillance monitoring have been coordinated for several years to avoid duplication. However, this coordination did not include the planning stages of the monitoring programs.

In an attempt to reduce redundancy further and make monitoring more efficient, representatives of the various contractors involved in 100-N groundwater monitoring held a series of workshops to consolidate and streamline monitoring. Monitoring networks were redesigned to disseminate information for all programs as efficiently as possible, and constituent lists were trimmed to the constituents of concern. Sampling frequency also decreased in some cases. Sampling trips and analytical costs are divided among data users. Borghese et al. (1996) describe the well and constituent lists for the combined program. That document does not include requirements for sampling and analysis protocols, QC, or statistical evaluations. Hartman (1996a) presents a revised groundwater-monitoring plan for the RCRA program, and this is summarized in the following section.

3.2.1 Well Location and Design

The monitoring network for 1301-N includes two upgradient wells and three downgradient wells (Figure 3.1, Table 3.1). All of the wells monitor the unconfined aquifer. As-built diagrams are included in Hartman (1996a). One of the downgradient wells, 199-N-105A, is an extraction well for the CERCLA pump-and-treat system. This well is screened across the entire thickness of the uppermost aquifer (7.3 m [24 ft]) instead of just the top 3.0 to 4.6 m (10 to 15 ft) of the aquifer like the other wells. Because it is an extraction well, 199-N-105A will pull in water from beneath a large area of the 1301-N Trench, making it a useful monitoring well

The construction of some of the 1301-N wells does not meet WAC requirements (Table 3.1). Wells 199-N-2 and 199-N-3 have perforated, carbon steel casing and no annular seals. However, these wells appear to yield representative data, and installing new wells is not warranted. Ecology has accepted the data from these and other wells since RCRA monitoring began at the 100-N Area in 1987.

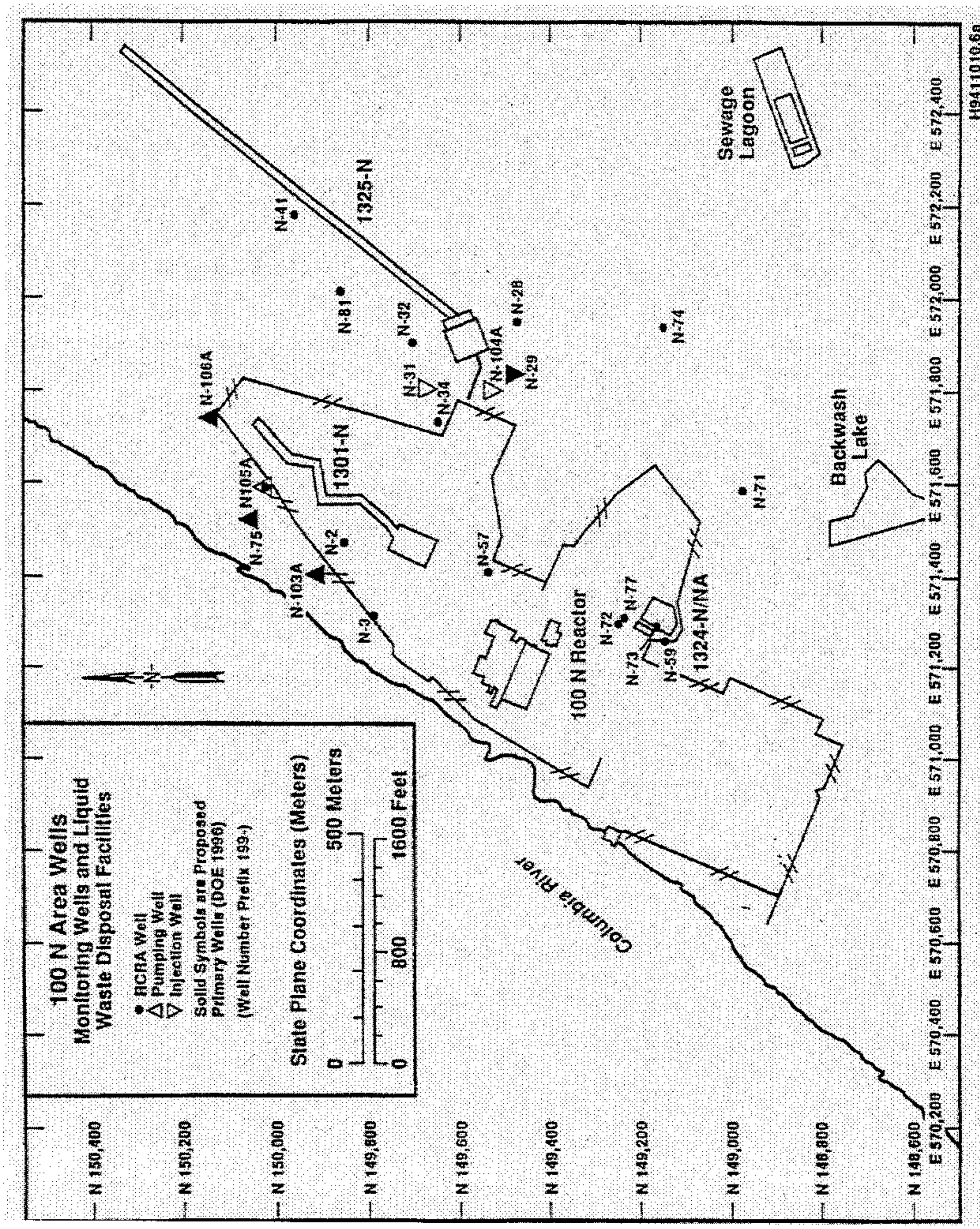
The monitoring network for 1325-N will include one upgradient and three downgradient wells (refer to Figure 3.1 and Table 3.1). Treated water from the CERCLA pump-and-treat system is injected into well 199-N-29 near the 1325-N. Well 199-N-28 is used by the RCRA program to monitor potential effects of injected water; it is not being used in statistical evaluations.

3.2.2 Sampling and Analysis Plan

The *Groundwater Monitoring Plan for the 1301-N, 1325-N, and 1324-N/NA Sites* (Hartman 1996b) describes the sampling and analysis plan for RCRA monitoring. Groundwater is sampled for the constituents listed in Table 3.2. Indicator parameters are analyzed semiannually; additional parameters are analyzed annually.

Groundwater sampling procedures, sample collection documentation, and chain-of-custody requirements are described in *Environmental Investigation Instructions (EII)* (WHC-CM-7-7), The *Environmental Activities Procedural Manual* (WHC-CM-7-8), and in the *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company* (WHC 1995). Work by other contractors is conducted to their equivalent approved standard operating procedures. Procedures for field measurements (pH, conductivity, turbidity) are specified in WHC-CM-7-8 and in the user's manuals for the meters used. Analytical methods are selected from those provided in *Test Methods for Evaluating Solid Wastes* (EPA 1990) as specified by WHC (1995) or its most recent revision.

Figure 3.1. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units



3.2.3 Quality Assurance and Quality Control

Quality assurance (QA) requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) or equivalent procedures, and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). Additional requirements for QA and QC are included in WHC (1995) or its' most recent revision.

Table 3.1. Proposed RCRA Groundwater Monitoring Networks for the 1301 N and 1325 N Liquid Waste Disposal Facilities

Well Number	Proposed Network	Drill Date	Elev. T.O.C.[a] (m)	Casing/Screen Materials	Screened or perf'd depth[b] (m)	Depth to Water[c] (m)
199-N-2	1301-N	1964	140.129	Carbon steel/ perf'd casing; no annular seal	10.7 - 28.0	21.010(6/96)
199-N-3	1301-N	1964	140.015	Carbon steel/ perf'd casing; no annular seal	10.4 - 27.7	20.793(6/96)
199-N-28	1325-N[d]	1983	141.647	Carbon steel/ stainless steel w/ packer; surface seal	14.32 - 25.3	23.311(9/94)
199-N-32	1325-N	1983	140.990	Carbon steel/ stainless steel w/ packer; surface seal	13.4 - 24.1	22.357(3/96)
199-N-34	1301-N	1983	140.247	Carbon steel/ stainless steel w/ packer; surface seal	10.4 - 23.5	21.732(3/96)
199-N-41	1325-N	1984	139.626	Carbon steel/ stainless steel w/ packer; surface seal	16.2 - 22.3	21.193(3/96)
199-N-57	1301-N	1987	139.671	Stainless steel/ stainless steel; full annular seal	17.7 - 22.3	20.708(3/96)
199-N-74	1325-N	1991	139.482	Stainless steel/ stainless steel; full annular seal	18.0 - 24.4	20.537(6/96)
199-N-81	1325-N	1993	142.067	Stainless steel/stainless steel	21.3 - 27.4	22.552(3/96)
199-N-105A	1301-N	1995	140.655	Stainless steel/ stainless steel; full annular seal	21.0 - 28.7	21.220(7/95)

a Surveyed to North American Vertical Datum of 1988.
b Approximate depth below land surface; converted from feet.
c Depth below top of casing; converted from feet.
d Well 199-N-28 to be used for supplemental information; no statistical evaluations.

Figure 3.2. Proposed RCRA Groundwater Monitoring Network for the 1301 N and 1325 N Units

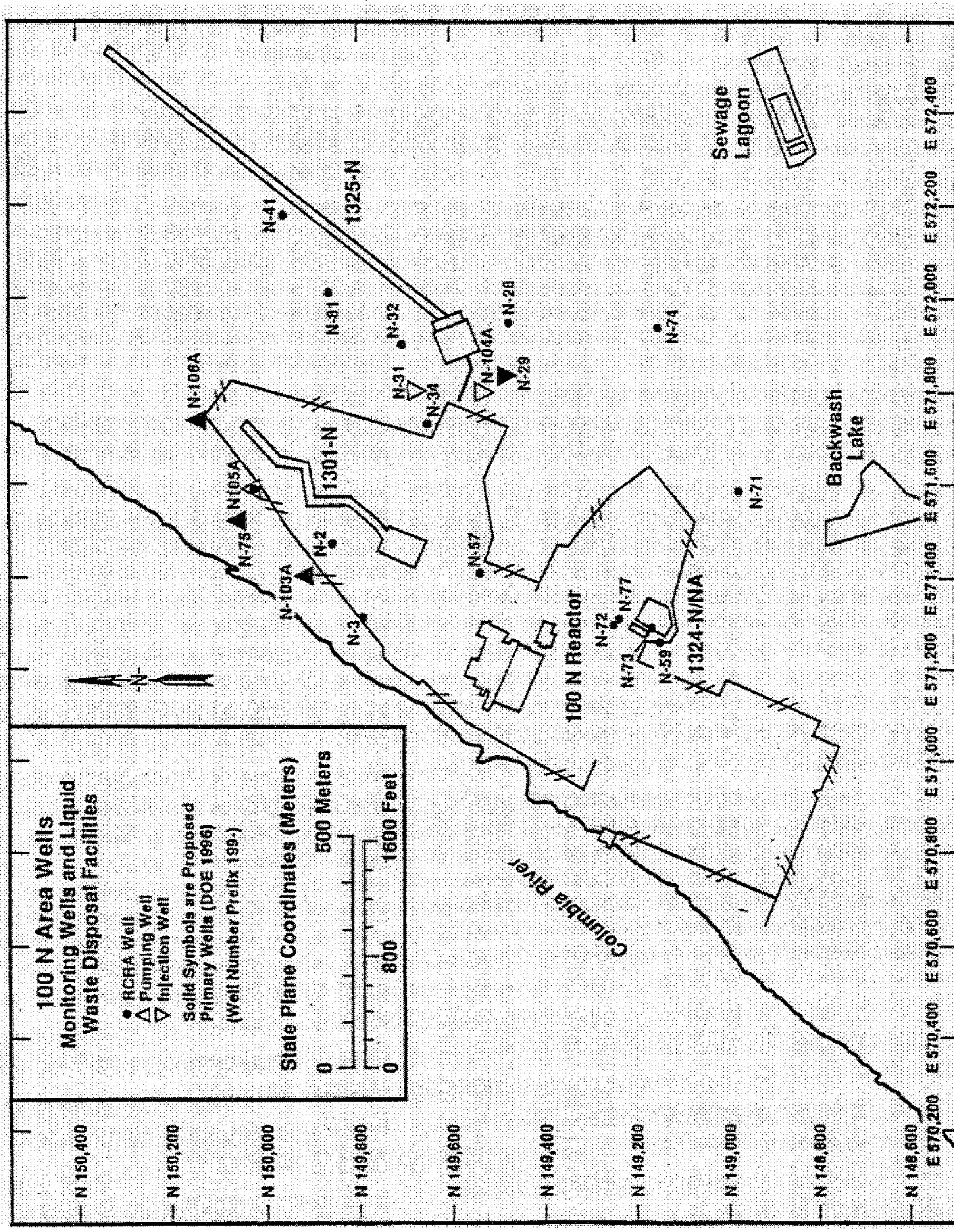


Table 3.2. Constituent List for 1301-N and 1325-N

Analyzed Semiannually	Analyzed Annually
Contamination Indicator Parameters (Quadruplicate samples): Specific conductance (field) pH (field) Total Organic Carbon Total Organic Halogen Turbidity (field)	ICP Metals (filtered) Anions Alkalinity

ICP = Inductively Coupled Plasma

3.3 RESULTS OF GROUNDWATER MONITORING

3.3.1 Potentiometric Level

At various times in the history of waste disposal at the 100-N Area, groundwater mounds formed beneath 1301-N and 1325-N. Changes in water levels are illustrated in Figure 3.2. Water levels have returned to "pre-Hanford" levels in the 100-N Area but are still affected by changes in river stage and, recently, by the operation of pumping and injection wells.

Water levels are measured in all wells before sampling. Many of the wells in the 100-N Area are also measured as part of the site-wide semiannual water level program (Serkowski et al. 1995). The Environmental Restoration Contractor has equipped about 20 wells with pressure transducers and data loggers. Any of the data described above can be used to construct water table maps to aid in determining groundwater flow directions.

During average or low river stage, natural groundwater flow is toward the northwest beneath 1301-N. When river stage is high, the gradient is reversed, and there is a potential for water to flow out of the river into the aquifer. Groundwater flow beneath 1325-N is toward the north regardless of river stage.

A groundwater pump-and-treat system has been in operation in the 100-N Area since August 1995. DOE-RL (1996b) reports the results of an evaluation of the first phase of the system's operation. Data from a network of transducers were used to construct water table maps and estimate capture zones.

Pumping of wells between 1301-N and the Columbia River has created a groundwater depression. Groundwater flows toward the pumping wells from the river and from beneath 1301-N. Treated water is injected into a well near 1325-N.

Vertical groundwater gradients are not well defined in the 100-N Area. There is no significant difference in head between wells completed at the top and bottom of the unconfined aquifer. There does appear to be an upward gradient immediately adjacent to the river. Water levels in deeper wells were consistently higher than shallow wells or the river, indicating an upward gradient (Gilmore et al. 1991).

3.3.2 Groundwater Quality

Groundwater quality in the unconfined aquifer beneath the 100-N Area has been affected by 1301-N, 1325-N, and the 1324-NA Percolation Pond. In addition, various leaks and spills may have affected soil or groundwater chemistry (DOE-RL 1991). Data from RCRA sampling and analysis are reported electronically in the Hanford Environmental Information System database. Interpretation of the data is included in annual reports (Hartman 1996a).

The indicator parameters at the 1301-N and 1325-N units are specific conductance, pH, total organic carbon (TOC), and total organic halogens (TOX) (40 CFR 265.92[b][3]). Groundwater is also analyzed for other constituents that were discharged to the 1301-N and 1325-N units during their use. These analytes include nitrate, chromium, phosphate, lead, and cadmium. Samples have also been analyzed for mercury and volatile organics in the past. Chromium, lead, and cadmium (in filtered samples), phosphate, or volatile organics have not been detected in 1301-N or 1325-N groundwater in significant concentrations. Nitrate increased in some wells near 1301-N and 1325-N during 1995, exceeding the drinking water standard in wells 199-N-2 and 199-N-3. One well southwest (upgradient) of 1301-N also had nitrate above the standard. Concentrations decreased in wells 199-N-2 and 199-N-3 in early 1996, but increased in excess of the drinking water standard in well 199-N-32. The source of nitrate is unknown.

While the 1301-N and 1325-N units were in use, they introduced radioactive constituents, primarily tritium and strontium-90, to the groundwater. These are not considered dangerous waste constituents under interim status RCRA regulations, but were monitored by RCRA in the past because they are the primary contaminants originating from the units.

3.4 GROUNDWATER MONITORING DURING CLOSURE

3.4.1 Monitoring Program

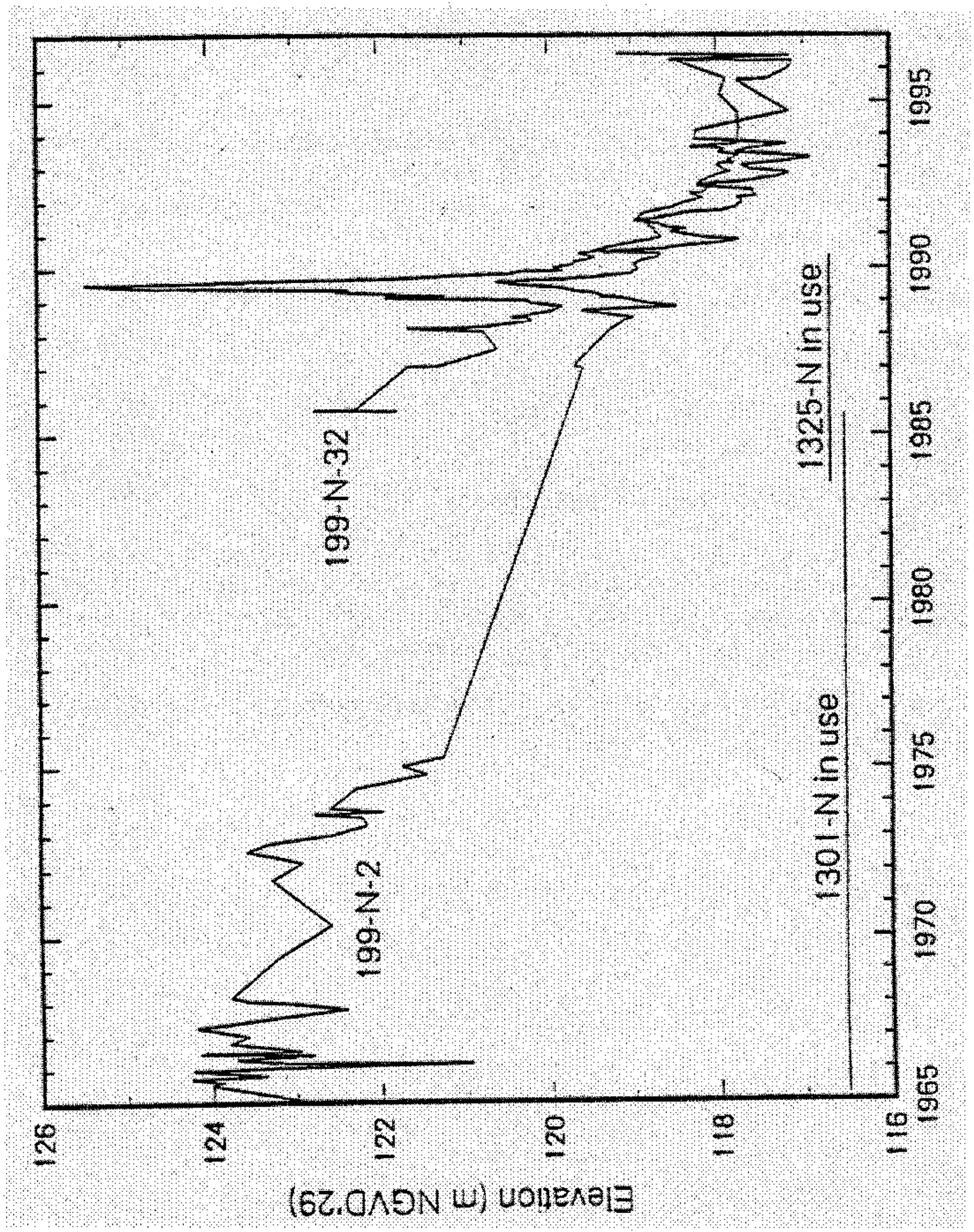
Groundwater monitoring will be done in accordance with the existing groundwater-monitoring program (Borghese, et. al 1996).

3.4.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the wellhead and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

Figure 3.3. Water Level Changes in Groundwater Below 1301-N and 1325-N



Contents

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4.0 CLOSURE ACTIVITIES

The physical activities required to close 1301-N and 1325-N Liquid Waste Disposal Facilities in accordance with WAC 173-303-610 and the Permit will be integrated with the ROD for DOE/RL 96-39, Rev. 1A. The ROD and the remedial design for the selected alternative will specify further the closure activities that will be required for CERCLA remedial action. Closure activities necessary to comply with dangerous waste regulations and the Permit will need to be consistent with CERCLA activities. CERCLA activities will be required to include elements necessary for closure of a dangerous waste unit. The Closure Plan presents the physical remedial activities and the sampling and analysis required to comply with WAC 173-303-610 and the Permit for each of the remedial alternatives presented in Attachment 41, Chapter 2.0, §2.2.

The closure activities are discussed in this section to highlight the site-specific elements of removal or characterization as clean of structures and piping for the 1301-N and 1325-N Liquid Waste Disposal Facilities. The other closure activities are not well defined for these sites at present but will be developed during the remedial design phase. Additional details about the alternatives can be found in DOE/RL-96-39, Rev. 1A, Section 5.2.

4.1 REMOVAL OF STRUCTURES

The structures in 1301-N and 1325-N Liquid Waste Disposal Facilities include concrete structures and earthen basins, trenches, fencing and signage surrounding the units, and ancillary surface structures such as valve houses associated with piping. The 1301-N and 1325-N Liquid Waste Disposal Facilities structures are discussed in Permit Attachment 41, Chapter 2.0

4.1.1 Earthen Structures

The contaminated soil in the earthen structures will be excavated by conventional earthmoving techniques. Removal technologies are described in DOE/RL-96-39, Rev. 1A, Section 5.1.3. Differing amounts of contaminated soils will be generated depending upon the remedial alternative selected for 1301 N and 1325 N. Alternatives that include soil removal are described in DOE/RL-96-39, Rev. 1A, Sections 5.2.1.5 through 5.2.1.8 for a residential exposure scenario and in DOE/RL-96-39, Rev. 1A, Sections 5.2.2.5 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. After loading into containers, contaminated soils will be treated if necessary and/or disposed in an approved disposal facility on the Hanford Site. Particular attention will be given to the protection of workers and the environment from exposure to airborne contaminants during excavation and container loading. Dust mitigating measures, such as water sprays and chemical fixatives, may be employed to control fugitive dust emissions. The as low as reasonably achievable review will consider the use of shielding and/or remote handling techniques to reduce worker exposures from direct ionizing radiation.

The 1301-N Liquid Waste Disposal Facility demolition waste volumes are discussed in DOE/RL-96-39, Rev. 1A, Sections 4.5.1.1 and 4.5.1.2 for the earthen crib structure and DOE/RL-96-39, Rev. 1A, Sections 4.5.2.1 and 4.5.2.2 for the trench. The 1325-N unit demolition volumes are presented in DOE/RL-96-39, Rev. 1A, Sections 4.5.3.1 and 4.5.3.2 for the crib, and in Sections 4.5.4.1 and 4.5.4.2 for the trench. Waste volume tabulations are provided in DOE/RL-96-39, Rev. 1A, Appendix D.

4.1.2 Concrete Structures

Alternatives that include removal of concrete structures are described in the DOE/RL-96-39, Rev. 1A, Sections 5.2.1.3 through 5.2.1.8, for a residential exposure scenario, and in Sections 5.2.2.3 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. The concrete weir box in the 1301-N Crib will be removed as contaminated waste. Demolition of the structure may be necessary or advantageous prior to removal. Dust controls will be employed to control fugitive emissions during any demolition. The demolition waste volume of the weir box is discussed in DOE/RL-96-39, Rev. 1A, Section 4.5.1.3.

The concrete cover support beams and cover panels over the 1301-N Trench and 1325-N Crib and trench will be removed as intact components, if possible. Demolition activities, if required, will be minimized to maintain control of airborne releases and to simplify soil excavation in the trench. As with the earthen structure removal, particular attention will be given to the control of fugitive dusts and worker exposures to direct ionizing radiation. The demolition waste volume of the cover system is discussed in DOE/RL-96-39, Rev. 1A, Section 4.5.2.3for 1301-N Liquid Waste Disposal Facility, and in DOE/RL-96-39, Rev. 1A, Section 4.5.4.3 for 1325 N. Waste volume tabulations are provided in DOE/RL-96-39, Rev. 1A, Appendix D.

Demolition debris and solid wastes in the cribs and trenches potentially include demolished concrete, wooden poles, and netting. These materials will be removed during crib and trench excavation operations and disposed with the contaminated soils.

4.2 PIPING REMOVAL OR CHARACTERIZATION AS CLEAN

The remediation of 1301-N and 1325-N Liquid Waste Disposal Facilities includes the excavation and removal of the contaminated piping systems that have not been characterized and determined to be clean (i.e., contain no dangerous waste constituents above residential MTCA B concentrations) between N Reactor and the cribs. Alternatives that include removal of piping are described in DOE/RL-96-39, Rev. 1A, Sections 5.2.1.3 through 5.2.1.8, for a residential exposure scenario, and in DOE/RL-96-39, Rev. 1A, Sections 5.2.2.3 through 5.2.2.8 for a modified CRCIA ranger/industrial exposure scenario. Two figures illustrate the potential extent of piping removal. Permit Attachment 41, Chapter 2.0, Figure 2.1 shows the pipelines to be removed between the 1722-N Building and 1301-N and between 1310-N and 1301-N. Permit Attachment 41, Chapter 2.0, Figure 2.2 shows the piping between the 1301-N Crib and the 1325-N Crib. Pipe lengths and map references are provided in DOE/RL-96-39, Rev. 1A, Appendix D.

The buried pipelines will be unearthed by conventional excavation equipment. The exposed piping may be segmented for removal manually or by remote methods, depending on contact radiation exposures. Contamination controls will focus on the drainage of residual fluids in the piping prior to, and during, segmentation and on the control of airborne contamination during cutting and pipe handling operations. After the piping has been removed, the pipe bedding soil will be surveyed for residual contamination, excavated, and disposed as necessary.

4.3 SAMPLING AND ANALYSIS ACTIVITIES

4.3.1 Past Soil Characterization Data

Data used to characterize the vadose zone soils were obtained from six boreholes drilled and sampled to support the 1301-N and 1325-N Liquid Waste Disposal Facilities limited field investigation (DOE/RL-96-39, Rev. 1A). DOE/RL-96-39, Rev. 1A, Figure 2-32 shows the locations of these boreholes. Two of the boreholes are adjacent to 1301-N Liquid Waste Disposal Facility (199-N-107A and 199-N-108A), one is next to 1325-N Liquid Waste Disposal Facility (199-N-109A), and three are located northwest of 1301-N Liquid Waste Disposal Facility (199-N-75, 199-N-76, and 199-N-80) between that facility and the river. Samples were obtained from near the surface to a depth of up to 30.2 m (99 ft). All of these data are presented in the limited field investigation.

In addition to the boreholes, sediment samples were collected from the 116-N-1 Crib. Data from these samples were not used in this evaluation because of insufficient QC associated with the sample collection process. Other soil samples have been collected from this vicinity, but most have only been analyzed for radionuclides.

Data from the characterization samples are summarized in Appendix A of the 1301-N and 1325-N limited field investigation. These data indicate that chromium is the only metal of concern in vadose zone soils at 1301-N Liquid Waste Disposal Facility below 3.0/4.6 m (10/15 ft). Chromium exceeded background concentrations in data associated with 1301-N Liquid Waste Disposal Facility. Mercury is the only other metal that is included in the contaminants of concern (COCs), but no data from the boreholes at 1301-N and 1325-N Liquid Waste Disposal Facilities are available to evaluate the presence or absence of this analyte in vadose zone soils. Therefore, it is retained as a COC in surface soils (0 to 3.0/4.6 m [10/15 ft]). In DOE/RL-96-39, Rev. 1A, Appendix G, mercury will not reach groundwater in 1,000 years. Therefore is not considered to be a constituent of concern for groundwater protection below 3.0/4.6 m (10/15 ft). Evaluation of nitrate concentrations in the soil is similarly limited because of a paucity of data, so that substance has been retained as a COC. Nitrate is a mobile constituent, and a nitrate plume exists in the groundwater. Therefore, nitrate is considered a COC for both surface and subsurface soils.

Data from the three boreholes located outside of these facilities indicate that no metals are above background values. One sample from the 150- to 180-cm (5- to 6-ft) interval in borehole 199-N-76 was analyzed for mercury, and its value is well below typical background concentrations. These data indicate that metals deposited in the TSDs did not migrate laterally in the vadose zone any substantial distance.

Sampling during remediation did not detect the presence of methanol in the soil. The Washington State Department of Ecology granted a contained-in determination for methanol in December 2000. The limited field investigation sampling was not analyzed for the presence of methanol, and methanol was not listed as detected in any other sampling efforts. Acetone, however, was detected in three samples collected from boreholes outside of the facilities, at concentrations up to 51 ppb. Organic analytes were not analyzed in samples collected within and adjacent to the TSD units; however, field screening using an organic vapor monitor did not detect any organic compounds. Acetone is a common laboratory contaminant, and most of the data reported by the laboratory either are at detection limit or are associated with a blank that contained detectable amounts of acetone. These circumstances cast doubt on the presence of detectable quantities of acetone in the wells outside the bounds of the TSD unit.

Additional sampling was performed in 1998 and is documented in the *Data Summary Report* (BHI 1999). Characterization of the sites was conducted through sampling in accordance with the *Sampling Analysis Plan for the 100-NR-1 Treatment, Storage, and Disposal Units During Remediation Closeout* (DOE 2000a).

4.3.2 Characterization Activities to Determine Closure Option

A *sampling and analysis plan* (DOE 2000a) has been developed to support site closure. As presented in Section 4.3 and in DOE/RL-96-39, Rev. 1A, Table 4-17, dangerous waste constituents are retained as constituents of concern in both surface soils and subsurface soils. All alternatives (other than the No-Action Alternative) will result in the removal of dangerous waste constituents above 3.0 m (10 ft) bgs for the modified CRCIA ranger/industrial exposure scenario and 4.6 m (15 ft) bgs for the rural-residential scenario. This will result in removal of all soils that could be contaminated at levels that present a direct exposure hazard as defined in MTCA. Verification sampling to determine MTCA direct soil exposure standard compliance will therefore not be required unless some areas around the units are not excavated and removed to the 3.0m and 4.6m level. Verification sampling will be performed on contaminants that may be present below 3.0 m or 4.6 m for the purposes of determining compliance with groundwater protection standards.

The Data Quality Objectives process was used (BHI 2000) to define the extent and type of sampling and analysis required during excavation and closure. This effort will define sampling issues, which may include analytes of interest, sample location, number of samples, number and frequency of field QC samples (i.e., trip blanks, equipment blanks, splits, and duplicates), sampling methodology, analytical methods, laboratory protocols, laboratory validation, data error tolerances, and data evaluation methods. This DQO effort will culminate in an Ecology-approved sampling and analysis plan.

Alternative-specific sampling and analysis activities are as follows:

RRES-6 and MCRIS-6 - The Remove/Treat if Required/Dispose/Backfill (Removal) alternatives will require sampling and analysis at the end of excavation to determine that, at a minimum, a modified closure option has been attained. Dangerous waste constituents must be below MTCA Method C direct soil exposure and groundwater protection standards in order to preclude landfill closure and placement of a cover. Dangerous waste constituents must be below MTCA B direct soil exposure and groundwater protection standards in order to achieve remediation under RRES-6.

MCRIS-7 - The Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Backfill/Capping alternative will result in the placement of a WAC 173-303-compliant cover should dangerous waste constituents be left in place above MTCA Method C levels. Concentrations of dangerous waste constituents remaining under the units would be irrelevant to the need for placement of a landfill cover; however, to determine whether other landfill postclosure requirements should be imposed at one or both units, concentrations of constituent would need to be defined. Sampling would be required after excavation and/or prior to backfilling and placement of the cap for this alternative.

MCRIS-8 - Sampling and analysis would be required for the Remove 3.0 m (10 ft) bgs/Treat if Required/Dispose/Vitrify (Vitrification) alternative to define the extent of contamination of the dangerous waste constituents needing treatment. Sampling after vitrification may be required in order to determine the effectiveness of the treatment for dangerous waste constituents.

In addition to the sampling described above, sampling may be performed during excavation to help define extent of contamination, to guide field activities, and for waste characterization to determine ex situ treatment and disposal requirements.

4.3.3 Piping Characterization

Should a determination be made that piping associated with the 1301-N and 1325-N Liquid Waste Disposal Facilities may be able to meet clean closure standards and be left in place, such a determination will be submitted to Ecology for their concurrence. This determination may be based on process knowledge, sampling, or both.

4.4 WASTE MANAGEMENT

Closure of the 1301-N and 1325-N Liquid Waste Disposal Facilities in accordance with the remedial alternatives identified will generate low-level radioactive or mixed waste in the form of contaminated soils and debris. Disposal of these wastes will be performed at the Environmental Restoration Disposal Facility or the W-025 Trench, both located on the 200 Area Plateau of the Hanford Site, in compliance with WAC 173-303 for any dangerous or mixed waste that will be generated. If generated wastes do not meet the acceptance criteria for these units, such as compliance with land disposal restrictions (40 CFR 268), a disposal plan will be developed to determine appropriate treatment or disposal options for these wastes. Waste generated as part of this remediation activity will be managed and disposed of in such a way as to ensure protection of human health and the environment.

Waste generation, management, and disposal will be conducted in accordance with operational procedures and with all State, Federal, and DOE Orders and regulations dealing with waste, including agreements with the public and stakeholders.

4.5 MODIFIED CLOSURE INSTITUTIONAL CONTROL REQUIREMENTS

Should a modified closure option be determined for 1301-N and/or 1325-N Liquid Waste Disposal Facilities, institutional controls in accordance with Permit Condition II.K.3.a and WAC 173-340-440 shall be adhered to. Institutional controls consist of physical measures and administrative and legal mechanisms. Possible methods of controlling access to contaminated sites include placement of signs, entry control such as locked fencing, artificial or natural barriers, and active surveillance. Measures to be used depend on specific site conditions and degree of hazard associated with contamination left at the end of remediation activities. Because of this, specific institutional controls cannot be detailed until after selection of an alternative and incorporation of design elements during the remedial design phase.

A notice in deed and survey plat will be submitted to the Benton County Auditor as described in Section 4.12.

4.6 FINAL COVER REQUIREMENTS FOR LANDFILL CLOSURE

Should dangerous waste contaminants be left within the soil column above MTCA Method C levels, a landfill cover would need to be designed and constructed over the unit(s). Specific design aspects associated with a landfill cover would require development after the ROD and during the remedial design phase associated with 1301-N and 1325-N Liquid Waste Disposal Facilities.

4.7 PERSONNEL TRAINING

Training will be provided to site personnel in accordance with the 1301-N and 1325-N Liquid Waste Disposal Facilities training plan contained in DOE/RL-96-39, Rev. 1A, Attachment A-4. This training will be effective until the postclosure period. At that point, the personnel training information contained in Attachment 41, Chapter 5.0, §5.4 will supplement training of personnel for postclosure care activities.

4.8 CLOSURE CONTACT

The DOE-RL will be the official contact for 1301-N and 1325-N Liquid Waste Disposal Facilities during the postclosure period at the following address:

Director, Office of Environmental Services *
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

4.9 CLOSURE SCHEDULE

Closure activities (actual cleanup) for 116-N-3 will begin in July 2000.

At the completion of 116-N-3, closure activities at 116-N-1 will begin. Approximately 600 feet (Permit Attachment 41, Chapter 2.0, Figure 2.1) of piping that is associated with the 116-N-1 TSD Waste Site and the 116-N-2 Facility and support facilities (1322-NA, NB, NC) will be deferred until decontamination and decommissioning (D&D) of these facilities. This deferral is due to safety concerns with remediating the piping and the radiological dose exposure to remedial action workers. Remediation will require excavation of the earthen berm at the 116-N-2 Facility, which provides radiological shielding.

Additionally, approximately 5,600 feet (Permit Attachment 41, Chapter 2.0, Figure 2.2) of piping that is associated with 116-N-1, 105-N and 109-N Facilities (part of the N Reactor Facility Complex) will be deferred until D&D activities of the 105-N Reactor Facility Complex. This deferral is also due to safety concerns with remediating the piping. Remediation will require excavation up to foundation walls of these facilities, thus, jeopardizing the integrity of the facilities. The pipelines intersect and/or follow active underground power lines and potable water lines. Finally, remediation will block the access routes to the ongoing pump-and-treat operations at the 100-N Springs and other active facilities in the 100-N Area.

The approximate duration of completion for both TSD units is 5 years, not including for the piping that will be deferred. The D&D of the 116-N-2 Facility and support facilities and removal of the deferred piping is planned for startup in the fiscal year 2004. The deferred piping associated with the 105-N and 109-N Facilities will be remediated as part of D&D of the 105-N Reactor Facility Complex in accordance with Tri-Party Agreement Milestone M-093-20.

The corrective action schedule of compliance for UPR-100-N-31 will be the same as the closure schedule.

4.10 AMENDMENT OF CLOSURE PLAN

The 1301-N and 1325-N Liquid Waste Disposal Facilities closure plan will be amended whenever changes in closure activities or postclosure requirements occur and prior to certification of closure and postclosure, respectively, that would constitute a Class 1, 2, or 3 modification to the Permit (WAC 173-303-830).

4.11 CERTIFICATION OF CLOSURE

In accordance with WAC 173-303-610(6), within 60 days of closure of 1301-N and 1325-N Liquid Waste Disposal Facilities, RL will submit to Ecology a certification of closure signed by both RL and an independent registered professional engineer. The certification will specify that the units have been closed in accordance with specifications contained within the approved closure plan, as amended, and as contained in the Permit.

4.12 SURVEY PLAT AND NOTICE IN DEED

A survey plat will be submitted by RL to the Benton County Planning Department no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). Also, a notice in deed will be submitted by RL to the Auditor of the Benton County no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). After submitting this notice, a certification signed by the Permittees will be submitted to Ecology stating that notification has been recorded along with a copy of the notice in deed. The notice in deed will specify the type, location, and quantity of dangerous wastes remaining after closure actions have been completed.

Contents

Table

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5.0 POSTCLOSURE PLAN

Postclosure requirements will be applicable to 1301-N and 1325-N. Because it is uncertain, whether postclosure requirements would involve modified closure requirements or landfill requirements, actions necessary to comply with both closure options are presented.

5.1 MODIFIED POSTCLOSURE INSTITUTIONAL CONTROLS AND PERIODIC ASSESSMENTS

Institutional controls under a modified closure option will consist of continued restrictions to access and use of groundwater and may consist of access controls to surface soils or deeper soils such as a fence. Institutional controls will be defined after remedial alternative selection. Inspections and maintenance of institutional controls and monitoring will be requirements of postclosure under a modified closure option.

5.1.1 Periodic Assessments

Periodic assessments shall include a compliance-monitoring plan in accordance with Permit Condition II.K.3.b and WAC 173-340-410. The compliance-monitoring plan will address the assessment requirements, which include protection and confirmation monitoring. This will include at least one assessment activity that is to take place after a period of five years from the completion of closure. The assessment activity will demonstrate whether the soils and groundwater have been maintained at or below the allowed concentrations for a modified closure as defined in Permit Condition II.K.3. The compliance plan will identify the nature and date of the assessment activities and will include a timetable for performance of these activities. This information will be contained in the CERCLA Operation and Maintenance Plan and its supporting documents.

Should the required assessment activities identify contamination above the allowable limits (i.e., landfill closure levels specified in Permit Condition II.K.4.), the unit must be further remediated or the postclosure plan must be modified to include activities to be undertaken at the unit to meet landfill closure and postclosure requirements. Should the required assessment activities demonstrate that contamination has diminished or remained the same, the Permittees may request that Ecology reduce or eliminate the assessment activities and/or institutional controls.

As allowed by WAC 173-340-410, such monitoring may be combined with other plans. It is the intention that protection and confirmation sampling of groundwater be achieved through implementation of the dangerous waste final status groundwater monitoring plan to be written prior to, and implemented upon, the effective date of the Permit modification adding 1301-N and 1325-N to the Permit (anticipated to occur in 1999).

In addition to groundwater monitoring, compliance monitoring for institutional controls will include routine visual inspections and evaluations. Visual inspections shall consist of examinations of soil cover surfaces for signs of deterioration and improper usage of the surface area (e.g., buildings, impervious surfaces such as concrete or asphalt). An evaluation of existing data from the groundwater monitoring system should also be performed, as well as any other activities that would help assess the integrity of the cover.

5.1.2 Inspections

Inspections of institutional controls and groundwater monitoring systems under a modified closure option will be required. Groundwater monitoring postclosure inspection requirements will be identical to those under a landfill closure option and are contained in Section 5.2. Because the exact nature of institutional controls that may be utilized at 1301-N and 1325-N depend upon the remedial alternative chosen, site conditions, further characterization efforts, and the success of remedial actions taken, a list of potential inspection items is contained in Table 5.5. Frequency of inspection of these potential items is also contained in this table. These inspections may be implemented in checklist form. Such a checklist could specify entering checklist performance and results in the appropriate inspection logbook.

5.1.2.1 Inspection logbook

Inspectors will be trained in accordance with the postclosure personnel training plan contained in Section 5.4. The inspector will record any damage to the area and/or maintenance needs as well as the weather conditions at the time of inspection. Separate logbook entries will be signed and dated. Performance of any related inspection checklists will be documented in the logbook. Maintenance actions will be started and should be completed within 90 days. Logbook entries will document the correction of the problem or the status of corrective actions. Entries should also uniquely identify, where possible, work documents that actually performed the activities.

5.1.2.2 Security control devices

The 1301-N and 1325-N units are currently surrounded by a fence with locked gate access. If fences are removed to accommodate remedial activities, they will be replaced with an appropriate physical barrier, if required, in accordance with institutional controls defined after remedial alternative selection.

Table 5.1. Minimum Inspection Schedule for 1301 N and 1325 N

Item(s)	Inspection Frequency		
	Monthly	**Quarterly**	**Annually**
Security control devices			X
Erosion damage	X (until vegetative cover is established)	X (thereafter)	
Cover settlement and displacement		X	
Condition of vegetative cover	X (first 2-3 years)	X (thereafter)	
Well condition and purge water collection system		X	
Benchmark integrity			X

5.1.2.3 Erosion damage and general integrity

Should surface ground covers or other earthen barriers be utilized as part of the modified closure institutional controls for 1301-N and 1325-N, inspection of these systems for erosion control and general integrity will be performed. Inspection frequency will be quarterly and will be performed by physically walking over the site to check visually for wind and water erosion, subsidence, displacement, and general site integrity. Any site damage noted during inspections will be recorded in the field logbook and reported to the appropriate maintenance authority.

5.2 LANDFILL POSTCLOSURE REQUIREMENTS

Should a landfill cover be required, an inspection and maintenance plan will be developed during remedial design for the 1301-N and 1325-N cover systems.

5.3 GROUNDWATER MONITORING POSTCLOSURE REQUIREMENTS

5.3.1 Postclosure Groundwater Monitoring

During the postclosure period, monitoring of groundwater will continue according to the existing groundwater-monitoring program (Borghese et. al., 1996). The detection-monitoring program in accordance with WAC 173-303-645(9) is scheduled for implementation when the 1301-N and 1325-N units are incorporated in the Permit.

5.3.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the wellhead and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

5.4 PERSONNEL TRAINING DURING POSTCLOSURE

This section describes the training of personnel required to complete postclosure care requirements contained in this closure plan and the Permit. It is intended to supplement the training plan currently in place and identified in DOE/RL 96-39, Rev. 1A, Attachment A-4. A brief description of how training will be designed to meet job tasks is presented below.

5.4.1 Surveillance Personnel

The following outline provides potential information on classroom or on-the-job training that surveillance personnel will complete before conducting independent site surveillance at 1301-N and 1325-N during a postclosure period. Only those that are applicable to the selected closure option will be used:

- Site surface inspections (water and wind erosion, settlement and displacement, vegetative cover)
- Security inspections
- Location, integrity, and inspection of benchmarks, if appropriate
- Location, integrity, and inspection of groundwater wells
- Erosion damage
- Cover settlement and displacement
- Vegetative cover condition.

5.4.2 Groundwater Sampling and Analysis Task Leader and Sampling Personnel

After closure of 1301-N and 1325-N, the sampling and analysis task leader or delegate (samplers) will be responsible for:

- Monitoring and reporting on groundwater well security and maintenance
- Collecting groundwater level data
- Collecting , packaging, and shipping groundwater samples to field and offsite laboratories
- Sampling and monitoring equipment operation and maintenance
- Providing sample chain of custody to the laboratory.

The training of the sampling and analysis task leader and sampling personnel will receive either classroom instruction or on-the-job training. Sampling and analysis personnel will be trained to perform these functions in accordance with the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996d). A person successfully completing the required training courses will be qualified as a groundwater sampler and/or task leader. All personnel will undergo training and at least an annual review for required courses.

5.4.3 Additional Training Descriptions for Landfill Closure

Training descriptions for additional tasks associated with a landfill closure are as follows:

- Site Cover Inspections – This on-the-job training program is established to ensure that the surveillance personnel know what to inspect after the closure of 1301-N and 1325-N. It will include how to inspect for obvious signs of erosion, proper drainage, settlement, and sedimentation. In addition, personnel will be informed as to what constitutes proper vegetation coverage.

Additional on-the-job or classroom training under a landfill closure option includes the following:

- Site Security Inspections – Personnel will be instructed on how to inspect for obvious signs of a security breach. Signs may include cut fencing, unlocked gates, or cut chains.
- Location, Integrity, and Inspection of Benchmarks – Personnel will be shown the location of benchmarks and report any obvious signs of destruction or deterioration.

5.5 SECURITY

5.5.1 24-Hour Surveillance System

The 1301-N and 1325-N units are located within the 100 Area of the Hanford Site. The 100 Area will remain an area controlled by RL for the near future due to the decommissioning and deactivation of facilities associated with and including the 100-N Reactor. These areas will be under 24-hour surveillance by Hanford Patrol Protective Force personnel.

5.5.2 Barrier, Means to Control Entry, and Warning Signs

Roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Posted federal warning signs restrict access to the 100-N Area from the Columbia River. Further institutional and administrative measures controlling TSD unit site access may be initiated for the site commensurate with the future use of the property.

5.6 POSTCLOSURE CONTACT

The RL will be the official contact for the 1301-N and/or 1325-N units during the postclosure period at the following address:

Director, Office of Environmental Services*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

5.7 CERTIFICATION OF POSTCLOSURE

No later than 60 days after completion of the postclosure care period, RL will submit to Ecology a certification of completion of postclosure care. This certification, stating that postclosure care for the unit was performed in accordance with the approved closure plan, will be signed by RL and an independent registered professional engineer. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the independent registered professional engineer's certification will be supplied upon request of the regulatory authority.

ATTACHMENT 42

1324-N Surface Impoundment and 1324-NA Percolation Pond Closure Plan

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ATTACHMENT 42

1324-N Surface Impoundment and 1324-NA Percolation Pond Closure Plan

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Contents

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FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/State I.D.. No.

W	A	7	8	9	0	0	0	8	9	6	7

FOR 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
05	13	1986

*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

☐ **2. New Facility** (Complete item below.)

MO	DAY	YEAR

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

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.

1. Amount – Enter the amount.

2. 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: 1. Amount *(Specify)*	B. process Design Capacity: 2. Unit of Measure *(enter code)*			For Official Use Only			
X-1	S	0	2	600		G					
X-2	T	0	3	20		E					
1	T	0	2	400,000		U					
2											
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.

T02

The 1324-N Surface Impoundment is a lined pond with a treatment design capacity of 400,000 gallons (1,514,160 liters) per day. The impoundment was used to treat waste from the regeneration of demineralized columns. The waste exhibited the characteristics of corrosivity (D002). Successive additions to the pond of acidic and caustic waste served to neutralize the waste. The nonregulated neutralized waste was transferred to the 1324-N Percolation Pond. The 1324-N Surface Impoundment no longer receives waste and will be closed under interim status.

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 odes 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:

1. 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.
2. 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.
3. 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 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)*				D. Processes 2. Process Description *(if a code is not entered in D(1))*
1	D	0	0	2	1,500,000,000		P		T02				neutralization
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
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44													
45													
46													

IV. DESCRIPTION OF DANGEROUS WASTE (continued)

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

The 1324-N Surface Impoundment was used to treat corrosive dangerous waste (D002) from the 163-N Demineralization Plant. The waste consisted of acidic and caustic backwashes from the regeneration of demineralizer columns. Approximately 1,500,000,000 pounds (680,338,600 kilograms) of waste were treated each year.

V. FACILIITY 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	John D. Wagoner	06/30/1994

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.

John D. Wagoner

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

6/30/94
Date

Edward S. Keen

Co-operator
Edward S. Keen, President
Bechtel Hanford, Inc.

6/30/94
Date

FORM 3 — **DANGEROUS WASTE PERMIT APPLICATION**

I. EPA/State I.D.. No.

W	A	7	8	9	0	0	0	8	9	6	7

FOR 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
09	01	1977

*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

☐ **2. New Facility** (Complete item below.)

MO	DAY	YEAR

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

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.

1. Amount – Enter the amount.
2. 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 1. Amount *(Specify)*	2. Unit of Measure *(enter code)*			For Official Use Only			
X-1	S	0	2	600		G					
X-2	T	0	3	20		E					
1	T	0	4	1,000,000		U					
2	D	8	4	1,000,000		G					
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.

<u>T04, D84</u>

The 1324-NA Percolation Pond received corrosive dangerous waste (D002) from the regeneration of demineralizer columns in the 163-N Demineralizer Plant. Acidic and caustic waste was discharged to the pond in series, which served to neutralize the waste in the pond. Any acidic or caustic waste that reached the soil was neutralized further by the calcareous nature of the soil. Discharge of dangerous waste to this pond was discontinued in April 1986. The pond also received nonregulated neutralized waste from the 1324-N Surface Impoundment and nonregulated process and cooling water from the 163-N Plant. The process design capacity reflects the maximum volume of water discharged daily rather than the physical capacity of the unit. The 1324-NA Percolation Pond no longer receives waste and will be closed under interim status.

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 odes 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

3. 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).

4. 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:

4. 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.

5. 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.

6. 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	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))*
1	D	0	0	2	1,500,000,000		P		T04	D84			Neutralization/Percolation
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
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46													

IV. DESCRIPTION OF DANGEROUS WASTE (continued)

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

The 1324-NA Percolation Pond received waste from the 163-N Demineralization Plant. The waste consisted of acid and caustic backwashes from the regeneration of demineralization columns. Approximately 1,500,000,000 pounds (680,338,600 kilograms) of corrosive waste (D002) were managed each year.

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	John D. Wagoner	06/30/1994

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.

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

6/30/94
Date

Edward S. Keen
Co-operator
Edward S. Keen, President
Bechtel Hanford, Inc.

6/30/94
Date

Contents

Tables

ABBREVIATIONS AND ACRONYMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CMS	corrective measures study
DOE	U.S. Department of Energy
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
ICP	inductively coupled plasma
LWDF	liquid waste disposal facility
MTCA	*Model Toxics Control Act*
OU	operable unit
Permit	Hanford Facility Dangerous Waste Permit
QA	quality assurance
QC	quality control
RCRA	*Resource Conservation and Recovery Act of 1980*
RL	U.S. Department of Energy, Richland Operations Office
ROD	record of decision
SEPA	State Environmental Policy Act
TOX	total organic halogen
TSD	treatment, storage, and disposal
WAC	*Washington Administrative Code*

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2.0 UNIT DESCRIPTION

Attachment 42 presents the closure plan for the 1324-N Surface Impoundment (1324-N), also known by the designation 120-N-2, and for the 1324-NA Percolation Pond (1324-NA), also known by the designation 120-N-1. The 1324-N and 1324-NA terminology will be used throughout this appendix because the liquid waste disposal facilities are identified as such in their Part A, Form 3, Permit. These nonradioactive dangerous waste units operated as treatment and disposal units under the authority of the *Washington Administrative Code* (WAC) 173-303. Closure of these units will commence pursuant to WAC 173-303-610 and the Hanford Facility Dangerous Waste Permit (Permit). Modification of the Permit to include this closure plan is anticipated to occur in calendar year 1998.

Soil data obtained during previous sampling efforts do not identify dangerous waste constituents above *Model Toxics Control Act* (MTCA) Method B residential standards. Thus, the soil column meets clean closure standards pursuant to Permit condition II.K.1. However, groundwater contaminated by sulfate will require closure of these units under a modified closure option in accordance with Permit Condition II.K.3.

2.1 REGULATORY BACKGROUND

The 1324-N and 1324-NA units are operated by U.S. Department of Energy (DOE), Richland Operations Office (RL) and co-operated by Bechtel Hanford, Inc. Although the U.S. Government holds legal title to this facility, the RL, for purposes of regulation under WAC 173-303, is considered the legal owner of the facility under existing U.S. Environmental Protection Agency (EPA) interpretive regulations (51 Federal Register 7722).

The Part A, Form 3, dangerous waste permit application documentation for these units was originally submitted to the Washington State Department of Ecology (Ecology) and the EPA in August 1986.

The Part A for the 1324-NA Percolation Pond defined this unit, during operation, as a treatment (through soil column neutralization) and disposal unit for acid and caustic waste. The 1324-N Surface Impoundment, a lined unit, was defined solely as a neutralization treatment unit during its operation. Three revisions of Part A have been submitted since that time. The latest revisions of these Part A's are contained in Attachment 42, Chapter 1.0. In addition, a State Environmental Policy Act (SEPA) checklist, pursuant to WAC 197-11-960, will be approved prior to incorporation of this closure plan into the Permit. A draft SEPA checklist is provided in DOE/RL-96-39, Rev. 1, Attachment B-3).

The Hanford Site Dangerous Waste Permit contains a schedule for incorporation of closure plans into the Permit. The closure plan for 1324-N and 1324-NA is scheduled for incorporation in 1998.

2.2 CLOSURE PLAN AND CORRECTIVE MEASURES STUDY INTEGRATION

Closure of the 1324-N and 1324-NA units (collectively referred to as 1324-N and 1324-NA, but including the South Settling Pond and associated soils, structures, and piping) will occur under the authority of WAC 173-303. These units are also defined under the 100-NR-1 Operable Unit (OU) and are part of DOE/RL-96-39, Rev. 1, Treatment, Storage, and Disposal Corrective Measures Study.

DOE/RL-96-39, Rev. 1, Section 2.5.5concludes that no contaminants of concern associated with operation of these units remain in the soil above MTCA Method B residential levels. Information in the closure plan supports this determination and is in Attachment 42, Chapter 4.0, Section 4.3. However, a sulfate plume attributable to operation of these units exists with concentrations above the secondary drinking water standard as described in the DOE/RL-96-39, Rev. 1. The presence of this sulfate plume will require closure of 1324-N and 1324-NA under a modified closure option. Integrated TSD and OU closure actions will be necessary to return the area *to the appearance and use of the surrounding land areas to the degree possible given the nature of the previous dangerous waste activity*

(WAC 173-303-610[2][a][(iii]) and to remediate the groundwater. Actions to accomplish this may include characterization to determine that piping and/or structures are clean, removing structures and piping associated with the units, backfilling, regrading and revegetating the area, and implementing groundwater remedial technologies for cleanup of the sulfate plume. Attachment 42, Chapter 4.0 provides details of the closure activities and includes characterization data, cleanup standards, and actions to be taken to accomplish the closure activities.

Actions taken to remediate these TSDs will comply with the provisions of both CERCLA and RCRA. The CERCLA public involvement, including public notice and opportunity to comment, has been enhanced to concurrently satisfy the RCRA closure process. The remedy selected under CERCLA will be incorporated into the Hanford Facility RCRA Permit as the RCRA closure action after issuance of the public notice and comment process.

It is anticipated that the CERCLA ROD will be issued subsequent to the RCRA permit modification. Should the CERCLA ROD contain provisions inconsistent with the approved RCRA modifications, the Hanford Facility RCRA Permit will be again modified to reconcile these differences during the next permit modification cycle.

2.3 CLOSURE PERFORMANCE STANDARDS

The closure performance standards of WAC 173-303-610(2) require that the owner/operator of a TSD unit close the unit in a manner that: (1) minimizes the need for further maintenance; (2) controls, minimizes, or eliminates postclosure escape of dangerous waste to the extent necessary to protect human health and the environment; and (3) returns the land to the appearance and use of surrounding land areas.

2.3.1 Minimize the Need for Further Maintenance

The 1324-N and 1324-NA units will achieve clean closure of the soil column; therefore, further maintenance will not be needed for surface activities after certification of closure. The existing groundwater-monitoring program (Borghese, et. al, 1996) will be continued upon the effective date of the Permit modification adding these units. This system will be operated to minimize maintenance activities.

2.3.2 Control Dangerous Waste Escape to Protect Human Health and the Environment

Because no dangerous waste or constituents above levels that are considered protective of human health and the environment exist in the soil column at these units prior to closure activities, this closure performance standard is not applicable to this media. Groundwater is administratively restricted from access as a drinking water source by RL and will continue to be restricted until decisions regarding remediation of the sulfate plume are made in a final ROD for the 100-NR-2 OU.

2.3.3 Return Land to Appearance and Use of Surrounding Area

The appearance and use of 1324-N and 1324-NA after closure will be consistent with the future use of the 100-N Area. Structures and piping that do not meet clean closure standards will be removed. Earthen basins will be backfilled, regraded, and revegetated in a manner consistent with the prior site condition.

2.4 GENERAL DESCRIPTION OF UNITS

This section provides a general description of the 1324-NA Percolation Pond and 1324-N Surface Impoundment. This description is intended to provide an overview of these units.

1324-N, 1324-NA, the South Settling Pond (100-N-58), and soils contained within the current fence line surrounding these units are subject to this WAC 173-303 closure action. Pipelines associated with dangerous waste discharges from generating units to the ponds/surface impoundment are within this closure scope as well.

A chronology of events associated with these units is contained in Table 2-6 of DOE/RL-96-39, Rev. 1. A brief description of the units that are the subject of this closure plan is presented below.

From August 1977 until spring 1983, the 1324-N Settling Pond system consisted of the North and South Settling Ponds and the 1324-NA Percolation Pond. These ponds received both the corrosive regeneration wastes from the 163-N Demineralization Plant and the nondangerous filter backwash waste stream. Plugging of the settling ponds may have caused some flooding on the northern side of the units as described in DOE/RL-96-39, Rev. 1, Section 2.4.4.

Because all ponds received corrosive dangerous wastes after the effective date of regulation for TSD units (November 19, 1980), they are all subject to closure under dangerous waste regulations. The settling ponds, however, have never been described in the Part A, Form 3 that would define them as interim status TSD units.

The 1324-NA is a large, unlined, inactive pond that was used to treat corrosive wastes. The pond was placed in service in August 1977 and was used to treat corrosive regeneration wastes from the 163-N Demineralization Plant and to dispose of nondangerous filter backwash water from the 183-N Filtered Water Plant. The corrosive wastes were treated in the Percolation Pond by the alternate addition of acidic cation column regeneration wastes and alkaline anion column regeneration wastes and were concomitantly disposed of through percolation throughout the soil column.

1324-N is an inactive basin that was used as a neutralization pond for the corrosive wastes generated from the 163-N Demineralization Plant. The addition of sulfuric acid and sodium hydroxide in series into this unit resulted in a neutralized nondangerous wastewater. This wastewater was then routed to 1324-N. The 1324-N basin had a double liner as well as leak detection and leachate collection system. This site appears as an unlined basin next to the 1324-NA site today.

For a general discussion on the unit background and an in-depth description of 1324-N, 1324-NA, the South Settling Pond, and associated piping, refer to DOE/RL-96-39, Rev. 1, Section 2.4.4.

2.4.1 Topographical Maps

The topographical map for 1324-N and 1324-NA is provided in Figure 2-30 of DOE/RL-96-39, Rev. 1.

2.4.2 Floodplain

The U.S. Army Corp of Engineers (Jamison 1982) has calculated the probable maximum flood based on the upper limit of precipitation falling on a drainage area and other hydrologic factors such as antecedent moisture conditions, snowmelt, and tributary conditions that could lead to a maximum runoff. The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 41 million L/s (1.4 million ft^3/s). The 1324-N and 1324-NA units are located above the 100-year floodplain.

2.4.3 Traffic

The majority of traffic inside the Hanford Site boundaries consists of light-duty vehicles used to transport employees to work areas. The 1324-N and 1324-NA units are located within the Hanford Controlled Access Area where roadways cannot be accessed by the general public. These units are isolated from the nearest public highway, State Highway 24, by approximately 6 km (4 mi). Vehicle traffic around the units is restricted and is minimal. Access to the units is prevented by a locked, 2.4-m (8-ft) chain link fence topped with barbed wire.

2.4.4 General Hydrogeologic Conditions

DOE/RL-96-39, Rev. 1, Section 2.4 provides information on the geology and hydrogeology underlying 1324-N and 1324-NA.

2.4.5 Physical Dimensions of the Waste Units

The 1324-NA Percolation Pond is a rectangular basin, 3.7 m (12 ft) deep, with outer dimensions of 95 m by 61 m (310 ft by 200 ft).

1324-N is a basin with outer dimensions of approximately 43 m by 23 m (140 ft by 75 ft) at grade, sloping to 24 m by 4.6 m (80 ft by 15 ft) at approximately 4.6 m (15 ft) below grade.

2.4.6 Design Capacity

Both 1324-N and 1324-NA units were designed with a 24-hour period discharge capacity of 1,050 L/min (277 gal/min).

2.4.7 Ancillary Equipment

The 1324-N and 1324-NA units are passive liquid waste handling/disposal units, which do not rely on active systems for operations support. The units consist of transfer piping, structures, and soil.

2.4.8 Containment Systems

The 1324-NA unit does not include containment systems. Diking exists between units. The 1324-N unit contains a double lining of 45-mil Hypalon and leak detection systems to contain disposed liquids and prevent percolation into the underlying soils.

2.4.9 Structures and Piping Requiring Removal or Characterization as Clean

Structures requiring removal include a sampling building, valve pits, leak detection systems, and the liners. Associated piping is described in DOE/RL-96-39, Rev. 1, Section 2.4.4.

2.4.10 Security

The entire Hanford Site is a controlled-access area. The Hanford Site maintains around-the-clock surveillance to restrict unauthorized access for the protection of the public and of government property, classified information, and special nuclear materials. The Hanford Patrol maintains a continuous presence of protective force personnel to provide Hanford Site security.

Within the Hanford Site are operational areas, including 100-N, to which access is restricted. There is a staffed checkpoint at the Wye Barricade through which access to the 100-N Area is allowed only to authorized personnel. Authorized personnel are those individuals with a DOE-issued security identification badge indicating the appropriate authorization. Such personnel are subject to a search of items carried into or out of controlled areas.

2.5 WASTE CHARACTERISTICS

2.5.1 Liquid Waste Discharges

The hazardous wastes treated in 1324-NA were produced by the regeneration of ion exchange columns in the 163-N Demineralizer Plant. The wastes consisted of acid and caustic regeneration fluids and process and cooling water flushes. The pH of the demineralized water plant wastes varied from less than 1.0 to 14 standard units. These discharges qualified as corrosive dangerous wastes defined in WAC 173-303-090(a)(i) when pH was less than 2.0, or greater than/equal to 12.5. The regeneration solutions would have contained a variety of metal constituents as a result of concentration on the ion exchange media. These metals were not detected at levels that would regulate them as characteristic waste (WAC 173-303-090).

Tables 2.1 and 2.2 contain the results of chemical analyses performed on the cation and anion regeneration wastes respectively. The analyses indicate that the discharges were corrosive dangerous wastes, but did not qualify as dangerous wastes under any of the other criteria. Table 2.3 contains analyses of the 183-N Filtered Water Plant backwash effluent, the nondangerous wastewater also discharged to 1324-N and 1324-NA.

2.5.2 Liquid Waste Discharge Chronology

A chronology of liquid waste discharges to the 1324-N/NA units is provided in Table 2.4.

Table 2.1. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Cation Regeneration Cycle

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	0.894	0.936	0.922	0.917
Conductivity (micromhos)	37000	40100	35000	37367
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.0013	0.0019	0.0018	0.0016
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.023	0.020	0.024
Cadmium (.002 ppm)	0.003	0.002	0.003	0.003
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	12.2	16.5	9.6	12.8
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	0.025	0.027	0.020	0.024
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	0.725	0.842	0.655	0.741
Manganese (.005 ppm)	0.027	0.035	0.027	0.030
Potassium (.1 ppm)	12.2	15.5	14.8	14.2
Iron (.05 ppm)	1.1	1.2	1.0	1.1
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	1.3	1.4	1.2	1.3
Zinc (.005 ppm)	0.016	0.024	0.067	0.036
Calcium (.05 ppm)	282.6	347.4	324.9	318.3
Nitrate (.5 ppm)	1.0	0.5	0.8	0.8
Sulphate (.5 ppm)	2310	4271	2952	3201
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.0	1.8	1.9	1.9
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	ND	ND	ND	ND
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	26	28	26	27

ND = Not Detected MDL = Minimum Detection Limit Data obtained from samples taken August 1985, DOE-RL (1994)

Table 2.2. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Anion Regeneration Cycle

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	13.72	13.74	13.77	13.74
Conductivity (micromhos)	62000	60000	70000	64000
Mercury (.001 ppm)	0.0001	0.0001	0.0001	0.0001
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	462	499	456	472
Cyanide (.01 ppm)	0.01	0.015	ND	0.013
Barium (.006 ppm)	ND	ND	ND	ND
Cadmium (.002 ppm)	ND	ND	ND	ND
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	26910	28200	26330	27150
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	ND	ND	ND	ND
Manganese (.005 ppm)	ND	ND	ND	ND
Magnesium (5 ppm)	ND	ND	ND	ND
Potassium (.1 ppm)	26.5	27.2	26.3	26.7
Iron (.05 ppm)	ND	ND	ND	ND
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND
Calcium (.05 ppm)	ND	ND	ND	ND
Nitrate (.5 ppm)	1.0	1.4	0.9	1.1
Sulphate (.5 ppm)	30.9	30.6	30.6	30.7
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.5	2.3	2.3	2.4
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	2.3	2.7	2.8	2.6
Coliform (3 MPN)	---	0.023	0.009	0.016
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	26	28	26	27

ND = Not Detected
MDL = Minimum Detection Limit
Data obtained from samples taken August 1987.
DOE-RL (1994)

Table 2.3. 183-N Filtered Water Plant Backwash Effluent Analysis

Parameter (MDL)	Sample			
	1	2	3	Average
pH (standard units)	7.08	7.65	7.64	7.46
Conductivity (micromhos)	160	150	150	153
Mercury (.001 ppm)	ND	ND	ND	ND
Ethylene glycol (10 ppm)	ND	ND	ND	ND
Enhanced thiourea (.2 ppm)	ND	ND	ND	ND
TOC (1 ppm)	0.002	0.002	0.002	0.002
Cyanide (.01 ppm)	ND	ND	ND	ND
Barium (.006 ppm)	0.03	0.031	0.030	0.030
Cadmium (.002 ppm)	0.004	0.002	0.002	0.003
Chromium (.01 ppm)	ND	ND	ND	ND
Lead (.03 ppm)	ND	ND	ND	ND
Silver (.01 ppm)	ND	ND	ND	ND
Sodium (.1 ppm)	2.202	2.287	2.186	2.225
Nickel (.01 ppm)	ND	ND	ND	ND
Copper (.01 ppm)	ND	ND	ND	ND
Vanadium (.005 ppm)	ND	ND	ND	ND
Antimony (.1 ppm)	ND	ND	ND	ND
Aluminum (.15 ppm)	0.392	0.389	0.376	0.386
Manganese (.005 ppm)	0.020	0.015	0.014	0.016
Potassium (.1 ppm)	0.799	0.814	0.762	0.792
Iron (.05 ppm)	ND	ND	ND	ND
Beryllium (.005 ppm)	ND	ND	ND	ND
Osmium (.3 ppm)	ND	ND	ND	ND
Strontium (.3 ppm)	ND	ND	ND	ND
Zinc (.005 ppm)	ND	ND	ND	ND
Calcium (.05 ppm)	17.34	17.72	17.02	17.36
Nitrate (.5 ppm)	0.789	0.50	0.50	0.596
Sulphate (.5 ppm)	18.9	20.98	19.11	19.66
Fluoride (.5 ppm)	ND	ND	ND	ND
Chloride (.5 ppm)	2.846	2.671	2.901	2.806
Phosphate (1 ppm)	ND	ND	ND	ND
Phosphorus Pesticides (.005 ppm)	ND	ND	ND	ND
Chlorinated Pesticides (.001 ppm)	ND	ND	ND	ND
Enhanced ABN List	ND	ND	ND	ND
Citrus Red (1 ppm)	ND	ND	ND	ND
Arsenic (.005 ppm)	ND	ND	ND	ND
Ammonium Ion (.05 ppm)	ND	ND	ND	ND
Coliform (3 MPN)	0.24	2.4	2.4	1.68
Selenium (.005 ppm)	ND	ND	ND	ND
Thallium (.01 ppm)	ND	ND	ND	ND
Enhanced VOA (10 ppm)	---	0.24	0.25	0.25

ND = Not Detected MDL = Minimum Detection Limit Data obtained from samples taken August 1985, DOE-RL (1994)

Table 2.4. Chronology of Liquid Waste Discharges

Year	Liquid Waste Discharge to 1324-N and 1324-NA (L/day)
1964	0
1965	0
1966	0
1967	0
1968	0
1969	0
1970	0
1971	0
1972	0
1973	0
1974	0
1975	0
1976	0
1977	1,703,250
1978	1,703,250
1979	1,703,250
1980	1,703,250
1981	1,703,250
1982	1,703,250
1983	1,703,250
1984	1,703,250
1985	1,703,250
1986	1,703,250
1987	1,703,250
1988	1,703,250
1989	1,703,250
1990	1,703,250
1991+	0

WHC (1991)

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Contents

Figures

Tables

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3.0 GROUNDWATER MONITORING

3.1 AQUIFER IDENTIFICATION

The unconfined aquifer in the 100-N Area is located primarily in the upper part of the Ringold Formation (sands and gravels) and is approximately 12 to 15 m (40 to 50 ft) thick. The base of the aquifer is believed to be a laterally continuous clay-rich unit containing a series of paleosols. Lithologies in this unit range from clay and silt to sand. Most of the wells in the 100-N Area were completed at the water table; therefore, the thickness of the clay-rich unit is not known at all locations.

The water table is approximately 22 m (72 ft) below land surface near the 1324-N and 1324-NA units. Water levels have returned to "pre-Hanford" levels after years of groundwater mounding caused by artificial recharge from the 1324-NA and other effluent disposal in the 100-N Area.

A representative range of transmissivity estimates for the unconfined aquifer in the 100-N Area is 93 to 560 m^2/day (1,000 to 6,030 ft^2/day) throughout most of the 100-N Area. Wells in the northwest seem to show a higher transmissivity (up to 1,900 m^2/day [20,500 ft^2/day]). These values correspond to horizontal hydraulic conductivity of 6 to 37 m/day (20 to 121 ft/day); 120 m/day (394 ft/day) in the northwest. Specific yield is estimated at 0.1 to 0.3. Hartman and Lindsey (1993) describe the hydrogeology of the 100-N Area in more detail.

3.2 INTERIM STATUS GROUNDWATER MONITORING

The 1324-N and the 1324-NA areas are monitored together because of their proximity to one another and their similar waste histories. Groundwater monitoring began at the 1324-N and 1324-NA units in December 1987. The original monitoring network was modified over the years as water levels declined and new wells were installed to replace dry wells.

After the first year of groundwater monitoring at the 1324-N/NA site, statistical evaluations were performed according to 40 *Code of Federal Regulations* (CFR) 265.93. Results indicated that specific conductance in all of the downgradient wells was significantly elevated above background (i.e., upgradient) levels. This was not unexpected because the effluent discharged to the units had high specific conductance. A groundwater quality assessment program was initiated (Gilmore 1989) in conjunction with the program for the nearby 1301-N Liquid Waste Disposal Facility. The assessment program found no evidence that dangerous waste constituents had entered the groundwater (Hartman 1992). Sulfate and sodium were elevated, but these were not historically defined as dangerous waste constituents under the interim status program defined by 40 CFR 265.

The 1324-N and 1324-NA monitoring program did not immediately revert to an indicator evaluation program. Total organic halogen (TOX) had become elevated in two of the downgradient wells. The assessment program was revised to investigate the cause of the elevated TOX (Hartman 1993). The revised program indicated the presence of chloroform, probably from reaction of chlorine with organic material disposed in a French drain near the units (Hartman 1996c). The TOX and chloroform levels decreased, and the units reverted to indicator evaluation monitoring in early 1996 (Hartman 1996c).

Groundwater is monitored under several programs in addition to the *Resource Conservation and Recovery Act of 1976* (RCRA) in the 100-N Area. The most significant in terms of number of wells and analytes are the RCRA and CERCLA programs, and sitewide surveillance. Sampling and analysis for RCRA, CERCLA, and sitewide surveillance monitoring have been coordinated for several years to avoid duplication. However, this coordination did not include the planning stages of the monitoring programs.

In an attempt to reduce redundancy further and make monitoring more efficient, representatives of the various contractors involved in 100-N groundwater monitoring held a series of workshops to consolidate and streamline monitoring. Monitoring networks were redesigned to provide the most information for all programs most efficiently, and constituent lists were trimmed to the constituents of concern. Sampling frequency also decreased in some cases. Sampling trips and analytical costs are divided among data users. Borghese et al. (1996) describe the well and constituent lists for the combined program. That document does not include requirements for sampling and analysis protocols, quality control (QC), or statistical evaluations. Hartman (1996b) presents a revised groundwater-monitoring plan for the RCRA program as summarized in the following section.

3.2.1 Well Location and Design.

The monitoring network for the 1324-N/NA site includes one upgradient well and four downgradient wells (Figure B.1, Table B.5). Well 199-N-59 was installed when the local water table was higher than it is now. The well is now nearly dry and will only be sampled when the water table is seasonally high. All wells monitor the unconfined aquifer, and are constructed to WAC 173-160 standards. As-built diagrams are included in Hartman (1996b).

3.2.2 Sampling and Analysis Plan

The *Groundwater Monitoring Plan for the 1301-N, 1324-N/NA, and 1325-N Sites* (Hartman 1996b) describes the interim status sampling and analysis plan for RCRA monitoring. Groundwater is analyzed for the constituents listed in Table B-6. Indicator parameters are analyzed semiannually; additional parameters are analyzed annually.

Groundwater sampling procedures, sample collection documentation, and chain-of-custody requirements are described in *Environmental Investigation Instructions (EII)* (WHC-CM-7-7), The *Environmental Activities Procedural Manual* (WHC-CM-7-8), and in the *Quality Assurance Project Plan for Groundwater Monitoring Activities Managed by Westinghouse Hanford Company* (WHC 1995). Work by other contractors is conducted to their equivalent approved standard operating procedures. Procedures for field measurements (pH, conductivity, turbidity) are specified in WHC-CM-7-8 and in the user's manuals for the meters used. Analytical methods are selected from those provided in *Test Methods for Evaluating Solid Wastes* (EPA 1990) as specified by WHC (1995) or its most recent revision.

Figure 3.1. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units

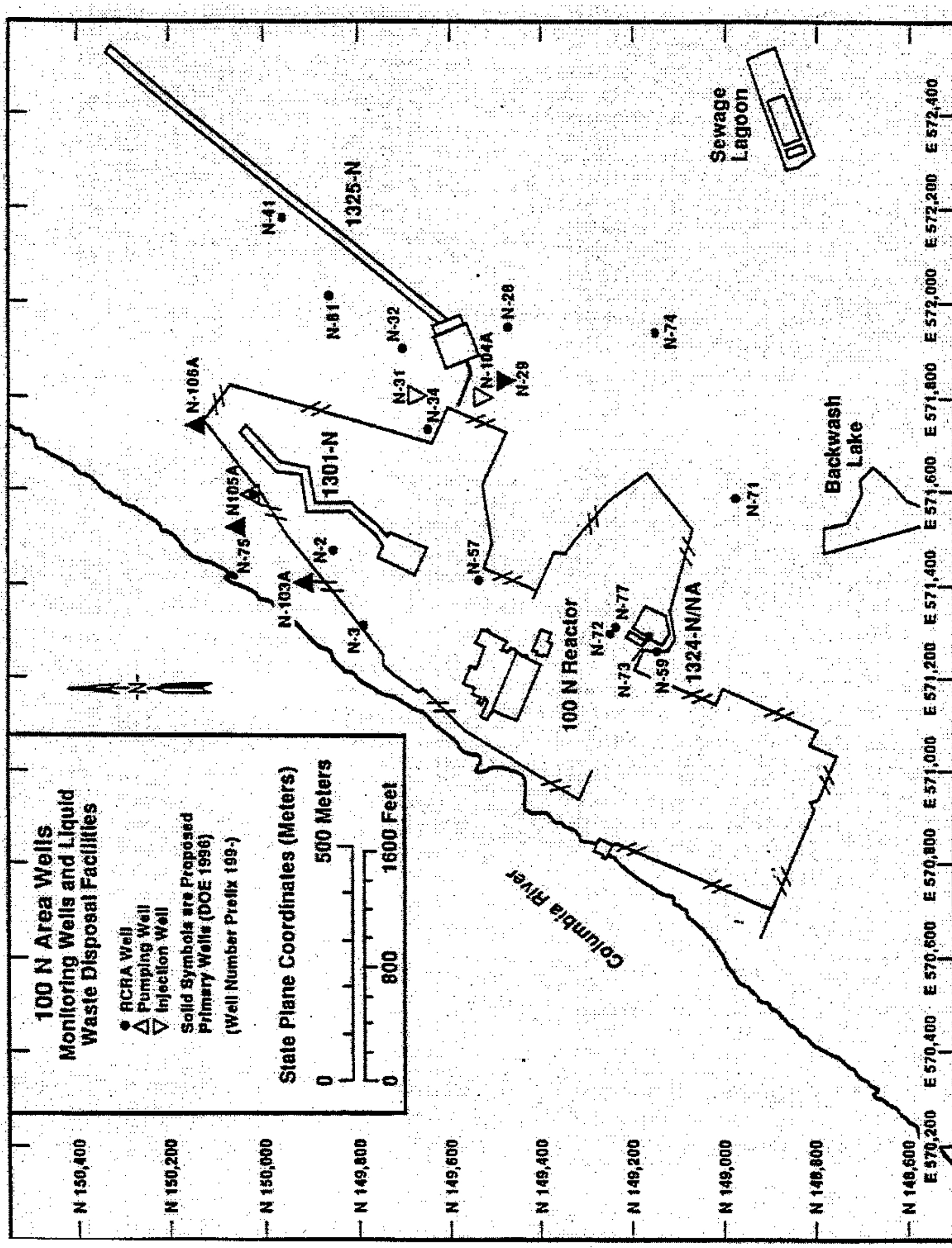


Table 3.1. Proposed RCRA Groundwater Monitoring Network for the 1324-N and 1324-NA Units

Well number	Drill date	Elev. top of casing[a] (m)	Casing/screen materials	Screened or perforated depth[b] (m)	Depth to water[c] (m)
199-N-59	1987	141.25	Stainless steel/stainless steel	17.4 - 21.9	22.616(3/96)
199-N-71	1991	141.121	Stainless steel/ stainless steel	19.5 - 25.9	22.314(3/96)
199-N-72	1991	139.889	Stainless steel/ stainless steel	18.6 - 25.0	21.080(3/96)
199-N-73	1991	141.194	Stainless steel/ stainless steel	19.8 - 26.2	22.171(6/96)
199-N-77	1992	141.06	Stainless steel/ stainless steel	25.6 - 29.0	22.231(3/96)

[a] Surveyed to North American Vertical Datum of 1988.
[b] Approximate depth below land surface; converted from feet.
[c] Depth below top of casing; converted from feet.

Table 3.2. Constituent List for 1324-N and 1324-NA Units

Analyzed Semiannually	Analyzed Annually
Contamination Indicator Parameters (Quadruplicate samples): Specific conductance (field)pH (field)Total Organic Carbon Total Organic Halogen Turbidity (field)	ICP[a] Metals (filtered) Anions Alkalinity

[a] ICP = Inductively Coupled Plasma

3.2.3 Quality Assurance and Quality Control

Quality assurance (QA) requirements are defined in the *Westinghouse Hanford Company Quality Assurance Manual* (WHC-CM-4-2) or equivalent procedures, and Article 31 of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1994). Additional requirements for QA and QC are included in WHC (1995) or its' most recent revision.

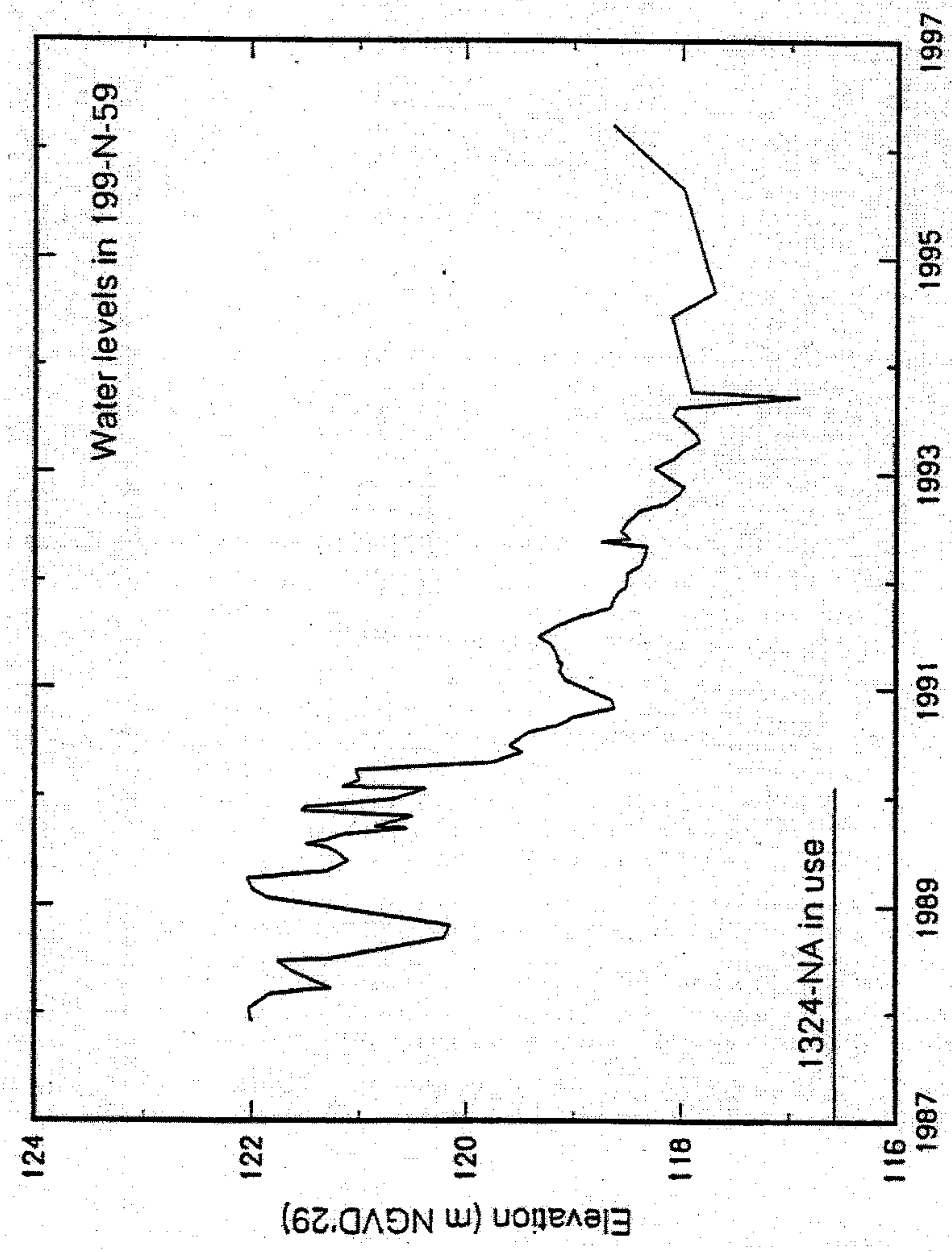
3.3 RESULTS OF GROUNDWATER MONITORING

3.3.1 Potentiometric Levels

Water levels are measured in all wells before sampling. Many of the wells in the 100-N Area are also measured as part of the sitewide semiannual water level program (Serkowski et al. 1995). About 20 wells are equipped with pressure transducers and data loggers. Any of the data described above can be used to construct water table maps to aid in determining groundwater flow directions.

At various times in the history of waste disposal at the 100-N Area, groundwater mounds formed beneath the 1324-NA Percolation Pond and other effluent disposal sites. Changes in water levels are illustrated in Figure 3.2. Water levels have returned to "pre-Hanford" levels in the 100-N Area but are still affected by changes in river stage. Groundwater flow beneath the 1324-N and 1324-NA units currently is toward the Columbia River.

Figure 3.2. Water Level Changes in Groundwater Below 1324-N and 1324-NA



Vertical groundwater gradients are not well defined in the 100-N Area. There is no significant difference in head between wells completed at the top and bottom of the unconfined aquifer near the 1324-N and 1324-NA units.

3.3.2 Groundwater Quality

Groundwater quality in the unconfined aquifer beneath the 100-N Area has been affected by the 1301-N liquid waste disposal facility, the 1325-N liquid waste disposal facility, and the 1324-NA Percolation Pond. In addition, various leaks and spills may have affected soil or groundwater chemistry (DOE-RL 1991). Data from RCRA sampling and analysis are reported electronically in the Hanford Environmental Information System database. Interpretation of the data has been included in annual reports (Hartman 1996a).

Groundwater beneath the 1324-N/NA units is characterized by high specific conductance, primarily because of elevated sulfate and sodium. Specific conductance increased in wells 199-N-72, 199-N-73, and 199-N-77 in 1993 and 1994, but leveled off in 1995. Sulfate and sodium concentrations follow the same pattern as specific conductance. The pH in 1324-N and 1324-NA wells generally is between 8 and 8.2, with no significant difference between upgradient and downgradient wells.

The TOX was slightly elevated in some of the 1324-N/NA downgradient wells in 1992-93, but subsequently decreased to background levels (usually below detection limits). A revised assessment program investigated the elevated TOX, and results indicated that chloroform was the cause of the TOX. A French drain, used to dispose of nondangerous chlorinated water, is located near the 1324-NA pond and was probably the cause of the chloroform (i.e., chlorine interacting with organic material). Results of TOX assessment are presented by Hartman (1996c).

3.4 GROUNDWATER MONITORING DURING CLOSURE

3.4.1 Corrective Action Program

The presence of a sulfate plume attributable to past operations at 1324-N and 1324-NA will require that a corrective action program (WAC 173-303-645[11]) be implemented upon the effective date of the modification to the Permit adding these closure units. Groundwater monitoring will be done in accordance with the existing groundwater-monitoring program (Borghese, et. al., 1996). A corrective action program to remove or treat the sulfate will be determined in a final ROD for the 100-NR-2 OU.

3.4.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the wellhead and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

Contents

Figures

Tables

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4.0 CLOSURE ACTIVITIES

The physical activities required to close 1324-N and 1324-NA in accordance with WAC 173-303-610 and the Permit will be integrated with the ROD for DOE/RL-96-39, Rev. 1 and the 100-NR-1/100-NR-2 corrective measure study. Closure activities necessary to comply with dangerous waste regulations and the Permit will need to be consistent with CERCLA activities. CERCLA activities will be required to include elements necessary for closure of a dangerous waste unit.

4.1 REMOVAL OF STRUCTURES

There will be no remediation excavation in the 1324-N/NA earthen basins for closure, but the Hypalon™ liner and leak detection systems in the 1324-N Surface Impoundment will be removed, using conventional excavation equipment, and disposed as noncontaminated waste. In addition, the sampling shed and perimeter fence will be removed. The structures are discussed in DOE/RL-96-39, Rev. 1, Section 2.4.4. DOE/RL-96-39, Rev. 1, Figure 2-29 shows the surface impoundment, sampling shed and perimeter fence.

The Hypalon™ liner, sampling shed, perimeter fence, and signage will be demolished and removed using conventional demolition/earthmoving equipment. The demolished components will be disposed of in an appropriate non-hazardous disposal facility or recycled as scrap, as appropriate.

4.2 PIPING REMOVAL OR CHARACTERIZATION AS CLEAN

Should a determination be made that piping associated with the units may be able to meet clean closure standards and be left in place, the determination will then be submitted to Ecology for its concurrence. This determination may be based on process knowledge, sampling, or both. Specific sampling requirements will be developed after the ROD and during the remedial design phase of the remedial action. Where piping cannot be determined to be clean, the influent pipelines between the 163-N facility and the 1324-N/NA units will be excavated and removed for disposal as scrap metal destined for recycling. Should piping not be appropriate for recycling, it will be sampled to determine its regulatory status and treated and disposed of accordingly. This piping is shown in DOE/RL-96-39, Rev. 1, Figure 2-28. DOE/RL-96-39, Rev. 1, Appendix D provides the reference maps and estimated pipe lengths.

If removal of the buried pipelines is required, they will be unearthed by conventional excavation equipment. The exposed piping will be segmented for removal manually or with the excavation equipment. Contamination controls will focus on the drainage of residual fluids in the piping prior to, and during, segmentation and on the control of airborne contamination during cutting and pipe handling operations. After the piping has been removed, the pipe bedding soil will be surveyed for residual contamination, excavated, and disposed as necessary.

4.3 EVALUATION OF SOIL DATA

4.3.1 Sampling and Analysis

Soil samples associated with the vadose zone at 1324-N and 1324-NA were collected from two boreholes and one test pit in late 1992 and early 1993. The test pit was excavated in the 1324-NA percolation pond, and samples were collected from the surface to 21.3 m (70 ft) in 1.5-m (5-ft) intervals. Samples from borehole 199-N-88 were collected from the surface to 21.9 m (72 ft), and samples from borehole 199-N-89 were collected from the surface to 23.2 m (76 ft). All the borehole samples were collected in approximately 1.5-m (5-ft) intervals, and composited over 0.15- to 0.76-m (0.5- to 2.5-ft) intervals. A total of 53 samples were collected from the three areas. Figure 4.1 contains a map showing the sample locations.

Data for ICP metals, mercury, cyanide, pH, and anions are presented in DOE/RL-96-39, Rev. 1, Attachment B-4. Analyses for organic constituents were also performed, but none of these were present above detection limits; thus, they will not be discussed further. The following sections use these data to evaluate whether the activities that occurred at 1324-N and 1324-NA have impacted the vadose zone soils.

Samples collected from the test pit and borehole 199-N-88 provide data on vadose zone soil composition beneath 1324-NA and the South Settling Pond, respectively. If significant amounts of contamination were deposited in the vadose zone under these two ponds, the data presented here would likely show evidence of this contamination. Borehole 199-N-89 is located to the northwest of 1324-N. Because of the boreholes location, using data from it to assess dangerous waste in the vadose zone is questionable.

4.3.2 Assessment of Contamination

In order to evaluate if 1324-N and 1324-NA have released contamination into the vadose zone, the data described above were statistically summarized and compared to background levels for the Hanford Site. Background is allowed as a default cleanup level in most environmental regulations (e.g., WAC 173-303, WAC-173-340), which recognize that background levels are rarely detrimental to human health or the environment and that remediating to levels below background concentrations is futile. The comparison with background values follows the methodology recommended by Ecology (Ecology 1992).

Table 4.1 lists the upper 95% confidence limit on the mean of the data from the units, as well as other statistical values. The data were determined to follow a log normal distribution, so the statistics were calculated on that basis.

Table 4.2 presents the evaluation of the data compared to background, using the three-part test recommended by Ecology. The data pass the first part of the test, which compares the background value at the 90th percentile to the 95% upper confidence level on the mean of the waste site data. Using this comparison, the data are below background for all analytes.

The second and third parts of the Ecology test evaluate frequency and magnitude of exceedences of the data above comparison criteria levels (background, in this case). The allowable frequency of exceedences for comparison to background is determined by using the binomial theorem to calculate the probability that a single sample is greater than background at a probability of 0.10. This calculation requires knowledge of the percentile chosen for background (0.90), the number of samples from the units (53), and the exceedence frequency (0.10). Using this criterion, a maximum of eight exceedences is allowed. Copper is the only analyte that has a significant number of exceedences (seven samples; see Table 4.2), and it is below the maximum number permitted.

The third part of the Ecology test requires that the largest value from the waste site data be less than two times the cleanup level. As seen in DOE/RL-96-39, Rev. 1, Attachment B-4, none of the analytes exceed this criterion.

Figure 4.1. Sample Locations for 1324-N and 1324-NA Soil Data

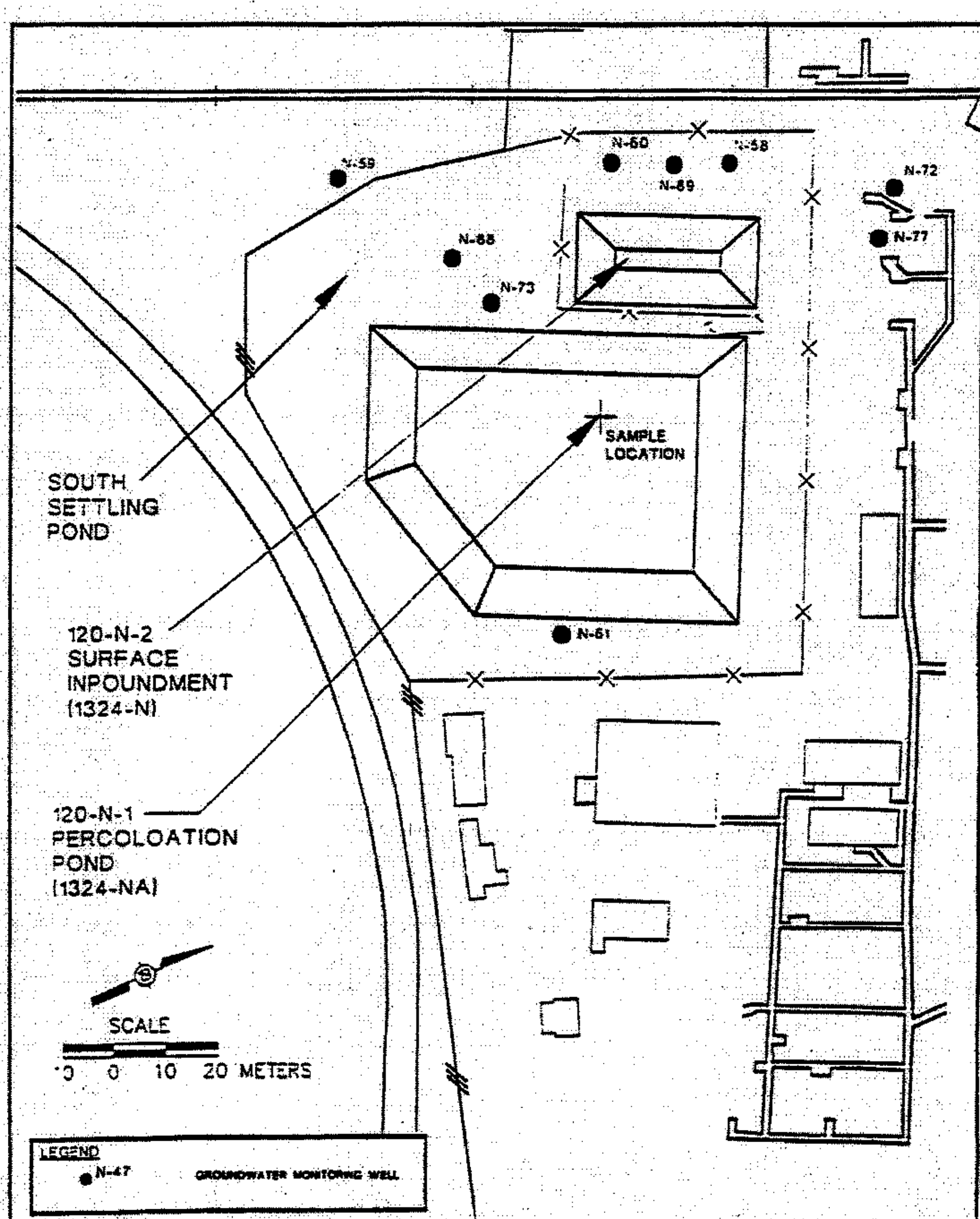


Table 4.1. Statistical Summary of Data from 1324-N/1324-NA/South Settling Pond TSD

	Geo. Mean	Min	Max	N	90th Percentile	95% UCL on Mean
Antimony[a]	3.04	1.70	6.35	53	5.14	3.66
Arsenic	1.05	0.37	3.5	53	2.03	1.37
Barium	48.43	16.80	93.7	53	72.61	54.99
Chromium	4.56	0.65	14.6	53	13.28	8.23
Cobalt	8.12	1.05	15.8	53	16.09	10.78
Copper	14.06	2.60	31.5	53	27.36	18.45
Fluoride	1.14	0.30	3.2	53	2.17	1.47
Lead	2.76	1.50	6.4	53	4.54	3.28
Manganese	213	73.80	702	53	341.81	250
Mercury	0.038	0.02	0.37	53	0.10	0.061
PH	8.10	5.6	9.8	53	9.76	8.42
Nickel	7.40	2.08	17.6	53	12.13	8.77
Selenium[a]	0.60	0.21	2.5	53	1.17	0.79
Sulfate	32.81	6.00	135	53	77.37	49.41
Vanadium	33.02	3.70	81.1	53	80.45	50.96
Zinc	34.74	6.80	94.4	53	67.80	45.66

[a] Background values for these analytes were below detection limit; highest detection limit reported by the laboratory is used. UCL = Upper Confidence Limit

Table 4.2. Comparison of TSD Soil Data to Background

	Average	Upper 95 UCL on Mean	Background, 90th percentile	# of data > BG	% of data > BG	Max value/ background
Antimony	3.29	3.66	11.1	0	0.0	0.57
Arsenic	1.20	1.37	6.47	0	0.0	0.54
Barium	50.68	54.99	132	0	0.0	0.71
Chromium	6.00	8.23	18.5	0	0.0	0.79
Cobalt	9.07	10.78	15.7	1	1.9	1.01
Copper	15.70	18.45	22	7	13.2	1.43
Fluoride	1.28	1.47	2.81	3	5.7	1.14
Lead	2.99	3.28	10.2	0	0.0	0.63
Manganese	227	250	512	1	1.9	1.37
Mercury	0.05	0.06	0.33	1	1.9	1.12
Nickel	7.92	8.77	19.1	0	0.0	0.92
Selenium	0.70	0.79	5	0	0.0	0.50
Sulfate	40.69	49.41	237	0	0.0	0.57
Vanadium	39.40	50.96	85.1	0	0.0	0.95
Zinc	38.85	45.66	67.8	4	7.5	1.39

UCL = Upper Confidence Limit

4.3.3 Summary and Recommendations

The data presented here strongly indicate that the vadose zone under 1324-N, 1324-NA, and the South Settling Pond has concentrations of metals indistinguishable from background compositions. The data used to lead to this conclusion were obtained from samples located in areas expected to record adverse impacts from the units. An exception to this is the lack of data from samples that may have been influenced by an overflow of the North Settling Pond. There are some indications that this event may have occurred and that standing water was present in the northern portion of the units. To evaluate any impacts from an event of this kind, two samples will be collected from the northern part of the units and analyzed for metals, pH, and sulfate. The location of the samples will be determined and agreed upon by all parties involved in the closure decisions.

4.4 WASTE MANAGEMENT

Closure of the 1324-N and 1324-NA units may generate small quantities of clean or contaminated nonradioactive debris. Disposal of these wastes will be dependent upon their level of contamination. It is doubtful that dangerous waste will be generated during cleanup of these units, however, should dangerous waste be generated, its management will occur in compliance with WAC 173-303. Waste generated as part of this closure activity will be managed and disposed of in such a way as to ensure protection of human health and the environment.

Waste generation, management, and disposal will be conducted in accordance with operational procedures and with all State, Federal, and DOE Orders and regulations dealing with waste, including agreements with the public and stakeholders.

4.5 SITE RESTORATION

After the system structures and piping have been removed or they have been characterized as clean, the earthen basins will be backfilled, regraded, and revegetated in a manner consistent with the prior site condition.

4.6 PERSONNEL TRAINING

No radioactive or dangerous waste constituent hazards are expected to be encountered during closure activities at 1324-N and 1324-NA, nor are dangerous wastes expected to be generated. However, should hazards be encountered or dangerous waste be generated that were not anticipated, training will be provided to site personnel in accordance with the site-specific training plan contained in DOE/RL-96-39, Rev. 1, Attachment B-5.

Training required during closure activities for personnel involved in the groundwater-monitoring program are the same as those identified in Attachment 42, Chapter 5.0, §5.5 the Postclosure Plan.

4.7 CLOSURE CONTACT

The DOE-RL will be the official contact during the postclosure period at the following address:

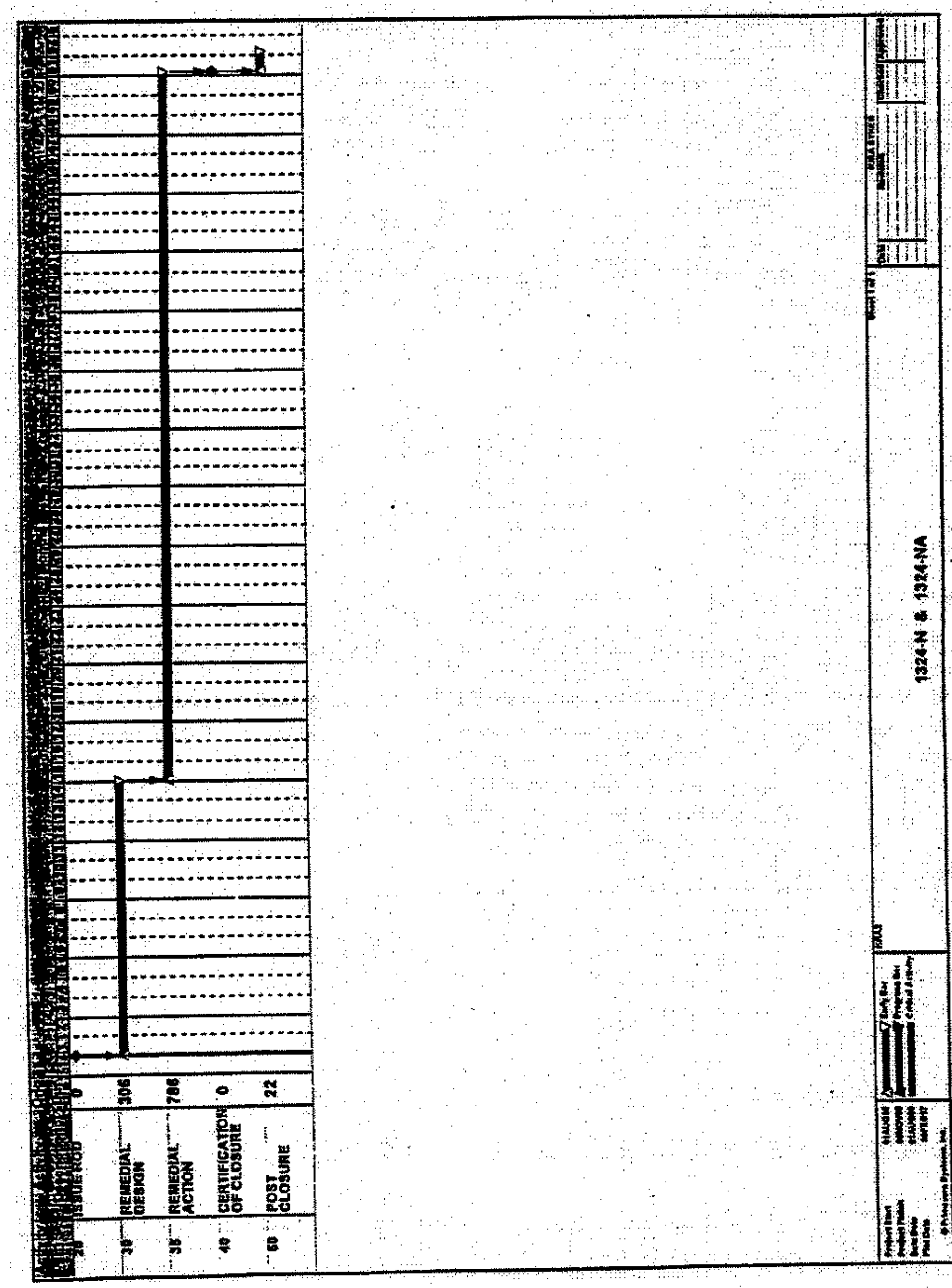
Director, Office of Environmental Services*
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

4.8 CLOSURE SCHEDULE

The closure schedule for 1324-N (120-N-2) and 1324-NA (120-N-1) is presented in Figure 4.2. Closure activities (actual cleanup) for the 120-N-1 and 120-N-2 will begin in July 2001 and will continue for an approximate duration of 15 months. The corrective action schedule of compliance for 100-N-58 will be the same as the closure schedule.

Figure 4.2. Closure Schedule for 1324-N and 1324-NA



4.9 AMENDMENT OF CLOSURE PLAN

The 1324-N and 1324-NA closure plan will be amended whenever changes in closure activities or postclosure requirements occur and prior to certification of closure and postclosure, respectively, that would constitute a Class 1, 2, or 3 modification to the Permit (WAC 173-303-830).

4.10 CERTIFICATION OF CLOSURE

In accordance with WAC 173-303-610(6), within 60 days of closure of 1324-N and 1324-NA, RL will submit to Ecology a certification of closure signed by both RL and an independent registered professional engineer. The certification will specify that the units have been closed in accordance with specifications contained within the approved closure plan as contained in the Permit.

4.11 SURVEY PLAT AND NOTICE IN DEED

A survey plat will be submitted by RL to the Benton County Planning Department no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). Also, a notice in deed will be submitted by RL to the Auditor of the Benton County no later than 60 days after certification of closure of each unit in accordance with WAC 173-303-610(10). After submitting this notice, a certification signed by the Permittees will be submitted to Ecology stating that notification has been recorded along with a copy of the notice in deed. The notice in deed will specify the type, location, and quantity of dangerous wastes remaining after closure actions have been completed.

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Contents

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5.0 POSTCLOSURE PLAN

Modified postclosure requirements will be applicable to 1324-N and 1324-NA. Permit condition II.K.3. allows a modified closure option for a unit if it can meet MTCA Method C cleanup levels. The soil column has been demonstrated to be able to meet clean closure standards under MTCA Method B. However, sulfate concentrations exceed MTCA Method C groundwater protection standards because MTCA Method B and Method C standards are identical when the basis is a federal drinking water standard, as is the case with sulfate.

Units where contamination exceeds MTCA Method C may be required to close as a landfill (Permit Condition II.K.4). However, as part of this postclosure plan, DOE/RL-96-39, Rev. 1, Attachment B-6 presents a demonstration that a landfill cover is not required over the 1324-N and 1324-NA units and therefore modified closure is the appropriate closure option for these units. The amount of clean soil meeting MTCA Method B cleanup standards that will remain at the closed 1324-N and 1324-NA units would prevent a downward driving force of precipitation that could contribute to further degradation of the groundwater. DOE/RL-96-39, Rev. 1, Attachment B-6 shows that precipitation would not reach groundwater for over 200 years. Because the soil column has been determined to be clean, and no downward driving force for further groundwater contamination exists, there would be no need for a landfill cover system at 1324-N and 1324-NA.

5.1 INSTITUTIONAL CONTROLS

No soil contamination that would present a hazard from direct exposure remains at 1324-N and 1324-NA. Therefore, no measures are required to prohibit or limit access at the surface. For example, fences or barriers will not be required.

Institutional controls are required to be maintained in order to ensure that groundwater is not used as a drinking water source. Because DOE-RL will maintain control over this site for the near future, it is not anticipated that additional actions will be required to limit controls over groundwater usage. Should groundwater use restrictions be required after DOE-RL relinquishment of the area, appropriate institutional controls will be established.

5.2 PERIODIC ASSESSMENTS

Periodic assessments are required by Permit Condition II.K.3.b. The first periodic assessment will take place after a period of five years from the completion of closure. As allowed by WAC 173-340-410, a compliance-monitoring plan for protection and confirmation monitoring during the five-year period may be combined with other plans. Protection and confirmation sampling of groundwater will be achieved through implementation of the dangerous waste groundwater-monitoring plan.

5.3 GROUNDWATER MONITORING POSTCLOSURE REQUIREMENTS

5.3.1 Postclosure Groundwater Monitoring

During the postclosure period, monitoring of groundwater will continue under a corrective action program in accordance with WAC 173-303-645(11). A groundwater-monitoring plan will be developed for 1324-N and 1324-NA and implemented prior to incorporation of this postclosure plan into the Permit.

5.3.2 Inspection, Maintenance, and Replacement of Wells

Each time a well is sampled, the wellhead and associated structures are inspected. Problems with the pump or with the sample (e.g., excessive turbidity) are also noted. Repairs are made according to approved contractor procedures. Subsurface inspection and maintenance is performed on a 3- to 5-year schedule, or as needed to repair problems identified during sampling.

If a monitoring well becomes unsuitable for use, the monitoring program will be reevaluated to determine if a new or existing well should be substituted.

5.4 CORRECTIVE ACTION PLAN

Because the groundwater monitoring data continues to show exceedences of sulfate concentrations above the secondary drinking water standard (250 mg/L) , corrective action to remove or treat the sulfate will be required. Corrective actions will be determined in a ROD for the 100-NR-2 OU. The sulfate plume is described in the DOE/RL-95-111, *Corrective Measures Study for the 100-NR-1 and 100-NR-2 Operable Units,* Section 3.3.3.2, Nature and Extent of Contamination. Alternatives for its remediation are presented and analyzed in DOE/RL-95-111, Sections 5 through 7. A Proposed Plan and ROD for the 100-NR-2 OU will determine any corrective actions required to remediate the sulfate plume.

5.5 PERSONNEL TRAINING DURING POSTCLOSURE

This section describes the training of personnel required to complete postclosure care requirements contained in this closure plan and the Permit. It is intended to supplement the training plan currently in place and identified in DOE/RL-96-39, Rev. 1, Attachment B-4. A brief description of how training will be designed to meet job tasks is presented below.

5.5.1 Surveillance Personnel

The following outline provides potential information on classroom or on-the-job training that surveillance personnel will complete before conducting independent site surveillance at 1324-N and 1324-NA during a postclosure period.

- Security inspections
- Location, integrity, and inspection of benchmarks, if appropriate
- Location, integrity, and inspection of groundwater wells
- Erosion damage
- Vegetative cover condition.

5.5.2 Groundwater Sampling and Analysis Task Leader and Sampling Personnel

This section describes the training of the groundwater sampling and analysis task leader and sampling personnel required to complete postclosure care requirements as contained in this postclosure plan. A brief description of how training will be designed to meet job tasks is presented below.

The sampling and analysis task leader or delegate and samplers will be responsible for:

- Monitoring and reporting on groundwater well security and maintenance
- Collecting groundwater level data
- Collecting , packaging, and shipping groundwater samples to field and offsite laboratories
- Sampling and monitoring equipment operation and maintenance
- Providing sample chain of custody to the laboratory.

The training of the sampling and analysis task leader and sampling personnel will receive either classroom instruction or on-the-job training. Sampling and analysis personnel will be trained to perform these functions in accordance with the *Hanford Analytical Services Quality Assurance Requirements Documents* (DOE-RL 1996b). A person successfully completing the required training courses will be qualified as a groundwater sampler and/or task leader. All personnel will undergo training and at least an annual review for required courses.

5.6 SECURITY

5.6.1 24-Hour Surveillance System

The 100 Area will remain an area controlled by the DOE-RL for the near future. These areas will be under 24-hour surveillance by Hanford Patrol protective force personnel.

5.6.2 Barrier, Means to Control Entry, and Warning Signs

No direct exposure hazards remain at 1324-N and 1324-NA. However, roadways to the unit and site access will remain administratively restricted to use by authorized personnel only. Access to the 100-N Area from the Columbia River is restricted by posted federal warning signs.

5.7 POSTCLOSURE CONTACT

The DOE-RL will be the official contact during the postclosure period at the following address:

Director, Office of Environmental Services *
U.S. Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

*or its equivalent should there be a future reorganization at DOE-RL

5.8 CERTIFICATION OF POSTCLOSURE

No later than 60 days after completion of the postclosure care period, the DOE-RL will submit to Ecology a certification of completion of postclosure care. This certification, stating that postclosure care for the unit was performed in accordance with the approved closure plan, will be signed by DOE-RL and an independent registered professional engineer. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the independent registered professional engineer's certification will be supplied upon request of the regulatory authority.

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ATTACHMENT 47

100-NR-1 and 100-NR-2 Operable Units

Contents

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Contents

Tables

7.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

This section presents the rationale and results of a comparison of remedial alternatives for the 100-NR-1 source OU and the 100-NR-2 groundwater OU. This comparison is based on five of the nine CERCLA evaluation criteria (EPA 1988) and NEPA values as discussed in DOE/RL-95-111, Rev. 0, Section 6.0. Source-site comparisons were done according to waste group types.

Key discriminators were selected within the evaluation criteria to compare the applicable remedial alternatives within each exposure scenario (i.e., rural-residential and modified CRCIA ranger/industrial) and are identified in Section 7.1. Based on key discriminators, this comparative analysis identifies the relative advantages and disadvantages of each alternative and provides a basis for selecting a remedial alternative for each exposure scenario.

7.1 EVALUATION CRITERIA AND KEY DISCRIMINATORS

To facilitate the evaluation of remedial alternatives, CERCLA prescribes nine specific evaluation criteria:

1. Overall protection of human health and the environment
2. Compliance with ARARs
3. Long-term effectiveness and permanence
4. Reduction of toxicity, mobility, and volume through treatment
5. Short-term effectiveness
6. Implementability
7. Cost
8. State acceptance
9. Community acceptance.

The first two criteria, overall protection of human health and the environment and compliance with ARARs, are considered threshold criteria that, if not met, would eliminate an alternative from consideration. Though it fails to meet the threshold criteria, the No-Action Alternative is retained in this comparative analysis for the purposes of providing a baseline assessment. The Institutional Controls Alternative for the 100-NR-1 OU (source sites) also fails the first criterion for the waste site groups, and it is inconsistent with unrestricted land use. Both the Institutional Controls and No-Action Alternatives, by definition in DOE/RL-95-111, Rev. 0, Section 5.0, may become part of other alternatives should site-specific soils data dictate that these alternatives are appropriate for individual sites.

The Institutional Controls Alternative is retained as a viable option for the 100-NR-2 OU (groundwater) remedial actions.

The overall protection and ARAR compliance criteria are not included in the comparative analysis presented in this section because all alternatives retained meet these threshold criteria. In addition, certain key discriminators within the overall protection criterion (e.g., impacts to natural and cultural resources, and residual risk) are inherent to other evaluation criteria such as long-term effectiveness and permanence and short-term effectiveness.

The last two criteria, state and community acceptance, will not be evaluated until after the proposed plan has been issued; therefore, they are not part of the comparative analysis presented below. This leaves five CERCLA evaluation criteria that are addressed in this Comparative Analysis:

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume through treatment
- Short-term effectiveness

- Implementability
- Cost.

An evaluation of NEPA values also has been added so as to comply with the policy requiring integration of NEPA values into the CERCLA process.

Sections 7.1.1 through 7.1.6 discuss the five evaluation criteria and NEPA values, as well as the associated key discriminators used to compare alternatives.

7.1.1 Long-Term Effectiveness and Permanence

This criterion is concerned with the long-term consequences of the Remedial Alternative. Key discriminators for this criterion include the following:

- Residual risk (e.g., removal of the source contaminants eliminates site risk while the capping of wastes in place results in residual risk that limits land use and requires monitoring)
- Adequacy and reliability of controls (e.g., the Containment Alternative needs to address the reliability of the containment barrier, and the Remove/Dispose Alternative needs to address the reliability of the engineered disposal site)
- Long-term natural resource and environmental consequences (e.g., ability to manage residual risks, potential for habitat restoration, and influence on biodiversity).

7.1.2 Reduction of Toxicity, Mobility, or Volume through Treatment

The key discriminator for this criterion is the ability of the remedial alternative to reduce the mobility, toxicity, or volume of contaminants. Most alternatives considered would decrease contaminant mobility using containment or treatment technologies, but the effectiveness of the alternatives differs. Some remedial alternatives may also reduce waste volume (e.g., soil washing by using physical separation processes to segregate clean material from contaminated material). In situ and ex situ bioremediation are expected to reduce toxicity.

7.1.3 Short-Term Effectiveness

The EPA (1988) includes several discriminators (risk to the community, the worker, and the environment) in the short-term effectiveness criterion. This criterion also considers the time required to achieve protectiveness. Several NEPA values also relate to short-term effectiveness, including potential impacts to cultural resources, natural resources, socioeconomics, and transportation. The health risk to the community is considered insignificant for this evaluation because of the remote location of the 100-N Area. Socioeconomics was not considered a key discriminator because impacts of the remedial alternatives being considered probably would not make much difference on a regional level. Risk to the environment varies at each waste site. The impacts to vegetation and natural habitats would be minor as most of the waste sites have been previously disturbed. However, the capability to revegetate and restore wildlife habitats has been considered. Also, impacts to protected or sensitive species may be critical. The key discriminators for this criterion follow:

- Risk to workers
- Transportation impacts
- Risks to natural and cultural resources.

7.1.4 Implementability

Technical feasibility, administrative feasibility, and availability of services and materials are discriminators for implementability. Technical feasibility is important because it takes into account the technical aspects of implementing a remedial action. Administrative feasibility considers how consistent the remedial action is with the future land-use options. Administrative feasibility is also significant because it includes coordination with other agencies and parties (agencies, trustees, and tribes) that have regulatory responsibility or stakeholder interests. Availability of services and materials is significant when considering waste removal and disposal, in situ treatment, capping, subsurface barriers, hydraulic controls, and sources of fill material. The key discriminators follow:

- Technical feasibility
- Administrative feasibility
- Availability of services and materials.

7.1.5 Cost

The estimated cost of each alternative is considered in all evaluations. The estimated costs available at this time should only be used to compare relative differences between remedial alternatives. These costs are not intended to be accurate estimates of total costs to remediate the sites.

7.1.6 NEPA Values

Key discriminators under this criterion include irreversible and irretrievable commitment of natural and cultural resources, cumulative impacts from implementation of the alternative, and environmental justice issues as they relate to Native American use of the land.

7.2 COMPARISON OF REMEDIAL ALTERNATIVES FOR SOURCE WASTE SITES

Comparative analyses were performed for the following four alternatives for both the rural- residential and modified CRCIA ranger/industrial exposure scenarios:

- No action (all waste groups types)
- Remove/dispose (all waste groups types)
- Remove/ex situ bioremediation/dispose (petroleum waste group)
- In situ bioremediation (petroleum waste group).

Comparative analyses of the following two alternatives were performed only for the modified CRCIA ranger/industrial exposure scenario:

- Containment (radioactive waste group)
- Solidification (radioactive waste group).

As discussed in DOE/RL-95-111, Rev. 0, Section 5.3, due to the lack of data on the extent of contamination in soil, all alternatives may potentially result in implementing no action or institutional controls upon obtaining further characterization data at a specific site within the 100-NR-1 OU.

Table 7.1 presents the remedial alternatives discussed in DOE/RL-95-111, Rev. 0, Sections 5.3 and 6.2.2 that are applicable to the rural-residential exposure scenario. If the rural-residential exposure scenario is selected, the remedial alternatives to meet unrestricted use are as shown in Table 7.1.

Table 7.2 presents the remedial alternatives considered to be applicable to the modified CRCIA ranger/industrial exposure scenario. In this case, land-use restrictions are appropriate and allow more options for remedial action.

The No-Action Alternative has been retained in this comparative analysis for both exposure scenarios as a basis for comparison with the other alternatives. However, as described in the detailed analysis presented in DOE/RL-95-111, Rev. 0, Section 6.0, the No-Action Alternative does not satisfy evaluation criteria for overall protection; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume; or implementability. Therefore, the No-Action Alternative is not considered a viable alternative for the remediation of source sites at the 100-N Area.

Remedial alternatives compared under a rural-residential exposure scenario for all waste groups (Table 7.1) include the No-Action Alternative and the Remove/Dispose Alternative. The Remove/Dispose Alternative encompasses treatment that may be required for RCRA LDR compliance or for meeting waste acceptance criteria for disposal, however, the need to treat for land-disposal-restriction compliance and waste acceptance is not anticipated. The Remove/Dispose Alternative assumes that no contamination above cleanup levels will be encountered at depths below 4.6m (15 feet). However, should contamination be found below 4.6m (15 ft), a site specific determination will be required to define the appropriate remedial action options may include leaving some contamination in place. An evaluation will be conducted during the remedial action activities that will balance the extent of deep excavation with the following: protection of human health and the environment; disturbance of ecological and cultural resources; worker health and safety; remediation costs; O&M costs; radioactive decay of short-lived radionuclides; the use of institutional controls; and long-term monitoring costs.

Specific information on ex situ bioremediation that is pertinent to a comparison of alternatives has been outlined in the comparative analyses in Sections 7.2.1 and 7.2.2. It must be emphasized that ex situ bioremediation is dependent upon detailed, site-specific information to determine if it is a cost-effective remedy. Because this information is not available, the comparative analysis cannot definitively assess the appropriateness of this technology for individual sites relative to other technologies. In addition, the petroleum waste group includes the In Situ Bioremediation Alternative, which is considered appropriate for two TPH-contaminated sites where TPH contaminants were detected in the groundwater. DOE/RL-95-111, Rev. 0, Section 6.0 provides detailed information on ex situ bioremediation, in situ bioremediation, and a no-treatment option that supports the comparative analysis.

Remedial alternatives compared for the modified CRCIA ranger/industrial scenario (Table 7.2) include the No-Action Alternative and the Remove/Dispose Alternative for all waste groups. In addition, the radioactive waste group includes the Containment Alternative, applicable to 16 sites, and the Solidification Alternative, which is applicable to 21 sites. Similarly to the rural-residential exposure scenario, the petroleum waste group includes the In Situ Bioremediation Alternative and the Ex Situ Bioremediation Alternative.

The comparative analysis of alternatives for source sites is presented in two subsections, Section 7.2.1 for the rural-residential exposure scenario, and Section 7.2.2 for the modified CRCIA ranger/industrial exposure scenario. The reader should note the following organization in reading the comparative analysis for source sites:

- In the comparative analysis, no distinction is made among the five waste groups. During the detailed analysis process, it was determined that the responses to the CERCLA and NEPA evaluation criteria depended primarily on the type of remedial action to be taken rather than on the type of contaminant present at the site.
- No direct comparison is made in the modified CRCIA ranger/industrial scenario between in situ bioremediation and containment (or solidification) because these alternatives do not apply to the same sites. In situ bioremediation is presented as an alternative to remediate petroleum spills at two sites where petroleum was observed in the groundwater; containment and solidification are presented as alternatives to remediate certain sites within the radioactive waste group.

7.2.1 Rural-Residential Exposure Scenario

7.2.1.1. Long-Term Effectiveness and Permanence.

The Remove/Dispose Alternative provides a high degree of long-term effectiveness and permanence. No sources of risk above approved cleanup levels would remain at the site. All removed soils would be treated, if needed and as appropriate, with treatment residuals being disposed at the ERDF. No additional long-term restrictions for residential use at the waste site would be required following remediation with this alternative, unless it is determined that wastes that could pose a direct exposure hazard may be left below 4.6 m (15 ft). In this case, restrictions on excavation below 4.6 m (15 ft) would be required. If appropriate, revegetation and restoration efforts could be implemented that have the potential to more rapidly restore ecological habitats to healthy, sustainable conditions than is currently possible through natural succession.

The Remove/Ex Situ Bioremediation/Dispose Alternative would compare similarly to the Remove/Dispose Alternative, but it would have the added advantage of returning all, or a significant part of the soil, to the site rather than sending it to the ERDF.

The In Situ Bioremediation Alternative would also provide a high degree of long-term effectiveness and permanence. No risks from TPH contamination would remain because the contaminants would be destroyed, assuming complete treatment. However, it may be impossible to determine whether the treatment reaches all of the contamination. Post-remediation monitoring would be required.

The No-Action Alternative does not offer long-term effectiveness and permanence. Contaminants would remain in near-surface and subsurface soils above levels protective of human health and the environment. Sources of contamination that could contribute to groundwater contamination would remain. No revegetation or restoration efforts would be performed with this alternative.

7.2.1.2. Reduction in Toxicity, Mobility, or Volume.

The Remove/Dispose Alternative would potentially provide reduced toxicity, mobility, or volume through application of treatment technologies, as appropriate for LDR compliance and ERDF waste acceptance. This alternative would remove wastes from the site, thereby reducing waste volume there. The Remove/Ex Situ Bioremediation Dispose Alternative might be employed for TPH where soil characteristics are amenable to the success of such a treatment technology. Ex situ and in situ bioremediation would reduce or destroy the toxicity of petroleum constituents through destruction. The reliability of technology and controls for ensuring complete treatment is less certain for in situ bioremediation. The No-Action Alternative would not reduce toxicity, mobility, or volume of contaminants in soils.

7.2.1.3. Short-Term Effectiveness.

For the Remove/Dispose Alternative, a large volume of contaminated soils would be generated relative to the other alternatives. As this would require handling through excavation, treatment, and transportation, it would have the potential for inherently greater short-term impacts. Petroleum sites, as well as others, may have contamination at depth. Excavation to greater depths may increase short-term impacts to natural resources. During implementation, risks to workers from exposure to contaminated soils and fugitive dust or from accidents may increase; however, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. Certain types of treatment may generate residuals that will require further management to meet LDR or ERDF waste acceptance criteria and, thus, would increase short-term risks to workers. Short-term impacts to vegetation and wildlife may be greatest with this alternative because it would disturb the largest land area. These impacts could be reduced through proper scheduling and implementation of the alternative. This alternative has the highest probability of impacting cultural resources in the short-term, simply due to the large land area impacted. Cultural resource locations are not precisely known; however, identification and mitigation of potential impacts would be addressed through the cultural resources mitigation plan.

Excavation impacts from the Remove/Ex Situ Bioremediation/Dispose Alternative would be similar to those of the Remove/Dispose Alternative. This alternative would take longer to be fully effective if determined to be appropriate. Therefore, at sites where treatment may be required, there may be more short-term disruption to the environment during this period. Transportation of wastes to ex situ bioremediation facilities may increase short-term impacts relative to the in situ treatment. Ex situ bioremediation, however, is expected to provide clean fill material to offset use of borrow material.

The In Situ Bioremediation Alternative is anticipated to require 5 to 25 years to complete at the two petroleum sites where it is applicable. Risks to workers from exposure to vented gases and fugitive dust or from accidents may be present during this time. However, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. The potential for worker exposure to contaminated soils would be minimal during in situ treatment in contrast to the ex situ bioremediation option. Because little or no waste would be generated by in situ treatment, few transportation impacts are anticipated. Only equipment would be transported to and from the site. Risks to natural and cultural resources would be minimized. Short-term impacts to vegetation and wildlife may occur but could be avoided or reduced through appropriate design and implementation of the alternative. Cultural resources, if present, should not be impacted. If potential impacts are identified, they would be addressed through the cultural resources mitigation plan.

The No-Action Alternative would not involve any remedial actions; therefore, risks to workers, transportation impacts, and short-term risks to natural and cultural resources would not be increased nor decreased.

7.2.1.4. Implementability

The Remove/Dispose Alternative performs most favorably for technical and administrative feasibility and the availability of services and materials. Technical problems in implementing excavation and disposal activities within this alternative are not expected.

Ex situ bioremediation implementability is dependent upon site specific information, much of which could be obtained using the observational approach during excavation. Equipment required for implementation is readily available. However, should contamination be found at great depths, it may become less feasible to excavate. Due to the lack of soil characterization data, this potential would have to be evaluated during the design phase of this alternative. It might also be necessary to treat soil constituents to meet LDRs for which there is no immediately available treatment technology. Should it be found upon characterization that petroleum contamination exists at depth, or that radionuclide or inorganic contaminants are present, this alternative would not be considered readily implementable.

There is less certainty regarding reliable implementation of in situ bioremediation because completeness of treatment cannot be accurately monitored. Characterization to better determine the extent of remediation may be required. Equipment required for implementation is readily available.

The No-Action Alternative would be easy to implement but would not be consistent with DOE's long-range objective.

7.2.1.5. Cost

Cost estimates for the source sites in DOE/RL-95-111, Rev. 0 were developed using either the Micro Computer Aided Cost Estimating System (MCACES) or the Remedial Action Cost Engineering and Requirements (RACER) package. Total costs presented in this section do not include a 3 percent design cost and a 3 percent cost data collection cost that applies to all estimates. Details of the cost estimates are presented in Permit Attachment 47, Appendix G. It needs to be kept in mind that the quality of a cost estimate is directly related to the quality of the input data used in the models. As has been noted earlier in this report, data on site-specific contamination, site locations, and site dimensions were limited, and this introduces uncertainty in the cost estimates. Despite this uncertainty, it is believed that the cost estimates are of sufficient quality to fulfill the primary objective, which is to aid in selecting preferred remedial alternatives. How representative these estimates might be of actual remediation costs is more difficult to answer and will not be resolved until the uncertainties in the data are resolved.

The No-Action Alternative would require no additional cost and is not considered further in this comparative analysis.

Individual cost estimates for each waste site, exposure scenario, and remedial alternative are presented in Table 6.2. Three alternatives (Remove/Dispose, Remove/Ex situ Bioremediation/Dispose, and In Situ Bioremediation) are proposed for petroleum-contaminated sites under both exposure scenarios. Ex situ bioremediation is proposed for 14 sites that have near-surface contamination, and in situ bioremediation is proposed for two sites with deep contamination. Because all of the petroleum contamination will be removed, there is no cost difference between the two exposure scenarios for this alternative. The cost comparison in Table 7.3 shows that in situ bioremediation is 65 percent less expensive than the Remove/Dispose Alternative. The cost comparison in Table 7.4 shows that ex situ bioremediation is 12 percent more expensive than the Remove/Dispose Alternative. Because of the uncertainty in the data used to develop these estimates, cost should not be used as a factor in deciding between these two alternatives. This 12 percent difference is not considered significant.

A summary of these results is presented in Table 7.5. The least cost alternative for the rural-residential scenarios is to select the Remove/Disposal Alternative for all sites except the two deep petroleum sites. This produces a cost saving of 7 percent over the using the Remove/Dispose Alternative for all sites.

7.2.1.6. NEPA Values

Irreversible and irretrievable commitment of a significant number of natural resources would not occur with the Remove/Dispose Alternative. Contaminated soils would be removed from a site and transported to the ERDF; therefore, there would be a commitment to use portions of that disposal unit for long-term waste management. Excavated material would be replaced with clean fill and topsoil, then revegetated to mirror more closely the native plant community. (This may be an interim benefit should future rural-residential use of the land dictate another vegetative regime.) Future use of the river and adjacent lands would allow Native American use in concert with a modified CRCIA ranger/industrial exposure scenario in a relatively short time frame. Excavation could disturb cultural resources contained at a site, and careful adherence to cultural resource mitigation planning would be required. Cumulative impacts may occur at borrow sites and transportation routes.

The In Situ Bioremediation Alternative would not irreversibly or irretrievably commit significant amounts of natural resources. Using ERDF resources would not be required under this alternative in comparison to the Remove/Dispose Alternative. Potential impacts on future land use would be comparable to the Remove/Dispose Alternative. Disturbance of cultural resources could occur with this alternative, but not to the degree that would be required with the Remove/Dispose Alternative. Irreversible and irretrievable commitment of natural resources would occur with the No-Action Alternative because contaminants would remain on site, so human and ecological receptors would continue to be exposed. For radiological constituents, this exposure will remain until decay results in contaminant levels below concern. For nonradiological constituents, exposure may be very long term. There may be an impact on Native Americans because they are potentially more likely than other groups to use the area. No direct impacts would result from implementing this alternative.

7.2.2 Modified CRCIA Ranger/Industrial Exposure Scenario

7.2.2.1. Long-Term Effectiveness and Permanence.

The Remove/Dispose Alternative provides a high degree of long-term effectiveness and permanence. No sources of risk above approved cleanup levels would remain at the site. All removed soils would be treated, if needed and if appropriate, with treatment residuals being disposed at the ERDF. No additional long-term restrictions for residential use at the waste site would be required following remediation with this alternative unless it is determined that wastes that could pose a direct exposure hazard may be left below 4.6 m (15 ft). In this case, restrictions on excavation below 4.6 m (15 ft) would be required. If appropriate, revegetation and restoration efforts could be implemented that have the potential to more rapidly restore ecological habitats to healthy, sustainable conditions than is currently possible through natural succession.

The Remove/Ex Situ Bioremediation/Dispose Alternative would compare similarly to the Remove/Dispose Alternative, but it would have the added advantage of returning all, or a significant part of the soil, to the site rather than sending it to the ERDF.

The In Situ Bioremediation Alternative would also provide a high degree of long-term effectiveness and permanence. No risks from TPH contamination would remain because the contaminants would be destroyed, assuming complete treatment. However, it may be impossible to determine whether the treatment reaches all of the contamination. Post-remediation monitoring would be required.

The Containment and In Situ Solidification Alternatives perform relatively equally on long-term effectiveness and permanence, but neither performs as well as the Remove/ Dispose Alternative. While contaminants are left in place under both alternatives, for the near term, human health and the environment are considered protected. Both alternatives have the potential for long-term failure (i.e., containment through failure of the barrier and in situ solidification through incomplete treatment or deterioration of the solidified matrix). Long-term post-closure monitoring, including maintenance of barriers, would be required with these alternatives. Revegetation is considered to have a good probability for success with these alternatives, but wastes would be left in place and would limit complete restoration.

The No-Action Alternative does not offer long-term effectiveness and permanence. Contaminants would remain in near-surface and subsurface soils above levels protective of human health and the environment. Sources of contamination that could contribute to groundwater contamination would remain. No revegetation or restoration efforts would be included with this alternative.

7.2.2.2. Reduction in Toxicity, Mobility, or Volume.

The Remove/Dispose Alternative would potentially provide reduced toxicity, mobility, or volume through application of treatment technologies, as appropriate for LDR compliance and ERDF waste acceptance. This alternative would remove wastes from the site, thereby reducing waste volume at the site. The Remove/ Ex Situ Bioremediation/Dispose Alternative might be employed for TPH where soil characteristics are amenable to the success of such a treatment technology. Ex situ and in situ bioremediation would reduce or destroy the toxicity of petroleum constituents through destruction. The reliability of technology and controls for ensuring complete treatment is less certain for in situ bioremediation.

Containment does not include a treatment option; however, a properly constructed engineered barrier would reduce the mobility of contaminants by reducing infiltration. Neither a reduction in toxicity nor volume is provided by this alternative.

The in situ solidification would reduce mobility through stabilization in the near term but would not reduce toxicity or volume of contaminants. Remobilization of contaminants could occur if the stabilized media degraded through time. Incomplete mixing of contaminants with the stabilization media could interfere with reduction in contaminant mobility, and some contaminants might not be stabilized to the same degree as others.

The No-Action Alternative would not reduce toxicity, mobility, or volume of contaminants in soils.

7.2.2.3. Short-Term Effectiveness

For the Remove/Dispose Alternative, a larger volume of contaminated soils would be generated relative to the other alternatives. This would require handling through excavation, treatment, and transportation, which would have the potential for inherently greater short-term impacts. Petroleum sites, as well as others, may have contamination at depth. Excavation to greater depths may increase short-term impacts to natural resources. During implementation, risks to workers from exposure to contaminated soils and fugitive dust or from accidents may increase; however, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. Short-term impacts to vegetation and wildlife may be greatest with this alternative because it would disturb the largest land area. These impacts could be reduced through proper scheduling and implementation of the alternative. This alternative has the highest probability of impacting cultural resources in the short term simply due to the large land area impacted. Cultural resource locations are not precisely known; however, identification and mitigation of potential impacts would be addressed through the cultural resources mitigation plan.

Excavation impacts from the Remove/Ex Situ Bioremediation/Dispose Alternative would be similar to that of the Remove/Dispose Alternative. This alternative would take longer to be fully effective if determined to be appropriate. Therefore, at sites where treatment may be required, there may be more short-term disruption to the environment during this period. Transportation of wastes to ex situ bioremediation facilities may increase short-term impacts relative to the in situ treatment. Ex situ bioremediation, however, is expected to provide clean fill material to offset the use of borrow material.

The In Situ Bioremediation Alternative is anticipated to require 5 to 25 years to complete at the two petroleum sites where it is applicable. Risks to workers from exposure to vented gases and fugitive dust or from accidents may be present during this time. However, these risks can be effectively minimized through appropriate engineering controls and through health and safety procedures. The potential for worker exposure to contaminated soils would be minimal during in situ treatment in contrast to the ex situ bioremediation option. Because little or no waste would be generated by in situ treatment, few transportation impacts are anticipated. Only equipment would be transported to and from the site. Risks to natural and cultural resources would be minimized. Short-term impacts to vegetation and wildlife may occur but could be avoided or reduced through appropriate design and implementation of the alternative. Cultural resources, if present, should not be impacted. If potential impacts are identified, they would be addressed through the cultural resources mitigation plan.

The Containment and In Situ Solidification Alternatives perform similarly with regard to short-term effectiveness. Both alternatives pose little risk to workers because they would not be exposed to contaminants during implementation. No contaminated soils would be transported. Transportation of materials and equipment for containment or solidification, and transportation of clean fill after containment, would increase traffic on haul roads. Short-term impacts to vegetation and wildlife could occur during the estimated 2- to 5-year restoration time frame, but these could be avoided or reduced through proper implementation of the alternative. Cultural resources, if present, should not be impacted. Identification and mitigation of these impacts would be addressed through the cultural resources mitigation plan.

The No-Action Alternative would not involve any remedial actions; therefore, risks to workers, transportation impacts, and short-term risks to natural and cultural resources would not occur.

7.2.2.4. Implementability

The Remove/Dispose Alternative performs most favorably for technical and administrative feasibility and the availability of services and materials. Technical problems in implementing excavation and disposal activities within this alternative are not expected.

Ex situ bioremediation implementability is dependent upon site-specific information, much of which could be obtained using the observational approach during excavation. Equipment required for implementation is readily available. However, should contamination be found at great depths, it may become less feasible to excavate. Due to the lack of soil characterization data, this potential would have to be evaluated during the design phase of this alternative. It might also be necessary to treat soil constituents to meet LDRs for which there is no immediately available treatment technology. Should it be found upon characterization that petroleum contamination exists at depth or that radionuclide or inorganic contaminants are present, this alternative would not be considered readily implementable.

There is less certainty regarding reliable implementation of in situ bioremediation because completeness of treatment cannot be accurately monitored. Characterization to determine the extent of remediation may be required. Equipment required for implementation is readily available.

Containment will be easy to implement; however, characterization of the extent of contamination will be required in order to properly locate the barrier. Technical problems causing delays are not anticipated. Large quantities of soil and rock material will be required for construction of the barrier; however, this material is considered available from sources within or near Hanford. The In Situ Solidification Alternative is considered less implementable than the Containment Alternative because of the potential for incomplete mixing of the treatment zone. Contaminants may be encountered that are not effectively treated through this technology. Problems in ensuring complete treatment could result in remediation delays. As with containment, further characterization of the extent of contamination will be required to determine proper treatment. Materials needed for implementation are considered readily available.

The a No-Action Alternative would be easy to implement, but would not be consistent with DOE's long-range objective.

7.2.2.5. Cost

Cost estimates for the source sites in DOE/RL-95-111, Rev. 0 were, in general, developed using either the MCACES or the RACER package. Total costs presented in this section include neither a 3 percent design cost nor a 3 percent data collection cost. Details of the cost estimates are presented in Permit Attachment 47, Appendix G.

As has been noted earlier in this report, data on site-specific contamination, site locations, and site dimensions were limited, and this introduces uncertainty in the cost estimates. The quality of a cost estimate is directly related to the quality of the input data used in the models. Despite this uncertainty it is believed that the cost estimates are of sufficient quality to fulfill the primary objective, which is to aid in selecting preferred remedial alternatives. How representative these estimates might be of actual remediation costs is more difficult to answer and will not be resolved until the uncertainties in the data are resolved.

The No-Action Alternative would require no additional cost and is not considered further in this comparative analysis.

Individual cost estimates for each waste site, exposure scenario, and remedial alternative are presented in Table 6.2. Five remedial alternatives (Remove/Dispose, Remove/Ex Situ Bioremediation/Dispose, In Situ Bioremediation, Capping, and In Situ Solidification) have been proposed for the modified CRCIA ranger/industrial exposure scenario. The evaluation of alternatives for the sites with petroleum contamination is the same as just presented for the rural-residential scenario and concludes that in situ bioremediation is the least expensive alternative for the two deep petroleum sites and remove/dispose for the near-surface petroleum sites.

Capping is considered for 5 clusters of waste sites to cover a total of 16 sites. As shown in Table 7.6, the cost of remediating 16 sites by capping is about $65,000,000 versus $2,400,000 for the Remove/Dispose Alternative for 20 sites. This is 27 times the cost of the Remove/Dispose Alternative. Additionally, the Remove/Dispose Alternative is less expensive than capping at all five cap sites. Although it may appear that some sites could be capped at less cost than the Remove/Dispose Alternative, this is deceptive. These costs reflect the cost of capping a cluster of sites and must be evaluated as a group because the costs are shared among the several sites within the cluster. When evaluating capping costs it is necessary to keep in mind that this cost estimate is based upon using a specific barrier, the Modified RCRA Subtitle C barrier. This is perhaps one of the most expensive barrier options. It was selected for use in DOE/RL-95-111, Rev. 0, because there was limited site-specific data with which to make a decision. As additional data is collected during the design process, other, less expensive cap designs may be appropriate.

In situ solidification is considered for the 16 capping sites and 4 additional ones. As shown in Table 7.6, the cost of remediating 20 sites by in situ solidification is about $6,600,000 as opposed to $3,100,000 for the Remove/Dispose Alternative. This is over two times the cost of the Remove/Dispose Alternative. Additionally, the In Situ Solidification Alternative was more expensive than the Remove/Dispose Alternative at all 20 sites.

A summary of these results is presented in Table 7.7. The least cost alternative for the modified CRCIA ranger/industrial scenario is to select the Remove/Disposal Alternative for all sites except the two deep petroleum sites. This produces a cost saving of 7 percent over using the Remove/Dispose Alternative for all sites.

There are many uncertainties dealing with developing cost estimate for sites with limited site-specific information. As already noted, for example, limited data lead to the selection of an expensive cap design.

7.2.2.6. NEPA Values

By definition, the modified CRCIA ranger/industrial scenario requires more of a commitment of onsite resources than does the residential exposure scenario. At the same time, there would be less commitment of ERDF resources because less soil may require excavation and disposal. There would also be less impact on cultural resources, and fewer cumulative impacts under a modified CRCIA ranger/industrial exposure scenario because of this. Restrictions on hunting and gathering are also inherent in the modified CRCIA ranger/industrial scenario defined in DOE/RL-95-111, Rev. 0.

An irreversible and irretrievable commitment of natural resources would occur with the Remove/Dispose Alternative. Contaminated soils would be removed and transported to the ERDF; therefore, there would be a commitment to use portions of that disposal unit for long-term waste management and the associated borrow pit commitment for ERDF cover. Excavated material would be replaced with clean fill topsoil (from the borrow pits), then revegetated to mirror more closely the native plant community existing prior to disturbance from 100-N Area activities. Future use of the river and adjacent lands would allow Native American use in concert with a modified CRCIA ranger/industrial exposure scenario in a relatively short time frame. Excavation could disturb cultural resources existing at a site, and careful adherence to cultural resource mitigation planning would be required. Cumulative impacts may occur at borrow sites and transportation routes.

The In Situ Bioremediation, Containment, and In Situ Solidification Alternatives perform similarly to the Remove/Dispose Alternative for key discriminators under this criterion with the exception that fewer ERDF resources would be utilized under these alternatives.

Irreversible and irretrievable commitment of natural resources would occur with the No-Action Alternative because contaminants would remain on site, and human and ecological receptors would continue to be exposed. For radiological constituents, this exposure would remain until decay results in contaminant levels below concern. For nonradiological constituents, exposure may be very long term. There may be an impact on Native Americans because they are potentially more likely to use the area than are other groups. No cumulative impacts would result from implementing this alternative.

7.3 COMPARISON OF REMEDIAL ALTERNATIVES FOR GROUNDWATER

Table 7.8 presents the seven alternatives described in DOE/RL-95-111, Rev. 0, Section 5.0 for the remediation of groundwater underlying the 100-N Area and for protection of the Columbia River. It indicates which technologies are used within each remedial alternative to address the four issues considered to be critical for remediating the contaminated groundwater system at the 100-N Area. These four issues follow:

- Protection of the river from tritium
- Protection of the river from Sr-90
- Reduction of Sr-90 in the aquifer
- Reduction of other contaminants in the aquifer.

In the comparative analysis of groundwater alternatives, no distinction is made between the rural-residential and modified CRCIA ranger/industrial exposure scenarios. No distinction is necessary because, under either exposure scenario, the existing beneficial uses of the Columbia River must be protected. The existing beneficial uses of the river include water supply, recreation, fish and wildlife habitat, hydroelectric power production, transportation, and agriculture. The remedial alternatives must meet the appropriate ARARs for these beneficial uses, regardless of whether the exposure scenario is rural-residential or modified CRCIA ranger/industrial. Also, under both scenarios, it is assumed that the goal is to restore groundwater for beneficial uses. Therefore, no distinction is required with respect to aquifer remediation.

The No-Action Alternative is not considered a viable alternative because it does not meet overall protectiveness or compliance with ARARs. The No-Action Alternative is retained as the baseline case for comparison with the other alternatives that incorporate some active response action.

7.3.1 Long-Term Effectiveness and Permanence

7.3.1.1. Protection of the River from Tritium.

Alternative 5 and Alternative 7 (Table 7.8) describe technologies to reduce tritium flux to the river (hydraulic controls or barrier with hydraulic controls) and therefore are equally effective in preventing the tritium from entering the river at concentrations above the MCL for tritium. The added impermeable barrier in Alternative 7 may provide some degree of protection above hydraulic controls alone for tritium, but the differences are considered neither quantifiable nor great because tritium is easily controlled hydraulically. Both are considered comparable in their reliability of controls, as well. The other alternatives do not include any action to prevent tritium from entering the river except through decay (although Alternative 4 might coincidentally prevent tritium discharge through hydraulic controls placed on the Sr-90 plume). For alternatives 1, 2, 3, and 6, the tritium reaching the river will exceed MCLs for approximately 15 years.

7.3.1.2. Protection of the River from Sr-90

Alternatives 1 and 2 do not include any action to prevent Sr-90 from entering the river; therefore, they provide a basis for comparison to the other alternatives. Taking no physical action, the Sr-90 concentrations in the groundwater/river interface will decay to concentrations below MCLs over a 300-year period. The remaining five alternatives use three different technologies to reduce the Sr-90 flux to the river: a permeable barrier (Alternative 3), hydraulic controls (Alternatives 4 and 5), and impermeable barriers (Alternatives 6 and 7). These three technologies for reducing flux may be interchanged within the three alternatives to accomplish this objective.

Although these technologies reduce flux of Sr-90 discharging to the Columbia River (i.e., mass of Sr-90 per unit time moving through the aquifer into the river), none of the alternatives are expected to significantly reduce Sr-90 concentrations entering the river above MCLs because a section of aquifer next to the river would be essentially unaffected by the technologies, and the slow release of the Sr-90 adsorbed onto the aquifer soils in this section would continue. This is true with all alternatives because a section of land remains between the river and the barrier in all cases--either by a physical barrier (impermeable or permeable) or a hydraulic barrier. This phenomenon is due to the sorbing ability of Sr-90 on soils which retard dissolution in the groundwater, as described in DOE/RL-95-111, Rev. 0, Sections 3.0 and 5.0. The impact of this Sr-90-contaminated area adjacent to the river on concentrations at the groundwater/river interface is not anticipated to decrease significantly faster than the decease that will occur solely because of natural decay. However, comparatively, hydraulic controls contained in Alternatives 4 and 5 may potentially reduce concentrations at the groundwater/river interface more effectively than the other alternatives, although not significantly, because of the net gradient effect. For example, the net groundwater flow in the aquifer immediately adjacent to the river is inland, with hydraulic controls in place, while the net groundwater flow with the barriers is toward the river. A permeable barrier (Alternative 3) is expected to be the next best alternative for reducing Sr-90 concentrations in the groundwater/river interface, with the impermeable barrier (Alternatives 6 and 7) being the least effective in reducing concentrations of Sr-90.

All alternatives (except 1 and 2) are expected to reduce flux of Sr-90 to the river by more than 90 percent. The Hydraulic Control Alternatives, because they reverse the groundwater flow near the river shoreline, are probably more effective than the other alternatives for reducing flux, and might be more effective in reducing concentrations of Sr-90. However, this increase in effectiveness has not been quantified. The Impermeable Barrier Alternatives would rank next in ability to reduce Sr-90 flux, with the Permeable Barrier Alternative ranking the least effective among Alternatives 3 through 7.

Relative to risk, reducing the flux of Sr-90 to the river may not be of great importance. Currently, the most stringent ARAR for Sr-90 is based on an MCL, which is established for the purposes of achieving human health protection from the use of surface or groundwater as a drinking water source. Decreasing the flux of Sr-90-contaminated waters to the river is inconsequential with respect to using the river as a drinking water supply, because of the near instantaneous reduction of Sr-90 concentrations that occurs near the groundwater/river interface. DOE/RL-95-111, Rev. 0, Section 3.3.5 describes Columbia River water quality relative to Sr-90, and it concludes that concentrations in the river are consistently below MCLs for Sr-90. However, the seeps located at N-Springs on the river bank adjacent to the 116-N-1 Crib do exceed MCLs, and institutional controls would be required to restrict this area of the river from use as a drinking water source.

With the exception of N-Springs, Sr-90 does not threaten the Columbia River as a drinking water source. In contrast, however, concentrations of Sr-90 in the sediments at the groundwater/river interface may be harming aquatic organisms. Site-specific data related to ecological effects may not be complete, and in any case, no alternatives are capable of substantially decreasing these concentrations or significantly reducing the time frame for achieving a protective concentration.

7.3.1.3. Reduction of Sr-90 in the Aquifer

Alternatives 1, 2, and 3 do not include any action to reduce the Sr-90 contamination in the groundwater, but Alternatives 2 and 3 include institutional controls to prevent exposure to humans from use of the groundwater until Sr-90 decays to acceptable levels, thereby providing a measure of long-term protectiveness. Alternative 3 does, however, immobilize large quantities of Sr-90 through capture in the permeable barrier. This capture does not change concentrations of Sr-90 in the groundwater upgradient of the barrier due to the equilibrium that will occur between soil and groundwater, but it will immobilize a large mass of Sr-90 from the aquifer. This immobilization action may not contribute much to reducing Sr-90 concentrations at the groundwater/river interface as described above.

Alternatives 4, 5, and 6 are more effective in reducing Sr-90 in the aquifer than the first three alternatives because these alternatives include pump-and-treat systems. They do not, however, have a significant increase in effectiveness because the alternatives only achieve a 10 percent reduction in the time to attain the remediation goal – 270 years versus 300 years. Alternative 7 (soil flushing) has the potential to be more effective and result in a shorter restoration time frame than any of the other alternatives. However, at this stage, it is considered an innovative technology for Sr-90 in the aquifer and for the site-specific conditions of the 100-NR-2 OU. A series of laboratory, bench, and field-scale tests would be required before a decision on the feasibility of soil flushing could be made. Because of this requirement, no objective comparison of soil flushing can be made against the other alternatives in DOE/RL-95-111, Rev. 0.

7.3.1.4. Reduction of Other Contaminants in the Aquifer

Alternatives 1 through 4 include no action to reduce the contamination in the aquifer from other contaminants; therefore, they are not compared against each other for long-term effectiveness and permanence. The other contaminants include nitrate, sulfate, manganese, chromium IV, and TPH. Some migration of those contaminants will occur over time. Utilizing travel-time predictions contained in DOE/RL-95-111, Rev. 0, Appendix D, gross predictions of natural migration can be made. These predictions are based on modeling assumptions that may not account for the heterogeneity inherent in the groundwater/river system over time. However, since groundwater at the 100-N Area flows into the river, the travel time for peak concentrations to reach the river roughly equates to the time required for natural migration of the contaminant from the aquifer (DOE/RL-95-111, Rev. 0, Appendix D).

Nitrate may migrate from groundwater to the river within 10 to 20 years. Sulfate may migrate from groundwater to the river in 5 to 15 years. Chromium VI may migrate to the river in 15 to 25 years. Manganese may take over 3,000 years to migrate from groundwater to the river. Migration times for TPH cannot be estimated because the product will continue to float on top of the aquifer for an indeterminate, but probably long, period of time.

It should be noted that chromium VI concentrations are based on data from a small number of wells and that there is no discernible plume. Also, since manganese and sulfate PRGs are based on secondary MCLs, the need for remediating these two contaminants may not be as critical as for the other contaminants.

Alternatives 5, 6, and 7 all rely upon the same pump-and-treat technology for remediation of the other contaminants. Pump-and-treat technologies can be effective in the long term because they permanently remove contaminants from the environment. It is anticipated that pump-and-treat technologies will decrease restoration time frames for groundwater protection as follows: nitrates, 5 years; sulfates, 5 years; chromium VI, 1 year; manganese, 88 years; and TPH, 5 years.

Given these estimates, long-term effectiveness can be achieved earlier with pump-and-treat technology than with natural migration:

- Nitrates may be remediated in the aquifer 5 to 15 years earlier.
- Sulfates may not be remediated in the groundwater at a significantly faster rate than could be achieved by natural migration.
- Chromium VI may be remediated 15 to 25 years earlier.

Manganese may be remediated over 3,000 years earlier.

- TPH may be remediated many years earlier, but time frames cannot be estimated.

Groundwater monitoring after cleanup would be required for a time to ensure that all of the plumes have been captured.

7.3.1.5. Summary

Seven alternatives have been compared that meet (except for no action) all or part of the needs for long-term effectiveness and permanence. For tritium river protection, Alternatives 5 and 7 are anticipated to provide, most effectively, long-term protection. Other than the No-Action Alternative, all of the alternatives that could be implemented are comparable for long-term effectiveness and permanence for addressing the Sr-90 releases to the river. An estimated 90 percent reduction in the mass of Sr-90 entering the river will result through utilization of Alternatives 3, 4, 5, 6, or 7 as opposed to an Institutional Controls Alternative. However, reduction in mass is anticipated to have little human health or environmental benefit. Reduction in the restoration time of Sr-90 concentrations is not anticipated to be significantly different for any of the alternatives with the possible exception of Alternatives 4 and 5 due to the net gradient effect of bringing clean river water inland.

For Sr-90 reduction in the aquifer, no alternative will resulting in remediation of Sr-90 to groundwater protection standards more rapidly than will natural attenuation, with the possible exception of soil flushing. Alternative 7 has the potential to improve the long-term effectiveness by shortening the time to meet remedial goals, but it is an innovative technology for Sr-90-contaminated soils at Hanford, and it must be the subject of further testing and evaluation before a decision on its use can be made. Alternative 7 has the potential for risks to natural resources by expansion of the Sr-90 plume, potentially to the river, if soil flushing is not carefully implemented. Given the uncertainties at this time relative to safe implementation of this option, these risks remain unknown.

Alternatives with pump and treat will reduce nitrate, chromium VI, and manganese (the latter two if proven to be a COCs upon further results of monitoring) at a faster rate than would be achieved through natural migration of contaminants in the aquifer. However, this improvement may not be significant when it is considered that a significant portion of the aquifer will remain unusable during the period of Sr-90 contamination.

7.3.2 Reduction in Toxicity, Mobility, or Volume through Treatment

For protection of the river from tritium, Alternatives 1 through 4 contain no treatment element and therefore would not reduce toxicity, mobility, or volume (i.e., mass) of tritium. Alternatives 5 and 7 reduce the mobility of the tritium to the river by establishing barriers to the flow to the river.

For protection of the river from Sr-90, Alternatives 1 and 2 contain no treatment element for Sr-90 and therefore would not reduce toxicity, mobility, or volume (i.e., mass) of Sr-90. Alternatives 3 through 7 would decrease the flux of Sr-90 entering the river by around 90 percent. Differences between these alternatives (permeable barrier, impermeable barrier, and hydraulic controls) are considered neither quantifiable nor great.

Alternatives 1 through 3 do not contain a treatment element for Sr-90 reduction in the aquifer. Alternatives 4 through 6, which have barriers to the river and pump-and-treat systems, compare favorably with respect to Sr-90 reduction in the groundwater; however, reductions in mobility, and/or volume are neither quantifiable nor great. Alternative 7 has the greatest potential for mass reduction, but will require that a test program be implemented before this alternative could be adequately compared with other alternatives.

For reducing other constituents in the aquifer, Alternatives 5 through 7, which have pump-and-treat systems, will reduce contaminant toxicity, mobility, and/or volume, dependent upon the specific constituent, to a higher degree than Alternatives 1 through 4.

7.3.3 Short-Term Effectiveness

None of the alternatives is expected to have significant short-term impacts on the community during implementation. No alternative will remediate the river or aquifer for Sr-90 within 270 years. Alternative 1, followed by Alternative 2, has the lowest short-term impacts associated with worker risk, as well as the lowest ecological, cultural, and transportation impacts from system installation. The greatest potential impacts to natural and cultural resources are from installation of barriers. Alternatives 4 and 5, which use wells rather than barrier, have less short-term impact than the barrier alternatives (Alternatives 3, 6, and 7) that use excavation techniques or cryogenics. Alternative 7 has the potential for risks to natural resources by expansion of the Sr-90 plume, potentially to the river, if soil flushing is not carefully implemented. Given the uncertainties at this time relative to safe implementation of soil flushing, these risks remain unknown.

7.3.4 Implementability

All alternatives, with the exception of the No-Action Alternative, will require institutional controls that will require some maintenance for close to 300 years. The technical and administrative feasibility of maintaining these controls is uncertain, but it is a comparable implementability issue for every alternative.

All three barriers are expected to be implementable, but each presents a concern because they represent a new application at Hanford. A treatability test plan is being considered for evaluation of the construction of the permeable wall in Alternative 3. This would help to refine this determination. Alternative 6 introduces some concerns because of the need to freeze the ground near the river and because of the need to maintain its integrity over 300 years. Alternative 7 presents implementability concerns regarding sheet pile installation because of past problems in installing a sheet pile barrier at Hanford. However, the alternative sheet pile installation method proposed in Alternative 7 is expected to resolve past concerns. There is little basis to distinguish between these alternatives with respect to barrier construction; however, all of the construction alternatives will require collection of additional information at the design stage.

Alternatives 4, 5, and 7 are less implementable than institutional controls because they involve installation of a complicated hydraulic control system. Hydraulic controls are subject to breakdown, and, as such, would not be effective 100 percent of the time. However, these alternatives are still technically and administratively feasible. Hydraulic control systems like the one contemplated in these alternatives would be similar to a system already in place at Hanford; therefore, these alternatives are considered more implementable than barrier construction alternatives.

The soil flush portion of Alternative 7 is not considered implementable without first successfully completing a series of laboratory, bench-scale, and field tests.

Alternatives that involve pump-and-treat systems for Sr-90 and/or other contaminants are considered less implementable than Alternatives 1 or 2.

In all of the alternatives, there is a strip of land along the river shoreline that is contaminated with Sr-90. The soil in this strip does not meet PRG levels for the rural-residential scenario and may not meet them for the modified CRCIA ranger/industrial exposure scenario. Remediation of the shoreline area would be difficult. The remove and dispose remedial alternative proposed for source waste sites could be implemented along the river shoreline, but would require excavation and backfilling to 4.6 m (15 ft) or 3 m (10 ft) for the rural-residential and modified CRCIA ranger/industrial scenarios, respectively. Such remedial actions would destroy the ecology of this riparian zone and possibly undercut the bluff along the shore, causing further destruction. Such actions may only provide temporary relief because there will likely be recontamination from upgradient groundwater. Additionally, the area appears to be within the Columbia River flood plain and residential construction may be limited or prohibited. Institutional Controls has been recommended in all of the alternatives (except No-Action) to ensure limited access to this area.

7.3.5 Cost

A summary of the cost estimates for each groundwater remedial alternative is presented in Table 7.9, and more detailed information is presented in Permit Attachment 47, Appendix G2. A simple quantitative comparison, as shown in Table 7.9 is not sufficient for evaluating the alternatives, since the alternatives represent different levels of remediation. An incremental analysis would be more appropriate. In this type of analysis, each alternative (or each group of alternatives with a similar level of remediation) is compared to the alternative with the next lowest level of remediation.

Alternative 1 includes no remediation because it proposes to do nothing and it costs nothing. Alternative 2 is similar to Alternative 1 in that it includes no remediation, but it proposes institutional controls such as warning signs and land-use restrictions. The total cost of institutional controls is $762,826.

Alternative 3 includes a remedial technology to prevent Sr-90 from entering the river. Constructing a clinoptilolite barrier will not prevent all Sr-90 from entering the river, but it will substantially reduce the amount. Strontium-90 will decay to an acceptable level in about 300 years. This degree of remediation will cost $8,499,399 more than Alternative 2, for a total cost of about $9,262,125. The objectives of Alternative 3 could also be met by using the hydraulic controls technology from Alternative 4 or the impermeable barrier technology from Alternatives 6 or 7.

In Alternative 4, the clinoptilolite barrier is replaced by hydraulic controls, which further reduces the amount of Sr-90 that will reach the river (although with less certainty). Additional remediation is provided by Alternative 4 in that a pump-and-treat system is used to remediate the Sr-90 that is present in the groundwater. The pump-and-treat system will extract Sr-90 from the aquifer and thereby reduce the mass of the contaminant. Operating the pump-and-treat system will reduce the time it takes to remediate the groundwater by about 10 percent, from 300 to 270 years. The cost of shortening this period by 30 years is about $4,983,489 more than Alternative 3, for a total of about $14,245,714.

Alternative 5 provides additional remediation by extending the hydraulic controls to protect the river from tritium, as well as Sr-90, and by to remediating the other contaminants (nitrate, iron, sulfate, manganese, TPH, and chromium VI) in the groundwater. Meeting this last objective is accomplished by operating a pump-and-treat system for the other contaminants. This pump and treat would shorten the time for the concentrations of these contaminants to reach acceptable levels in the groundwater, but it would not shorten the time until the groundwater would be available for use. The concentrations of these contaminants would be at acceptable levels (with no action) well before the Sr-90 concentration reached an acceptable level. The cost of the additional remediation is about $24,920,116 more than Alternative 4, for a total cost of about $39,165,605.

Alternative 6 actually results in less remediation than Alternative 5 because it replaces the hydraulic controls for protecting the river from Sr-90 with a cryogenic barrier that will not provide total protection from tritium. This alternative is not as effective as hydraulic controls used in preventing the Sr-90 from reaching the river. In this alternative, the protection of the river from tritium is not included as it was in Alternative 5. These changes in remediation reduce the cost of Alternative 6 compared to Alternative 5 by about $17,492,921 to $56,658,526.

Alternative 7 has the potential to provide a greater degree of remediation than any of the other alternatives because it proposes to significantly shorten the time it will take for the Sr-90 concentration in the groundwater to reach acceptable levels. Because this alternative is still in the development and evaluation stage, a reliable estimate of what this reduction in time might be cannot be made. This alternative costs $79,872,099 more than Alternative 6, for a cost of $136,530,625. This alternative is in the development stage, and this cost estimate is not as reliable as the estimates for the other alternatives.

7.3.6 NEPA Values

An interim (270 to 300 years) irreversible and irretrievable commitment of the unconfined aquifer and river shoreline would result with all alternatives because none would effectively reduce Sr-90 concentrations in the aquifer or river bank seeps within a shorter time. Also, none are effective in reducing Sr-90 concentrations at the groundwater/river interface. Aquatic resources at the groundwater/river interface may be impacted; however, more information must be acquired before impacts can be quantified. Restrictions on the use of the shoreline by humans may be required for a long period of time, regardless of the alternative chosen. Use of the river as a downstream drinking water supply or for other uses such as fishing will not be impacted by implementation of any alternative. Restrictions on the use of the groundwater will be required for 300 years under Alternatives 1 through 3 and for 270 years under Alternatives 4 through 6. Alternative 7 may result in use of the groundwater in a shorter time frame if soil flushing can be successfully implemented, but reduction in years cannot be quantified at this time. Alternative 6 may require a large expenditure of energy in order to initially implement the cryogenic barrier. There may be an impact on Native Americans because they are potentially more likely than other groups to use the area.

7.4 INTERIM ACTION FOR REMEDIATION OF GROUNDWATER

7.4.1 Potential for Implementing an Interim Action

An interim action for the 100-NR-2 groundwater OU may be warranted. Within the detailed and comparative analyses of alternatives for remediation of the groundwater, certain analyses have been complicated by a lack of information in two critical areas: confirmation that an alternative can or cannot significantly shorten restoration time frames from that of natural attenuation (300 years), and quantification of current and future risk to aquatic receptors living in the river and in river bottom substrate. A summary of these information needs and their significance in making a remedy decision is presented below.

7.4.1.1. Groundwater Remediation for Sr-90

No Sr-90 groundwater remedial alternative has been identified in DOE/RL-95-111, Rev. 0 that would provide a significantly shorter restoration time frame than the estimated natural attenuation period of 300 years. Soil flushing was identified as an innovative technology that could potentially shorten groundwater remediation. However, the lack of information regarding its implementability, safety, and cost raises doubts as to its technical feasibility.

State and public acceptance of a 300-year groundwater remedial action may be very difficult to obtain. Maintenance of a long-term remedy and its associated institutional controls would also be difficult over such an extended time frame. Because of the problems inherent with a long-term remedy and because of the lack of information supporting innovative technologies such as soil flushing, an interim action on groundwater remediation may be warranted.

River Protection from Sr-90. Data on Sr-90 impacts to aquatic resources are incomplete. Should it be concluded that there are no impacts to aquatic resources from Sr-90 contamination, no remediation for protection of the river would be necessary. Conversely, should it be concluded that substantial impacts exist, more aggressive actions may be warranted.

The existing alternatives may remove or prevent 90 percent or more of the Sr-90 mass within the aquifer from entering the river. However, the fate of approximately 5 Ci of Sr-90 in the soil (aquifer sediments) in the strip of land adjacent to the river is not well understood. The ability of any of the selected technologies to remove the Sr-90 from the aquifer sediments adjacent to the river is unknown. As detailed in Section 7.3.1.2, it is the persistent Sr-90 concentrations in this area that will cause long restoration time frames for protection of the river even if the movement of contaminated groundwater to the river is significantly reduced. Further evaluation of these technologies and their capabilities in this area may be warranted.

The lack of information on technologies and receptors may be deemed by the regulatory agencies, the DOE, and the public to be of critical importance to the determination of a final remedy for the 100-NR-2 OU. Because of this, an interim action may be necessary in order to provide adequate time for investigations designed to support the selection of a final remedy. The length of the interim action will depend upon the type and scope of interim investigations needed. However, it is anticipated that an interim action would be planned and executed for approximately a 5-year period. At the conclusion of this period, the need to continue the interim action would be evaluated.

7.4.2 Remedial Action Objective for a Groundwater Interim Action

No alternative has been identified that can remediate the groundwater or protect the river in less than 270 years. The purpose for an interim action at this OU would be to:

- Prevent exposure to contaminated groundwater
- Provide protection of the river by limiting the Sr-90 movement to the river
- Obtain information to allow selection of a final remedial action
- Take action consistent with the likely final remedies.

Remedial alternatives would be chosen that would act in concert with these objectives and be capable of providing further information for use in making a final alternative determination. Because of the uncertainties associated with ecological risk in the area along the river, and in the river bottom substrate, an alternative that controls the movement of Sr-90 to the groundwater-river interface would be an added objective of the interim action.

7.4.3 Remedial Technology Descriptions for an Interim Action

Viable remedial alternatives to achieve the interim remedial action objective should provide the most efficient use of budgetary resources and be consistent with any potential final remedy. It is evident using this basis that none of the final action alternatives presented in Section 7.3 that include long-term physical barriers would be appropriate for an interim action. Construction costs for these barriers are estimated at $8,200,000 for a permeable barrier (Alternative 3), $16,500,000 for a cryogenic barrier (Alternative 6), and $8,600,000 for a soil flush system that incorporates a sheet pile barrier (Alternative 7). The soil flush system associated with Alternative 7 is considered to be too speculative and costly at this time to be considered for an interim use. The physical barriers could potentially preclude the implementation of final remedies that do not incorporate the chosen barrier in the final action, or conversely would require removal costs to implement a different final remedy. Therefore, all alternatives associated with these physical barriers have been screened from consideration as viable interim actions.

The objectives of the interim action could be met by implementing hydraulic controls using a pump-and-treat system such as described in Alternative 4, or just by implementing the hydraulic control portion of such a system. Since this is for an interim action, the full system described as Alternative 4 would not be needed. The existing N-Springs ERA (as modified to optimize costs) could be used to fulfill the interim action objectives, operated as either a hydraulic control or a pump-and-treat operation.

The remedial alternatives that would remain as possible interim actions are: No-Action; Institutional Controls; Hydraulic Controls; and, Pump and Treat. These alternatives are compared below against applicable interim action CERCLA criteria. This comparison has been performed for the purpose of supporting the selection of a remedial alternative should an interim action be recommended.

7.4.3.1. No-Action and Institutional Controls

Descriptions of the technologies included in these alternatives are contained in DOE/RL-95-111, Rev. 0, Sections 5.4.1 and 5.4.2, respectively. Components of the Institutional Controls Alternative specific to Sr-90 would apply during an interim action.

7.4.3.2. Pump-and-Treat Alternative

A full description of the pump-and-treat system and operating plan is described in (DOE-RL 1997). This system would consist of four extraction wells, an ion exchange treatment skid, two injection wells, and plant equipment such as piping, electrical equipment, and instrumentation. The extraction well network would include wells N-75, N-103A, N-105A, N-106A (although well N-105A is not being used), located downgradient of the 1301-N Crib. The pump-and-treat system would be operated continuously at a nominal rate of 228 L/min (60 gal/min) with an average removal of 90 percent for the volume of water treated over a given period. Water from the extraction wells would be pumped to a large influent tank located at the treatment facility. The influent tank acts as a surge tank and provides feed water to the treatment system.

The four ion exchange columns would each contain 1.4 m3 (50 ft3) of clinoptilolite, a natural zeolite. Contaminated water would be pumped from the influent tank through the four clino-containing ion exchange columns, where the Sr-90 would be removed from the water. The clino would be changed out on a cycle duration that results in an average removal rate greater than or equal to 90 percent. The treated water would be discharged into a large effluent tank. The effluent tank acts as a surge tank and provides feed water to the injection well network.

The injection well network would include wells N-29 and N-104A, which are located upgradient of the 1301-N Crib. The processed water would be injected into both wells.

7.4.3.3. Hydraulic Controls Alternative

The Hydraulic Controls Alternative would consist of the same extraction and injection systems as in the Pump-and-Treat Alternative described above. The flow of contaminated liquid would bypass the treatment system and be injected without treatment.

7.4.4 Detailed Analysis of Remedial Alternatives for Groundwater Interim Action

Alternatives applicable to an interim action are compared against the CERCLA criteria described in DOE/RL-95-111, Rev. 0, Section 6.0, which for the most part would apply to an interim action. However, the long-term effectiveness criterion would not be applicable to an interim action, and the costs presented in DOE/RL-95-111, Rev. 0, Section 6.0 would not be applicable for the interim time period. Interim costs are presented in Table 7.10.

7.4.4.1. No-Action Alternative

The No-Action Alternative (Alternative 1) discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.1 is retained for interim action as a baseline for comparison. This alternative is, however, not realistic since DOE is maintaining Institutional Controls in this area in connection with other activities. No costs are associated with the No-Action Alternative.

7.4.4.2. Institutional Controls Alternative

The Institutional Controls Alternative (Alternative 2) is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.2. The detailed analysis of CERCLA criteria for this alternative as it relates to Sr-90 final remediation would be applicable to an interim action as well, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, which would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) no additional costs would be associated with the Institutional Controls Interim Alternative because DOE would maintain its present system of site controls during the interim period. Other facilities and circumstances require institutional controls to continue; therefore, additional costs need not be considered for the interim action alternative.

7.4.4.3. Hydraulic Controls Alternative

A hydraulic controls system is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 as a river protection technology within Alternative 4. The detailed analysis of CERCLA criteria relative to Sr-90 remediation that is presented in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 would be applicable to an interim action, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, and this would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) a cost-effectiveness study (DOE-RL 1997) of operating the ERA pump-and-treat system at various treatment levels was recently completed. This study noted that no capital cost would be associated with operating this system since it is already in place. A cost analysis (Permit Attachment 47, Appendix G) based on that study shows that the hydraulic control system could operate at $261,900 per year. This cost includes an expanded well monitoring system but no treatment costs.

7.4.4.4. Pump-and-Treat Alternative

A pump-and-treat system is discussed in DOE/RL-95-111, Rev. 0, Section 6.3.2.4 as a groundwater remediation technology within Alternative 4. The detailed analysis of CERCLA criteria relative to Sr-90 remediation that is presented in that section would be applicable to an interim action, with the following exceptions: (1) the NEPA values define irreversible and irretrievable commitments for the long-term action, which would not be applicable in the short term; (2) impacts on Native American access to cultural resources would not be applicable in the short term; and (3) a cost-effectiveness study (DOE/RL-1997) of operating the ERA pump-and-treat system at various treatment levels was recently completed. This study noted that no capital cost would be associated with operating either system since the systems are already in place. A cost analysis (Permit Attachment 47, Appendix G) based on that study shows that the pump-and-treat system could operate at $329,100 per year. This cost includes a reduced well monitoring system and treatment costs.

7.4.5 Comparative Analysis of Remedial Alternatives for Groundwater Interim Action

The following information provides a comparison of the four interim action alternatives utilizing applicable CERCLA criteria. A discussion of how these alternatives compare for final remedy purposes is included in Sections 7.3.1 through 7.3.6. As stated in Section 7.1, the overall protection and ARAR compliance criteria have not been included in this comparative analysis because all alternatives retained (excluding the No-Action Alternative) meet these threshold criteria except for discharge limits for the discharge of groundwater MCLs, which would not be met. This, however, is an interim action. State and community acceptance will not be evaluated until after the proposed plan has been issued; therefore, they also are not part of this comparative analysis.

7.4.5.1. Long-Term Effectiveness and Permanence

This criterion would not apply to interim action.

7.4.5.2. Reduction of Toxicity, Mobility, or Volume through Treatment

Only the Pump-and-Treat Alternative would reduce Sr-90 mass in the groundwater through treatment. However, this reduction is not significant compared to what would occur by natural attenuation, or by implementing one of the other alternatives. The Hydraulic Controls and Pump-and-Treat Alternatives would significantly reduce the flux of Sr-90 towards the river, thus reducing the mobility of the major contaminant in the 100-N Area. None of the alternatives would provide for a shorter restoration time frame because none would remediate the groundwater or protect the river at the conclusion of the interim measure.

7.4.5.3. Short-term Effectiveness

The Pump-and-Treat and Hydraulic Control Alternatives are already in place as a result of the N-Springs ERA (DOE-RL 1996g, 1997). Therefore, short-term impacts from these alternatives would be small and associated primarily with worker risk from continued operation of these systems. Because pump-and-treat contains two operating systems, the hydraulic control system and the ion exchange treatment system, it would have a slightly higher potential for short-term worker risk during O&M than the Hydraulic Control Alternative. However, the short-term impacts would not be significantly different from the other interim action alternatives. Only minor, if any, short-term physical, biological, or cultural impacts would result from any of the alternatives.

7.4.5.4. Implementability

As a short-term action, all four of the alternatives would be considered technically and administratively feasible. Implementability would not be significantly different for any of the alternatives. No action would be the easiest alternative to implement; however, implementation of this alternative would not be viable because the DOE will continue to maintain restrictions and controls over the 100-N Area groundwater for purposes other than 100-NR-2 remediation. Institutional controls are already in place as part of the DOE operation of the Hanford Site. Hydraulic control implementation, required for both the Pump-and-Treat and Hydraulic Controls Alternatives, would be less implementable than the No-Action or Institutional Controls Alternatives due to the continued operation of a complicated hydraulic control system that could be subject to breakdown. Finally, because pump and treat contains another operating system, it would be slightly less implementable compared to hydraulic controls.

7.4.5.5. Cost

The detailed analysis in Section 7.4.4 showed that there were no additional costs associated with the No-Action and Institutional Controls Alternatives, because these interim action alternatives would not require actions beyond what is currently in place. A comparative cost analysis (Table 7-10) for a 5-year period shows that Hydraulic Controls, at a Present Worth cost of $1,153,109 is the second lowest cost alternative, after the No-Action and Institutional Controls Alternatives. The Pump-and-Treat Alternative is the most expensive alternative, at a Present Worth cost of $1,448,981.

7.4.5.6. NEPA Values

None of the alternatives would require construction of new systems. Impacts to wildlife from construction noise, and disturbance of the land area for construction of well systems, would therefore not occur from any alternative. Ecological, cultural, and natural resource reviews would not be required for any alternative. Impacts to aquatic resources are not anticipated to be significantly different for any of the four interim actions, because decreases in river-bottom and shoreline sediment concentrations during the interim period would not be appreciably different with any of the alternatives. Restrictions on the use of groundwater and river water in the vicinity of the 100-N Area would remain in the short-term regardless of which interim alternative is selected, due to continued DOE control over the Hanford Site in the time frame of the interim action.

Table 7.1. Applicable Remedial Alternatives for Source Waste Sites Assuming a Rural Residential Exposure Scenario.

Waste Group	No Action	Remove/ Dispose	In Situ Bioremediation
Radioactive	X	X	
Petroleum	X	X	X[a]
Inorganic	X	X	
Burn Pits	X	X	
Solid Waste	X	X	

[a] This alternative is only applicable to 2 out of 22 sites within the petroleum waste group.

Table 7.2. Applicable Remedial Alternatives for Source Waste Sites Assuming a Modified CRCIA Ranger/Industrial Exposure Scenario

Waste Group	No Action	Remove/Dispose	In Situ Bioremediation	Containment	Solidification
Radioactive	X	X		X[a]	X[b]
Petroleum	X	X	X[c]		
Inorganic	X	X			
Burn Pits	X	X			
Solid Waste	X	X			

[a] This alternative is only applicable to 16 out of 37 sites within the radioactive waste group.
[b] This alternative is only applicable to 20 out of 37 sites within the radioactive waste group.
[c] This alternative is only applicable to 2 out of 22 sites within the petroleum waste group.

Table 7.3. Cost Comparison of Remedial Action Alternatives for Deep Petroleum Source Sites.a
(Applicable to both the Rural-Residential and Modified CRCIA Ranger/Industrial Exposure Scenarios)

Site	Remove/Dispose	In Situ Bioremediation	Percent Difference from Remove/ Dispose
UPR-100-N-17	$2,409,203	$ 903,509	
UPR-100-N-42	$2,842,571	$ 910,025	
Total Cost	$5,251,774	$1,813,534	-65%

[a] Costs do not include a 3 percent design cost and a 3 percent design data collection cost.
UPR = unplanned release

Table 7.4. Cost Comparison of Remedial Action Alternatives for Near-Surface Petroleum Source Sites.[a] (Applicable to both the Rural-Residential and Modified CRCIA/Ranger Industrial Exposure Scenarios)

Site	Remove/Dispose	Remove/Ex Situ Bioremediation/Dispose	Percent Difference from Remove/Dispose
UPR-100-N-18	$105,000	$107,994	
UPR-100-N-19	$105,944	$112,486	
UPR-100-N-20	$102,056	$105,660	
UPR-100-N-21	$97,168	$100,162	
UPR-100-N-22	$105,092	$108,696	
UPR-100-N-23	$103,593	$104,720	
UPR-100-N-24	$107,499	$121,304	
UPR-100-N-36	$96,816	$97,408	
UPR-100-N-43	$106,574	$116,719	
100-N-3	$254,529	$329,895	
100-N-12	$93,743	$94,334	
100-N-35	$98,242	$99,369	
100-N-36	$94,724	$98,254	
124-N-2	$149,807	$212,349	
Total Cost	$1,620,787	$1,809,350	+12

[a] Costs do not include a 3 percent design cost and a 3 percent design data collection cost.
UPR = unplanned release

Table 7.5. Present Worth Cost Comparison of Remedial Alternatives for Source Waste Sites for the Rural-Residential Exposure Scenario

Remedial Alternative	Number of Sites[a, b]	Remove/ Dispose	Remove/Ex Situ Bioremediation/ Dispose	In Situ Bioremediation	Percent Difference from Remove/ Dispose
Remove/Dispose[c]	80	$52,030,513	N/A	N/A	NA
Remove/Dispose	63	$50,409,726	$50,409,726		
Remove/Ex Situ Bioremediation/ Dispose	17	$ 1,620,787	$ 1,809,350		+12
Cost[c]	80	$52,030,513	$52,219,056		~ 0
Remove/Dispose	78	$46,777,739		$46,777,739	
In Situ Bioremediation[b]	2	$ 5,251,774	N/A	$ 1,813,350	-65
Cost[c]	80	$52,030,513		$48,592,089	- 7

[a] There are four sites (100-N-28, 116-N-4, 118-N-1, UPR-100-N-35) where all of the waste is below 4.6 m (15 ft), and these sites may not be remediated under this scenario. See DOE/RL-95-111, Rev. 0, Appendix B for information regarding excavation depths.
[b] There are five sites (100-N-46, 100-N-50, 100-N-51a, 100-N-51b, and 100-N-65) for which costs or additional costs will be established during design.
[c] The cost shown in this table does not include a 3 percent design cost and a 3 percent cost for collecting design data in the field.
N/A = not applicable

Table 7.6. Costs for Source Units

Site Name	Remove/Dispose	Capping	In Situ Solidification
CAP 1-1			
UPR-100-N-10	$95,391	$653,884	$157,016
UPR-100-N-39	$99,297	$3,767,236	$415,600
Subtotal	$194,688	$4,421,120	$572,616
CAP 1-2			
UPR-100-N-29	$100,630	$41,563	$158,467
UPR-100-N-30	$112,776	$4,086,761	$349,849
UPR-100-N-32	$101,908	$389,430	$173,568
Subtotal	$315,314	$4,517,754	$681,884
CAP 4-1			
UPR-100-N-4	$97,464	$83,646	$192,295
UPR-100-N-5	$218,961		$651,238
UPR-100-N-6	$104,056	$190,527	$217,955
UPR-100-N-8	$95,391	$4,647	$157,016
UPR-100-N-25	$97,779	$106,881	$202,532
100-N-26	$101,593	$23,235	$163,047
124-N-4	$766,864	$38,909,260	$1,388,214
Subtotal	$1,482,108	$46,469,916	$2,972,297
CAP 4-2			
UPR-100-N-9	$104,307	$4,672,424	$345,617
UPR-100-N-14	$95,409	$82,740	$158,496
Subtotal	$199,716	$4,755,164	$504,113
CAP 4-3			
UPR-100-N-13	$88,873	$749,331	$181,321
UPR-100-N-26	$99,908	$3,674,112	$252,221
Subtotal	$188,781	$4,423,443	$433,542
Misc In Situ Solidification			
UPR-100-N-1	$150,214	N/A	$386,077
UPR-100-N-11	$95,835	N/A	$345,010
100-N-13	$98,242	N/A	$340,414
100-N-14	$98,242	N/A	$340,414
Subtotal	$442,533	N/A	$1,411,915
Total for Capping and Remove/ Dispose	$2,380,607	$64,587,397	
Total for In Situ Solidification and Remove/Dispose	$2,823,140	N/A	$6,576,367

[a] Costs based on the Modified CRCIA Ranger/Industrial Exposure Scenario.
NA = not applicable

Table 7.7. Present Worth Cost Comparison of Remedial Alternatives for Source Waste Sites for the Modified CRCIA Ranger/Industrial Exposure Scenario [a]

Remedial Alternative	Number of Sites[b,c]	Remove/ Dispose	Remove/ Ex Situ Bioremediation/ Dispose	In Situ Bioremediation	Containment	In Situ Solidification	Percent Difference from Remove/ Dispose
Remove/Dispose	80	$49,896,037					
Remove/Dispose	63	$48,275,250	$48,275,250	N/A	N/A	N/A	
Remove/Ex Situ Bioremediation/ Dispose	17	$ 1,620,787	$ 1,809,350	N/A	N/A	N/A	+12
Cost	80	$49,896,037	$50,084,600				0
Remove/Dispose	78	$44,644,263	N/A	$44,644,263	N/A	N/A	
In Situ Bioremediation	2	$ 5,251,774	N/A	$ 1,813,350	N/A	N/A	-65
Cost	80	$49,896,037		$46,457,613			-7
Remove/Dispose	64	$47,515,430	N/A	N/A	$ 47,515,43	N/A	
Containment	16	$2,380,607	N/A	N/A	$64,587,39	N/A	+2703
Cost	80	$49,896,037			$112,102,82		+ 125
Remove/Dispose	60	$46,820,831	N/A	N/A	N/A	$46,820,83	
In Situ Solidification	20	$3,075,206	N/A	N/A	N/A	$6,576,36	+114
Cost	80	$49,896,037				$53,397,19	+7

[a] The cost shown in this table does not include a 3 percent design cost and a 3 percent cost for collecting design data in the field.
[b] There are five sites for which costs or additional costs will be established during design.
[c] There are eleven sites for which all of the waste is below 3 m (10 ft), and these sites may not be remediated under this scenario.

Table 7.8. Remedial Alternatives for Groundwater Contamination at the 100-N Area

Alternative		River Protection Technology		Aquifer Cleanup Technology	
No.	Title	Protection of the River from Tritium	Protection of the River from Strontium	Reduce Strontium-90 Concentration/ Activity in the Aquifer[a]	Reduce Concentrations of Other Contaminants in the Aquifer[b]
1	No Action	No Action	No Action	No Action	No Action
2	Institutional Controls	Institutional Controls	Institutional Controls	Institutional Controls	Institutional Controls
3	Permeable Barrier for River Protection	Institutional Controls	Permeable Barrier Wall	Institutional Controls	Institutional Controls
4	Hydraulic Controls for River Protection and Pump and Treat for Strontium in the Aquifer	Institutional Controls	Hydraulic Control (270 years)	Pump and Treat	Institutional Controls
5	Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation	Hydraulic Control (15 years)	Hydraulic Control (270 years)	Pump and Treat	Pump and Treat
6	Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation	Institutional Controls	Impermeable Barrier Wall (cryogenic wall)	Pump and Treat	Pump and Treat
7	Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation	Impermeable Barrier Wall (with hydraulic control for tritium)	Impermeable Barrier Wall (sheet pile wall with pre-excavation)	Soil Flush System	Pump and Treat

[a] Strontium-90 remediated by removing strontium from the aquifer (concentration) and by providing time for natural radioactive decay (activity).
[b] Other contaminants include nitrate, sulfate, hexavalent chromium VI, TPH, and manganese.

Table 7.9. Cost of Remedial Alternatives for Groundwater

No.	Remedial Alternatives	Initial Capital Cost ($)	Present Worth of Future Costs ($)	Total Present Worth Cost ($)
1	No Action	0	0	0
2	Institutional Controls	63,558	699,468	762,826
3	Permeable Barrier for River Protection	8,240,697	1,021,528	9,262,225
4	Hydraulic Controls for River Protection and Pump and Treat for Strontium in the Aquifer	1,754,609	12,491,105	14,245,714
5	Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation	4,580,204	34,585,401	39,165,605
6	Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation	20,389,389	36,269,137	56,658,526
7[a]	Sheet Pile Barrier for River Protection and Soil Flushing/ Pump and Treat for Aquifer Remediation	22,416,808	114,113,817	136,530,625

[a] This alternative is in the development and evaluation stage; therefore, a reliable cost estimate cannot be made.

Table 7.10. Comparative Cost Summary of the Interim Groundwater Remedial Alternatives

Alternative	Capital Cost ($)	One Year Operating Cost ($)	Present Worth Cost ($)
No Action	0	0	0
Institutional Controls	0	0	0
Hydraulic Controls	0	$261,900	$1,153,109
Pump and Treat	0	$329,100	$1,448,981

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Contents

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9.0 RECOMMENDED CORRECTIVE MEASURES FOR 100-NR-1 AND 100-NR-2 OPERABLE UNITS

According to EPA guidance, a RCRA corrective measures study should identify the recommended corrective measure. This section is included for consistency with EPA RCRA guidance, and the recommended corrective measures presented in this section correspond to the preferred remedial alternatives that will be identified in the integrated CERCLA Proposed Plan and RCRA Permit Modification proposal for the 100-NR-1 and 100-NR-2 Operable Units (OUs). The preferred alternative that will be presented in the Proposed Plan is only a preliminary recommendation, and changes to the preferred alternative, or a change from the preferred alternative to another alternative, may be made based on public comment. The recommended corrective measures presented in this section will be revised, if necessary, to reflect the remedy eventually selected by the CERCLA ROD.

In addition to identifying the recommended corrective measure, the RCRA process requires that the specific permit conditions associated with the recommendation be identified. This section includes detailed information to be referenced for purposes of establishing RCRA permit conditions. If, as a result of public comment, the preferred alternative is changed, then the permit conditions and information presented in this section will be modified accordingly.

The Tri-Party Agreement defines the 100-NR-1 and 100-NR-2 OUs as RCRA past-practice sites. RCRA corrective action authority applies to releases of dangerous[1] waste and dangerous constituents including releases from solid waste management units and to releases of mixed waste (mixtures of hazardous waste and radiological contaminants), but not to waste that only contains radiological contaminants. Since many of the waste sites in the operable units contain radiological contaminants, and because they are in the 100 Area, which is listed on the NPL, the adequacy of any action taken under another regulatory authority will be evaluated against CERCLA program criteria. The recommended RCRA corrective measures[2] that are discussed in this section have been developed to satisfy requirements for both RCRA corrective action and CERCLA remedial action. By applying CERCLA authority concurrently with RCRA corrective action requirements through an integrated plan, all regulatory and environmental obligations at the 100-NR-1 and 100-NR-2 OUs can be met as effectively and efficiently as possible. Also, by applying CERCLA authority jointly with that of RCRA, additional options for disposal of corrective action and remedial action wastes at the ERDF are possible. By allowing flexibility in final disposal options, disposal costs can be minimized while still being protective of human health and the environment.

The following discussion explains RCRA corrective action performance standards, which must be met by the recommended corrective measures.

9.1 RCRA CORRECTIVE ACTION PERFORMANCE STANDARDS

The RCRA corrective action performance standards found at WAC 173-303-646(2) state that the corrective measure:

1. *Shall protect human health and the environment from all releases of dangerous wastes and dangerous constituents, including releases from all solid waste management units at the facility.* For purposes of corrective action at the 100-NR-1 and 100-NR-2 Operable Units, protection is generally determined as follows:

[1] RCRA authority with respect to hazardous waste management and corrective action has been delegated to the State of Washington. The State of Washington has published regulations for this authority at WAC 173-303, "Dangerous Waste Regulations." The State terms "dangerous waste" and "dangerous constituents" are generally equivalent to the RCRA terms "hazardous waste" and "hazardous constituents."

[2] RCRA corrective measures are essentially equivalent to CERCLA remedial actions.

a. Human health[3] will be protected by preventing exposure to contaminants above unacceptable levels (i.e., MTCA B with a residential land-use scenario for soil sites).

b. Protection of the Columbia River will be enhanced by removing contamination from the source sites and by utilizing the existing pump-and-treat system (via hydraulic controls) to reduce discharges of contaminated groundwater.

c. Ecological resources will be protected by minimizing impacts resulting from corrective measures, by cleaning up source sites (except the shoreline site) to levels that are protective of human health, and by continuing the existing pump-and-treat operations to reduce discharges of contaminated groundwater to the river.

d. Cultural resources will be protected by minimizing impacts resulting from corrective measures.

A discussion of how these performance standards will be achieved is provided in Permit Sections 9.2 and 9.3.

2. *Is required regardless of the time at which waste was managed at the facility or placed in such units, and regardless of whether such facilities or units were intended for the management of solid or dangerous waste;*

The 100 Area was evaluated to identify sites where waste was placed or handled. The results of this investigation are provided in a variety of documents listed in DOE/RL-95-111, Rev. 0, Section 2.2. Based on three principle resources (i.e., 100 Area Technical Baseline Report, RCRA Facility Investigation/Corrective Measure Study Work Plan, and WIDS), DOE/RL-95-111, Rev. 0 identifies 114 potentially contaminated source sites in the 100-NR-1 Operable Unit. Thirty three of these have been eliminated from further consideration in the evaluations of alternatives because either they were never contaminated, are not currently contaminated, or they fall under other regulatory jurisdictions and are not subject to RCRA regulations. The remaining 81 potentially contaminated waste sites would be subject to RCRA corrective measures because dangerous constituents were handled at and potentially released from the sites. Corrective measures recommended for the various categories of waste sites are described in Section 9.2.1 below.

3. *Must be implemented by the owner/operator beyond the facility property boundary, where necessary to protect human health and the environment.*

The recommended corrective measures are interim actions that address contaminated soils and groundwater within the 100-NR-1 and 100-NR-2 Operable Units. There have been releases of dangerous constituents to locations beyond the boundaries of the areas addressed by DOE/RL-95-111, Rev. 0 and the DOE is undertaking studies of the impacts of these releases and how they will need to be addressed in final actions for the Hanford Site. Although the recommended corrective measures will reduce the potential for future off site releases, this performance standard will be addressed during final remediation of the Hanford Site as discussed in Section 9.1 above.

In addition to the performance standards cited in the WAC, the following also applies:

[3] It is assumed that protection of human health will also result in the protection of various ecological receptors (i.e., plants and animals) that could come into contact with the potentially contaminated sites as discussed in Section 4.3. It is also a basic assumption in recommendations for corrective measures that they will not preclude any future land use.

4. Corrective action must be conducted in compliance with training requirements established in 29 *CFR* 1910.120(e) and Permit Condition II.C.2.

Training to be implemented to meet this requirement is described in Section 9.2.5 below.

9.2 CORRECTIVE MEASURES FOR THE 100-NR-1 OPERABLE UNIT SOURCE SITES

The 100-NR-1 OU addresses contaminated soils and underground pipelines. It also includes the shoreline site, which is composed of the riverbank seeps in the 100-N Area (N-Springs) and the contaminated soil associated with waste site 100-N-65. The 100-NR-1 Operable Unit does not include the contaminated groundwater underlying this area. The groundwater is addressed in the 100-NR-2 OU.

Based on the types of contaminants that occur at the waste sites, the 81 waste sites included in the 100-NR-1 OU have been categorized into the following types:

- Radioactive waste sites (37)[4]
- Inorganic waste sites (6)
- Burn pits (6)
- Surface solid and miscellaneous waste sites (9)
- Surface petroleum sites (20)
- Deep petroleum sites (2)
- Shoreline site (1).

9.2.1 Recommended Actions and Justifications

Different corrective measures have been recommended for the various categories of waste sites in the 100-NR-1 OU. The recommended corrective measures are as follows:

- Remove/Dispose for the radioactive and inorganic waste sites, the burn pits, and the surface solid and miscellaneous waste sites. The Remove/Dispose corrective measure would consist of removing contaminated media that exceed cleanup levels; disposing media at the ERDF; backfilling, grading, and revegetation excavated areas; and land-use restrictions and access controls as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.4.

- Remove/Ex Situ Bioremediation/Dispose for near-surface petroleum sites. The Remove/ Ex Situ Bioremediation/Dispose corrective measure would consist of removing contaminated media that exceed cleanup levels; treating excavated soil through biodegradation to reduce toxicity (ex situ bioremediation); disposing residual, contaminated media at the ERDF; backfilling and revegetation excavated areas; and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.5.

- In Situ Bioremediation for deep petroleum sites. The In Situ Bioremediation corrective measure would consist of treating contaminated soil in place through biodegradation to reduce toxicity (in situ bioremediation); revegetating disturbed areas; and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 5.3.6.

- Institutional Controls under a modified CRCIA ranger/industrial scenario for the shoreline site. The Institutional Controls corrective measure would consist of land-use and/or access controls and groundwater monitoring as described in detail in DOE/RL-95-111, Rev. 0, Section 8.7.2.

In developing the recommended corrective measures, the various alternatives were compared against both the CERCLA evaluation criteria and the RCRA performance standards. Alternatives that met the two

[4] These sites are called radioactive waste sites because radioactive constituents are the primary concern; however, these sites are also potentially contaminated with dangerous constituents.

CERCLA threshold criteria (i.e., overall protection of human health and the environment and compliance with ARARs), would also meet the RCRA performance standards numbered 1 through 3 in Section 9.1. All the recommended corrective measures provide protection of human health (performance standard 1.a). The measures that include a removal or treatment component will be protective by removing and disposing of contaminated soil or treating contaminated soil to reach acceptable levels in accordance with ARARs. Similarly, the in situ component will treat contaminated soil to ARARs. The institutional controls recommendation will be protective of human health by preventing exposure through the use of access controls and land-use restrictions.

In addition, the recommended corrective measures, except for institutional controls, would be protective of the environment (performance standard 1.b). By removing or treating contaminated soils, no contaminants above acceptable cleanup levels would remain at the site. Therefore, the potential for contaminants to migrate to other environmental resources is minimized. Institutional controls would not be protective of the environment because they are not effective in preventing migration of contaminants to the groundwater or the river. However, the recommendation to implement institutional controls is viewed as only an interim measure pending availability of information that would support selection of a final remedy for the shoreline site. Attaining ARARs for final cleanup are beyond the scope of the recommended corrective measures, but they will be addressed as part of final cleanup of the site.

All of the recommended corrective measures would minimize impacts to ecological and cultural resources (performance standards 1.c and 1.d). For recommendations with removal components, impacts would be minimized through careful adherence to ecological and cultural resources mitigation planning. With the in situ treatment component, little disturbance of the site would be required, therefore impacts to ecological or cultural resources would be minimal. In addition, both the remove and treatment recommendations should have a beneficial impact on ecological and cultural resources by reducing the amount of contamination discharged to offsite sources. Institutional controls, which are already widely used at Hanford, would present no additional risk to ecological or cultural resources.

Performance standard 2 is being met with these recommended corrective measures because all of the sites that have been identified as being potentially contaminated in the 100-NR-1 are being addressed by one of the corrective measures.

By removing or treating contaminated soils to acceptable cleanup levels, and by controlling migration of contaminants to the groundwater, the potential for releases beyond the boundaries of the 100-NR-1 or 100-NR-2 Operable Units is greatly reduced. Therefore, the recommended corrective measures would satisfy performance standard 3, both in the near term and the future. In addition, this performance standard will be addressed during final remediation of the Hanford Site as discussed in Section 9.1 above.

Performance standard 4 pertaining to training is discussed in Section 9.2.5 below.

9.2.2 Cleanup Standards for the 100-NR-1 Operable Unit

The cleanup standards for the 100-NR-1 OU are MTCA Method B values identified for the contaminants of concern listed in DOE/RL-95-111, Rev. 0, Table 4-7. If there are sites where deep soil contamination (more than 4.6 m below surrounding grade) is in excess of the cleanup standards, several factors will be considered to determine the extent of additional corrective actions. These factors include protection of human health and the environment, remediation costs, size of the ERDF, worker safety, presence of ecological and cultural resources, the use of institutional controls, and long-term monitoring costs. The extent of remediation must also ensure that contaminant levels in the soil are protective of groundwater and the Columbia River. The decision of whether to proceed with the Remove/Dispose recommendation below 4.6 m will be made by the regulators in consideration of the factors listed above.

9.2.3 Cost

The estimated cost for the various Remove/Dispose alternatives that are recommended for the 80 source sites (which excludes the shoreline site) is $48.7 million. The cost for the Institutional Controls under the Modified CRCIA Ranger/Industrial Alternative that would be applicable to the shoreline site is estimated to be $63,358. Detailed cost analyses for all the alternatives are contained in Permit Attachment 47, Chapter 7.0, §7.2.

9.2.4 Schedule

Corrective measures for the 100-NR-1 Operable Unit will begin upon completion of all the TSD units and will follow the duration schedule identified in the *Engineering Evaluation/Cost Analysis for the 100-N Area Ancillary Facilities and Integration Plan* (Permit Attachment 48).

9.2.5 Training

All personnel working at the Hanford Site, including at sites associated with the 100-NR-1 Operable Unit, will be provided with and will successfully complete general site training as specified in Permit Condition II.C.2 of the Hanford Facility Dangerous Waste Permit. The general requirements specified in Permit Condition II.C.2 are as follows:

All Hanford Facility personnel shall receive general training within 6 months of hire. This training shall provide personnel with orientation of dangerous waste management activities being conducted on the Hanford Facility. This training shall include:

- Description of emergency signals and appropriate personnel response
- Identification of contacts for information regarding dangerous waste management activities
- Introduction to waste minimization concepts
- Identification of contact(s) for emergencies involving dangerous waste
- Familiarization with the Hanford Facility Contingency Plan.

In addition to the training specified in the permit condition, personnel who work at or visit the 100-NR-1 OU sites and who have the potential for exposure to contaminants above permissible levels will be provided with training in accordance with 29 CFR 1910.120(e). All such personnel shall receive the required training before they are permitted to engage in hazardous waste operations that could expose them to hazardous substances, safety, or health hazards. The training shall consist of provision of the following information:

- Names of personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on the site
- Use of personal protective equipment
- Work practices by which the employee can minimize risks from hazards
- Safe use of engineering controls and equipment on the site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazards
- Familiarization with the site safety and health plan.

This information shall be provided both initially and in annual refresher courses, and certifications shall be made as summarized in subsection 9.2.5.3.

9.2.5.1. Initial Training

- For general site workers, initial training shall consist of a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor.

- For workers who are on site only occasionally for a specific limited task, or those who will work only in areas where no health hazards or the possibility of an emergency exists (i.e., are not required to wear respirators), initial training shall consist of a minimum of 24 hours of instruction off the site, and a minimum of 1 day of supervised field experience.
- For on-site managers and supervisors directly responsible for employees engaged in hazardous waste operations, initial training shall consist of a minimum of 40 hours of instruction and 3 days of field experience. This may be reduced to 24 hours of instruction and 1 day of field experience if supervision is limited to those workers who are on site only occasionally or work in areas where no health hazards exist. Managers and supervisors must also have 8 hours of specialized training on such topics as employer's safety and health program and associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques.
- For trainers, they shall have academic credential and instruction experience in the subjects they are expected to teach, or must have satisfactorily completed a training program for teaching the subjects, and shall demonstrate competent instructional skills and knowledge of the subject matter.
- For those employees engaged in responding to hazardous emergency situations at hazardous waste cleanup sites that may expose them to hazardous substances shall be trained in how to respond to such expected emergencies.

9.2.5.2. Refresher Training

Employees and supervisors required to have completed the initial training as described above shall receive 8 hours annually of refresher training in the required topics and/or a critique of incidents that occurred during the previous year that could serve as training examples.

9.2.5.3. Certification

Employees and supervisors that have received and successfully completed the training and field experience shall be certified by their instructor as evidenced by a written certificate. Uncertified employees shall be prohibited from engaging in hazardous waste operations.

9.3 CORRECTIVE MEASURE FOR THE 100-NR-2 OPERABLE UNIT

The 100-NR-2 OU contains the contaminated groundwater in the aquifer underlying the 100-NR-1 OU. Sr-90 is the contaminant of greatest concern in the groundwater because, without remediation, it renders the groundwater unusable for nearly 300 years and presents a potential threat to both human health and environment as it mixes with the Columbia River at the 100-N Springs area. Besides Sr-90, the groundwater currently contains tritium, nitrate, sulfate, iron, chromium, manganese, and TPH above groundwater and/or river protection standards. Groundwater is migrating toward and has the potential of discharging into the Columbia River because of the natural water table gradient. The corrective action taken under the existing Expedited Response Action Memorandum (Ecology and EPA, 1994) has reduced SR-90 contamination and flow of discharges to the river. The riverbed and riverbank seeps that discharge contaminated groundwater are known as the N-Springs. The following is a discussion of the recommended interim corrective measure for the 100-NR-2 OU.

9.3.1 Recommended Action and Justification

The capability of a technology to achieve groundwater remediation and river protection, and the identification of aquatic or riparian resources that may be impacted by Sr-90 concentrations, cannot be determined at this time. This information would be a prerequisite to determining a final remedy. Therefore, as additional information is collected on the groundwater and potential impacts and the effectiveness of new remediation technologies are evaluated, it is recommended that an interim corrective measure be pursued. The interim measure should be able to prevent exposure to contaminated groundwater, provide protection of the river by limiting the Sr-90 movement to the river, result in information that would allow for the selection of a final remedy, and be consistent with the likely final remedy.

The recommended interim corrective measure for the 100-NR-2 OU is composed of the following elements:

- Provide control of Sr-90 discharges to the Columbia River through the operations of the existing pump-and-treat system, which is being operated under the action memorandum, i.e., operation of the pump-and-treat to attain an average reduction of 90% of the Sr-90 concentration in the extracted groundwater.
- Propose additional actions if, during the initial 5-year period, information indicates that such measures would be necessary to protect human health and the environment, or if the pump-and-treat system is shown to have no beneficial effect on discharges to the river.
- Continue operation of the pump-and-treat system after the initial 5-year period if the pump-and-treat system is shown to have had positive impact on the Sr-90 discharges to the river.
- Remediate the floating petroleum hydrocarbons that have been observed in some 100-N Area wells using a discriminating intake system installed directly into the wells. Purge the recovered product into an onsite tank for separation from water. Recycle quantities of cost-effective free product, and transport nonreclaimable waste to an approved facility for disposal.
- Evaluate Sr-90 remediation technologies excluding the pump-and-treat system, which is believed to be ineffective as a sole remediation technology in the long term. (Pump-and-treat operations as a component of a larger alternative would not be excluded from the evaluation.)
- Continue to monitor the network of existing wells for all contaminants of concern during the interim period. The objectives of the well monitoring program should be to assess the performance of the chosen interim action and other technologies, help define the extent and nature of the groundwater plume, and help define the nature and extent of plumes that may be associated with other COCs.

This recommendation would be protective of human health (performance standard 1.a) by preventing exposure to contaminants through continued use of access controls and use restrictions. The recommended interim measures would be partially protective of the environment (performance standard 1.b) by controlling the flux of Sr-90 to the river. However, since interim actions are not intended to meet final action ARARs, drinking water and ambient water quality standards would not be ARARs for this interim measure. Performance standards that are in place at the time the final remedy is selected will be addressed. Also, since the pump and treat system is already in operation, this recommended interim measure would have no additional impacts to ecological or cultural resources (performance standards 1.c and 1.d).

Additionally, the existing pump-and-treat system is operating within the performance standards established by the action memorandum and a DOE letter clarifying the N Springs expedited response action cleanup plan and modification of performance monitoring for N Springs Pump and Treat, (Olson, 1997). The requirement is the pump-and-treat system will operate on a 50-day treatment cycle while maintaining the SR-90 removal rate of 90%. This requirement also provides a degree of protection to the environment by reducing the SR-90 concentration to the river.

Performance standard 2 is being met with these recommended interim corrective measures because the contaminated groundwater in 100-NR-2 is being addressed in the interim with the intent of gathering information needed for final remedy selection.

Performance standard 3 pertaining to offsite releases will be addressed during final remediation of the Hanford Site as discussed in Section 9.1.

Performance standard 4 pertaining to training is discussed in Section 9.3.5.

9.3.2 Cleanup Standards for the 100-NR-2 Operable Unit

As stated above, interim measures are not intended to meet ARARs for final cleanup, although it is desirable that the interim measure move toward ARARs that would be applicable to the final remedy. The groundwater and river protection standard for Sr-90 is 8 pCi/L based on the drinking water standard. Other standards that will need to be addressed by the final remedy and the COCs are listed in DOE/RL-95-111, Rev. 0, Table 4-9.

9.3.3 Cost

The annual operating costs for the pump-and-treat system are estimated at $329,100. Since the pump-and-treat system is already established, no additional capital costs would be required. The present worth of the system is $1.45 million. Detailed cost analyses for all the alternatives are contained in Permit Attachment 47, Chapter 7.0.

9.3.4 Schedule

Operation of the existing pump-and-treat system will continue.

9.3.5 Training

Required training for the 100-NR-2 OU is described in Section 9.2.50.

Appendix A
Applicable or Relevant and Appropriate Requirements

Contents

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A1.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

A1.1 INTRODUCTION

Applicable or relevant and appropriate requirements (ARAR) are standards, requirements, criteria, or limitations promulgated under federal or state environmental laws that must be met or waived for remedial actions as required by Section 121 of the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). Only the substantive provisions of ARARs must be met (or waived) for actions conducted entirely on site (CERCLA 121(d)(2)) because such onsite actions are exempted from obtaining federal, state, and local permits (CERCLA 121(e)(1)). A component of an action's protectiveness is its ability to comply with ARARs. The "to be considered" (TBC) materials are other federal or state guidance, criteria, advisories, proposed regulations, or similar materials that, while not enforceable, provide additional standards that may be pertinent in selecting or designing a remedy.

Below is a listing of the major ARARs and TBCs pertinent to remediation of the 100-NR-1 and 100-NR-2 Operable Units. These ARARs and TBCs are further described and cited in

Tables A-1 through A-3 and are discussed relative to each remedial alternative in Sections A.1.1 through A.1.7.

- The *Model Toxics Control Act* (MTCA) Regulations
- The *Safe Drinking Water Act* (SDWA) Primary and Secondary Drinking Water Standards
- Draft EPA Radiation Site Cleanup Regulations
- The *Resource Conservation and Recovery Act* Hazardous Waste Regulations
- State of Washington Dangerous Waste Regulations
- The U.S. Environmental Protection Agency Transportation Regulations
- Nuclear Regulatory Commission Licensing Requirements for Land Disposal of Radioactive Wastes
- State of Washington Waste Discharge Permit Program
- State of Washington Underground Injection Control Program
- National Emissions Standards for Hazardous Air Pollutants
- State of Washington Radiation Protection Air Emissions
- State of Washington Control of New Sources of Toxic Air Pollutants
- The *National Historic Preservation Act*
- The *Native American Graves Protection and Repatriation Act*
- The *Archeological and Historical Preservation Act*
- The *Endangered Species Act*
- The *Migratory Bird Treaty Act*
- The *Hanford Reach Preservation Act*
- U.S. Department of Energy Occupational Radiation Protection Regulations
- Nuclear Regulatory Commission Standards for Protection Against Radiation
- U.S. Department of Energy Order - Radiation Dose Limit

A1.1.1 Standards for Soil, Groundwater, and River Cleanup

The state MTCA is implemented by Chapter 173-340 of the *Washington Administrative Code* (WAC) and establishes cleanup standards (including cleanup levels and points of compliance) for nonradioactive contaminants in soil and groundwater. In setting standards, MTCA prescribes a methodology for calculating cleanup levels based on potential land use and exposure assumptions and also draws on other standards, such as maximum contaminant levels (MCLs) established for drinking water under the SDWA. In addition, MTCA specifies that soil and groundwater cleanup must be accomplished so that other interconnected media, such as adjacent surface waters, are protected. The MTCA standards are relevant and appropriate and are incorporated into the remediation goals for all remedial alternatives evaluated in this CMS.

Few standards exist for the cleanup of radioactive constituents at waste sites. Standards for MCLs for certain radionuclides, based on an annual dose limit, are provided in 40 CFR 141 and are relevant and appropriate and are incorporated into the remediation goals for alternatives that address groundwater. Standards for remediation of radioactive constituents in soil have not been promulgated. Two agencies (the U.S. Environmental Protection Agency [EPA] and the U.S. Nuclear Regulatory Commission [NRC]) have proposed regulations for acceptable levels of residual radioactivity for cleanup of soil. These are TBC materials rather than ARARs, but in the absence of ARARs they are incorporated into the remediation goals for soil cleanup.

The following information provides an analysis of how each source-site and groundwater alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.1.1 100-NR-1: Source Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. The No-Action Alternative would not result in compliance with soil and groundwater protection ARARs or TBCs.

Institutional Controls Alternative. Because there is a general lack of data on soils within the 100-NR-1 source operable unit, it is unknown whether institutional controls would be adequate to meet standards for soil and groundwater cleanup. Should contaminant of concern concentrations be present at a site that would contribute to an increase in groundwater contamination (i.e., cause new or expanded areas of contamination above and beyond existing contaminant plumes) or a decrease in river protection, the ARARs and TBCs for this alternative would not be met. The type of institutional controls that may be necessary to preclude direct exposure to contaminants is also dependent upon the need for more information on constituent concentrations in the soil. It is assumed, however, that controls such as access controls (e.g., signs) and restrictions on groundwater usage would be adequate to meet soil and groundwater standards based on direct exposure in the short term. However, because this alternative will require that controls are in place for over 200 years due to Sr-90 decay, it becomes less certain that institutional controls would be able to provide compliance with soil and groundwater direct exposure standards. Institutional controls would preclude rural-residential use at sites where direct soil exposure levels are above residential standards. At the shoreline site, contaminants would be left in place above groundwater and river protection standards with this alternative until contaminated groundwater is remediated. Compliance would be attained at the end of the groundwater/river protection remediation, which may require 270 to 300 years.

Remove/Dispose Alternative. Removal, treatment where appropriate and subsequent disposal of contaminated soils will provide compliance with all soil and groundwater cleanup standards. However, due to the lack of data on constituent concentrations in the soil, the degree of removal that would be required at a site in order to reach compliance with soil and groundwater cleanup standards cannot be ascertained. A potential exists that it would become technically impracticable or cost prohibitive to excavate deep vadose zone soils if large, deep areas of contamination are discovered. Removal, treatment where appropriate, and subsequent disposal of contaminated shoreline site soils will provide compliance with all soil and groundwater cleanup standards if contaminated groundwater is prevented from recontaminating the soil through implementation of a hydraulic or physical barrier system.

In Situ Bioremediation of Petroleum Waste Group. In situ bioremediation is a proven technology that has achieved good results at other remedial action sites. It is anticipated to achieve compliance with soil and groundwater cleanup standards for total petroleum hydrocarbons (TPH). However, given the lack of data identifying the extent of contamination, there is a possibility that remediation using this alternative would not be practical.

Containment for Radioactive Waste Group. Although this alternative likely will not comply with the direct soil exposure numerical cleanup standards and possibly the groundwater protection numerical cleanup standards of MTCA. MTCA considers this a compliant alternative provided that the compliance monitoring program is designed to ensure the long-term integrity of the containment system (WAC 173-340-740[4][6][d]). Without any removal of contaminants from soils, there is a potential that after failure of the cap, contaminants could still be in place in the soils that could exceed the soil cleanup standards and could cause exceedence of groundwater cleanup standards. Therefore, maintenance of the cover is critical to maintaining compliance with these ARARs and TBCs. For the shoreline site, a cover alternative would also be expected to comply with soil and groundwater cleanup standards during the design life of the cover. This alternative would be in conflict with unrestricted land use.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. In situ solidification will provide compliance with soil and groundwater cleanup levels for constituents expected to be remaining in the soils for the radioactive waste group. It is possible that constituents might be present in the soil that cannot be immobilized through the chosen solidification technology, such as mobile inorganic constituents, but this possibility is considered unlikely.

A1.1.1.2 100-NR-2: Groundwater Alternative Compliance with ARARs/TBCs

There is a general lack of data on the impacts of aquatic organisms from Sr-90 concentrations entering the river. Groundwater and river protection standards for Sr-90 are based on the MCL in this CMS. However, because ecological impacts are unknown and because concentrations of Sr-90 are anticipated to exceed MCL river-protection standards for 270 years for any of the alternatives, further study is warranted. (Note: Modeling efforts show that manganese will require over 3,000 years to meet cleanup standards based on its secondary MCL. Because of the uncertainties in modeling plume dispersion over this time frame and because the standard is based on a secondary MCL, Sr-90 remediation time frames are considered the primary focus.) One potential avenue for obtaining some information on impacts to aquatic organisms is the pending *Columbia River Comprehensive Impact Assessment* study (Tri-Party Agreement Milestone M-15-80, scheduled for submittal of a revised draft in March 1998). This study is planned to further define ecological impacts, including aquatic ecosystems potentially impacted by Sr-90 along the 100-NR-2 groundwater/river interface. When this information is obtained, it will become available to the public for consideration. In addition, reassessment of ecological impacts associated with remediation of 100-NR-2 will be made during the CERCLA five-year review (40 CFR 300.430(f)(4)(ii)).

No-Action Alternative. The No-Action Alternative would not result in compliance with soil and groundwater protection ARARs and TBCs.

Institutional Controls Alternative. Compliance with groundwater and river protection standards will be attained for all contaminants of concern (COC) at the end of remediation, which is estimated to require 300 years under this alternative. One exception will be manganese, which may exceed secondary MCLs for over 3,000 years.

Because of the length of time necessary to ensure that institutional controls are maintained, compliance with ARARs and TBCs becomes less certain. Access controls and groundwater use restrictions would restrict exposure to contaminants in groundwater until contaminant plumes decay and/or naturally attenuate to concentrations below groundwater protection standards. River protection standards would continue to be exceeded for Sr-90 for 270 years and would be exceeded for tritium for 10 to 15 years. Groundwater protection standards would be exceeded for Sr-90 and tritium for 300 years and 25 years, respectively. Except for manganese, inorganic contaminants will not meet MCLs in groundwater from a few to about 30 years, depending upon the specific contaminant. Nitrates will exceed MCLs at the groundwater/river interface in the future and manganese may exceed MCLs at a future date under this alternative.

Permeable Barrier for River Protection. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to require 300 years under this alternative. One exception will be manganese, which may exceed secondary MCLs for over 3,000 years.

The permeable wall would not allow compliance with groundwater protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90. River protection standards are not met at a faster rate due to the continued flushing of Sr-90 into the groundwater/river interface from the contaminated soils that remain in the strip of land between the groundwater/river interface and the permeable wall. This alternative will reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river, but may have no effect on the time it will take to achieve compliance with groundwater and river protection standards due to the continued release of Sr-90 from this strip of land. River protection standards would continue to be exceeded for Sr-90 for 270 years and would be exceeded for tritium for 10 to 15 years. Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years). "Other" inorganic contaminants will have restoration time frames for compliance with groundwater protection standards as identified in Section 5.0. Most significantly, manganese may exceed groundwater protection standards for over 3,000 years under this alternative.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative (except manganese which may exceed secondary MCLs for over 3,000 years).

Hydraulic controls would not allow compliance with groundwater protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90. The time necessary to achieve compliance with groundwater protection standards for Sr-90 would not be significantly shortened (from 300 years without treatment to 270 years with treatment). River protection standards would not be met in a significantly shorter time frame due to the continued flushing of Sr-90 into the groundwater/river interface from the Sr-90 that remains in the aquifer sediments adjacent to the river. This alternative will reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river, but may have no effect on the time it will take to achieve compliance with river protection standards due to the continued release of Sr-90 from the sediments. Tritium would not be actively remediated along the entire plume (although the hydraulic controls for Sr-90 would remediate much of the tritium plume), and, therefore, groundwater and river protection standards would not be met until decay and natural attenuation brought concentrations below the MCL (25 and 10 to 15 years, respectively). Other groundwater plumes would not be actively remediated with this alternative and, therefore, would not achieve compliance with groundwater or river protection standards until decay and/or natural attenuation resolved concentrations below the standards. "Other" inorganic contaminants will have restoration time frames for compliance with groundwater protection standards as identified in Section 5.0. Most significantly, manganese may exceed groundwater protection standards for over 3,000 years under this alternative.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

Hydraulic controls and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative would reduce the time frame for Sr-90 remediation from 300 to 270 years. Groundwater protection standards would be met for all COCs, other than tritium and Sr-90, in a much shorter time frame than could be achieved through decay and/or natural attenuation. Strontium-90 groundwater protection standards would not be met in a significantly shorter time frame (300 years without treatment and 270 years with treatment). Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years) but would meet MCLs in the groundwater/river interface shortly after hydraulic controls are fully operational. This alternative is anticipated to be able to reduce concentrations of Sr-90 entering the groundwater/river interface, thus allowing for greater overall protection of the river (although the amount may not be significant), but would have no effect on the time it will take to achieve compliance with river protection standards due to the continued release of Sr-90 from the aquifer sediments near the river. Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

The barrier and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90 in aquifer sediments immediately adjacent to the river. Strontium-90 would continue to cause exceedences of river protection standards due to continued flushing of sediments on the river side of the barrier. Groundwater protection standards would be met with this alternative for all COCs, other than Sr-90 and tritium, in a much shorter time frame than could be attained through decay and/or natural attenuation. Strontium-90 groundwater protection standards would not be met in a significantly shorter time frame (300 years without treatment and 270 years with treatment), and tritium would continue to exceed groundwater protection standards until decay and natural attenuation decreased concentrations below MCLs (25 years). Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Compliance with groundwater and river protection standards will be attained for all COCs at the end of remediation, which is estimated to take 270 years under this alternative.

The barrier and pump-and-treat systems would not allow compliance with river protection standards at a significantly faster rate because this alternative does not actively treat the Sr-90 in aquifer sediments immediately adjacent to the river. Groundwater protection standards would be met with this alternative for all COCs, other than Sr-90 and tritium, in a much shorter time frame than could be attained through decay and/or natural attenuation. It is unknown how rapidly soil flushing could remediate groundwater for Sr-90. Tritium would continue to exceed groundwater protection standards until decay decreased concentrations below MCLs (25 years) but would meet MCLs in the groundwater/river interface shortly after hydraulic controls are fully operational. Manganese will not meet MCLs in groundwater for close to 90 years using pump-and-treat technologies. Other inorganic contaminants will have shortened restoration time frames for compliance with groundwater protection standards as identified in Section 5.0.

A1.1.2 Waste Management Standards

The *Resource Conservation and Recovery Act of 1976* (RCRA) regulates the generation, transportation, storage, treatment, and disposal of solid and hazardous waste. Authority to implement much of RCRA has been delegated to the state and is implemented by WAC 173-303 (for dangerous waste) and WAC 173-304 (for solid waste that is not dangerous waste). Authority for land disposal restrictions (LDR), including standards for the treatment of wastes prior to land disposal, are retained at the federal level and implemented via 40 CFR 268. The *Atomic Energy Act* (AEA) establishes standards for the management of radioactive wastes. Regulations pertaining to the management and land disposal of low-level radioactive waste are contained in 10 CFR 61.

Alternatives that involve the removal of waste or contaminated media or in situ or ex situ treatment may generate solid, dangerous, or radioactive waste. The RCRA requirements are applicable to those alternatives that may generate, transport, treat, store, or dispose of solid or dangerous waste. Offsite shipment of hazardous materials must comply with EPA's 49 CFR transportation and packaging requirements. DOE Order 1540.1A is considered a TBC for onsite waste transport. It requires substantive compliance with 49 CFR unless other methods allow an equivalent degree of safety. The substantive requirements of 10 CFR 61 are relevant and appropriate to those alternatives that generate, treat, or dispose of radioactive waste. All waste generated under any alternative would be evaluated and managed in compliance with the appropriate waste designation. Waste disposal would be to the Environmental Restoration Disposal Facility (ERDF), which is designed to meet the requirements of both RCRA and the radioactive waste standards. For alternatives that involve leaving solid or dangerous waste in place, RCRA performance standards for landfill covers are applicable or relevant and appropriate (depending on the date when the waste was first placed at the site) and are incorporated into the design. Cover performance and boundary requirements, locators, and post-operational monitoring contained in 10 CFR 61.52 are relevant and appropriate to the in-place disposal of radioactive waste.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.2.1 100-NR-1: Source Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative does not result in waste generation, information specific to compliance with ARARs and TBCs has not been provided.

Institutional Controls Alternatives. Institutional controls are not anticipated to generate waste.

Remove/Dispose Alternative. Potentially large quantities of soil and debris (piping, structures, and cleanup materials) may be generated under the alternatives requiring disposal. These wastes may or may not require treatment in order to be disposed to the ERDF. Shoreline site wastes may require dewatering. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. It is anticipated, however, that compliance with waste management standards will be achievable. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Because of the potential for much greater quantities of waste generated from this alternative, ARAR and TBC compliance will be more difficult than the other alternatives.

In Situ Bioremediation of Petroleum Waste Groups. Small quantities of waste may be generated from in situ bioremediation such as contaminated soils and cleanup debris during preparation of the soil surface for treatment. These wastes may or may not require treatment in order to be disposed to the ERDF. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. It is anticipated, however, that compliance with waste-management standards will be achievable. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303.

Containment for Radioactive Waste Group and Shoreline Site. Small quantities of waste may be generated from placement of a cap such as contaminated soils and cleanup debris during site preparation and construction. Operational wastes may include run-on and run-off waters. Wastes may also be generated during maintenance of the cap. These wastes may or may not require treatment in order to be disposed to the ERDF; however, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. It is anticipated, however, that treatment and subsequent compliance with waste-management standards will be achievable.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Small quantities of waste may be generated from in situ solidification such as contaminated soils and cleanup debris during preparation of the soil surface for treatment. These wastes may or may not require treatment in order to be disposed to the ERDF. However, due to the lack of data on soils, the type and extent of waste treatment cannot be defined. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. It is anticipated, however, that compliance with waste-management standards will be achievable.

A1.1.2.2 100-NR-2: Groundwater Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative does not result in waste generation, information specific to compliance with ARARs and TBCs has not been provided.

Institutional Controls Alternative. Institutional controls are not anticipated to generate waste.

Permeable Barrier for River Protection. Construction of a permeable wall is anticipated to generate waste in the form of contaminated soils and construction debris. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, groundwater, cleanup debris, treatment residuals, and resins. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, groundwater, cleanup debris, and resins. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Construction of a cryogenic barrier is anticipated to generate waste in the form of contaminated soils and construction debris. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, cleanup debris, treatment residuals, and adsorbents. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303. Compliance with waste management ARARs and TBCs are anticipated to be easily attained.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Construction of a sheet pile barrier is anticipated to generate waste in the form of contaminated soils and construction debris. Construction and operation of wells and a pump-and-treat system will generate small quantities of waste in the form of contaminated soils, cleanup debris, treatment residuals, and adsorbents from treatment systems. These waste streams may or may not require treatment in order to meet waste acceptance criteria for the ERDF and/or LDR requirements. Compliance with waste management ARARs and TBCs are anticipated to be easily attained with the exception of the soil-flushing adsorbents. This waste stream is anticipated to contain extremely high concentrations of Sr-90, and treatment of this waste stream will be required in order to comply with the ERDF waste acceptance criteria. Management of this waste stream will require careful planning in order to comply with handling treatment, packaging, and transportation requirements. Treatment system design may be dictated by the type of wastes generated, e.g., dangerous waste treatment systems would require substantive compliance with unit-specific design requirements contained in WAC 173-303.

A1.1.3 Wastewater Management Standards

WAC 173-216 establishes requirements for discharges to waters of the state, other than discharges subject to an NPDES permit under the *Clean Water Act*, including effluent discharges to the soil column. WAC 173-218 establishes requirements for injection to the underground aquifer.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.3.1 100-NR-1: Source-Site Alternative Compliance with ARARs/TBCs

All source-site alternatives, other than the No-Action and Institutional Controls Alternatives, could result in the generation of some quantity of decontamination or dewatering wastewaters. Depending upon volumes of soils, debris, and types and concentrations of contaminants, a number of treatment/disposal options may be used that may result in wastewater discharges to the ground or to groundwater. Treatment and disposal options that may invoke these standards include discharge of wastewaters to the ground after verification that contaminant concentrations are below the substantive requirements contained in WAC 173-216, transport of wastewaters to a pump-and-treat system in substantive compliance with WAC 173-218 and designed to treat COCs in wastewaters, and transport of wastewaters to a site water-treatment system in compliance, or substantive compliance depending upon operating authority, with WAC 173-216 or 40 CFR 122. Regardless of which alternative is used, compliance with these ARARs and TBCs can be accomplished.

Remove/Dispose Alternative. Some soil treatments will produce a wastewater stream that could require treatment at the end of the treatment phase. Treatment and disposal options would include trucking the washwaters to a water-treatment facility within the Hanford Site or testing the waters and, if they comply with ARARs associated with WAC 173-216, discharging them to the ground. Regardless of which treatment and disposal option is chosen, the ARARs associated with wastewater management would be able to be complied with.

A1.1.3.2 100-NR-2: Groundwater Alternative Compliance with ARARs/TBCs

All alternatives other than the No-Action and Institutional Controls Alternatives will require construction and development of wells. This activity has the potential to require disposal of purge water from well installation and development activities. Purge-water management will be accomplished in accordance with the Hanford Site Purge Water Agreement. Injection of treated groundwater is considered in the groundwater removal and treatment alternatives. Reinjection would be subject to the provisions of WAC173-218. If this cannot be accomplished, a waiver would be required.

A1.1.4 Standards for Protection of the Columbia River from Direct Discharges

40 CFR 122 addresses technology-based limitations and standards, control of toxic pollutants, and monitoring for direct discharges to waters of the United States, including stormwater.

No direct wastewater discharges to the Columbia River are planned under any of the alternatives. Use of National Pollutant Discharge Elimination System-permitted water-treatment units for treatment of wastewaters from source-unit cleanup may be utilized as identified above. Erosion and stormwater controls would be used as necessary while working near the river. A stormwater management plan would be prepared to prevent discharges of contaminated stormwater to the Columbia River.

Two alternatives with remediation of the shoreline site, the Remove/Dispose and the Containment Alternatives, could trigger ARARs associated with river construction activities. These ARARs include the U.S. Army Corp of Engineers permitting requirements contained in 33 CFR 320-330, which contain provisions for dredging and filling material to the Columbia River. Because the Columbia River may be included in the Wild and Scenic River System, the substantive requirements associated with a Section 10 permit under 33 CFR 322 may be an ARAR for these alternatives. State ARARs associated with river construction include the Shoreline Development Permits contained in WAC 173-14, and Hydraulic Projects Permits contained in WAC 220-110.

A1.1.5 Air Standards

The Clean Air Act (CAA) establishes standards for the control of air emissions. Authority has partially been delegated to the state. Under 40 CFR 61, Subpart H, and WAC 246-247 , radionuclide airborne emissions from all combined operations at the Hanford Site may not exceed 10-mrem/yr effective dose equivalent to the hypothetical offsite maximally exposed individual (MEI). For an emission unit with a potential to emit less than 0.1 mrem/yr total effective dose equivalent to the MEI, WAC 246-247 allows for an estimate of those emissions in lieu of monitoring and requires verification of compliance through periodic confirmatory measurements. An emission unit is defined as a point source, nonpoint source, or source of fugitive emissions. WAC 246-247 requires verification of compliance through monitoring. WAC 173-400 establishes requirements for the control and/or prevention of the emission of air contaminants, including particulates. WAC 173-460 establishes acceptable source impact levels for more than 500 carcinogenic acutely toxic air pollutants. In addition, WAC 173-480-050 requires that emissions are kept as low as reasonably achievable (ALARA).

The radionuclide emission limits would apply to all fugitive, diffuse, and point source air emissions of radionuclides generated by any of the removal or treatment (in situ or ex situ) alternatives. If there is the potential for any non-zero radioactive emissions, best available radionuclide control technology (BARCT) would be required. If the alternative would generate an increase of toxic air pollutants to the atmosphere above the small-quantity emission rates, implementation of BARCT for toxics would be required.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.5.1 Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative would have contaminants in place, compliance with ARARs and TBCs would not be achieved.

Institutional Controls Alternative. Institutional controls are not anticipated to generate airborne emissions of radionuclides.

Remove/Dispose Alternative. Remove, treatment, and disposed activities have the potential to increase emissions of radionuclides. If radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247. No toxic emissions are expected.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. Remove, aboveground bioremediation, and dispose activities have the potential to increase emissions of radionuclides if radionuclides are present in the soil. However, ex situ bioremediation would not be used if radionuclides are present along with petroleum hydrocarbons. Bioremediation is not expected to increase any emissions of TPH; therefore, no additional controls are required.

In Situ Bioremediation of Petroleum Waste Group. Preparation for in situ bioremediation may require limited surface disturbance of a surface radiation area. If radionuclides are present in the surface soil at the site and there is the potential for any non-zero emissions, BARCT would be required, as specified in WAC 246-247. Once preparation is completed, no additional emissions are expected from the activity. If radionuclides are present in deep soil, then in situ bioremediation would not be selected as an alternative. In addition, bioremediation is not expected to increase any emissions of TPH; therefore, no additional controls are required.

Containment for Radioactive Waste Group and Shoreline Site. Containment is a standard practice on the Hanford Site for surface contaminants. The Radiation Area Remedial Action program uses clean fill to cover and stabilize surface contamination. The placement of a cover to contain radiation units is not anticipated to generate airborne emissions of radionuclides. The BARCT will be required, as specified in WAC 246-247, to prevent the release of particulates during placement of the cover.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Preparation for in situ solidification may require limited surface disturbance of the surface radiation area. If radionuclides are present in the surface soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247. Once preparation is competed, no additional emissions are expected from the activity.

A1.1.5.2 100-NR-2: Groundwater Alternative Compliance with ARARs

No-Action Alternative. Because the No-Action Alternative would not actively cause airborne emissions, compliance with ARARs and TBCs will be achieved.

Institutional Controls Alternative. Institutional controls are not anticipated to generate airborne emissions of radionuclides.

Permeable Barrier for River Protection. Installation of the permeable wall has the potential to encounter radionuclide contaminated soil. If radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the

Aquifer. Installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Cryogenic Barrier for River Protection and Pump and Treat Aquifer Remediation. Installation of the cryogenic barrier has the potential to generate emissions of radionuclides while the installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Installation of the sheet pile barrier has the potential to generate emissions of radionuclides while the installation of the pump-and-treat system should not generate radionuclide emissions. However, if radionuclides are present in the soil at the site and there is the potential for any non-zero emissions, BARCT would be required as specified in WAC 246-247.

A1.1.6 Standards for the Protection of Cultural and Ecological Resources

The *National Historic Preservation Act of 1966* (16 USC 470 et seq, implemented in regulation by 36 CFR 800) requires federal agencies to take into account the effect of an activity on any significant cultural resource, including properties listed, or eligible for inclusion, on the National Register of Historic Places. The *Native American Graves Protection and Repatriation Act* establishes statutory provisions for the treatment of inadvertent discoveries of Native American remains and cultural objects. The *Archeological and Historical Preservation Act of 1974* (16 USC 469a) requires action to recover and preserve archaeologic or historic data in areas where activity may cause irreparable harm, loss, or destruction of significant data.

The *Endangered Species Act of 1973* (16 USC 1531) is implemented by 50 CFR 402 and WAC 232-12-297 WAC and prohibits activities that threaten the continued existence of listed species or destroys critical habitat. The *Migratory Bird Treaty Act* makes it illegal to take, capture, or kill, as applicable, any migratory bird or any part, nest, or egg of any such birds.

All National Register evaluations have been performed to determine whether the buildings in the 100-N Area are eligible for inclusion on the National Register of Historic Places, and this determination may affect alternatives for nearby waste sites. The cultural resource protection requirements are applicable for those properties in the 100-N Area that have been determined to be historically significant. In addition, the 100 Area in general is rich in cultural resources related to Native Americans, and several of the alternatives involve ground-disturbing activities. If any discoveries related to Native American remains or cultural objects are made during such activities, activity in the area will cease, and appropriate notifications and negotiations regarding further actions will be made.

Threatened and endangered species are known to be present in the 100 Area, and the area is within an established migration route; however, no adverse impacts on protected species or sensitive habitat from any of the alternatives are anticipated. Area-specific ecological reviews will be conducted prior to implementing any alternative to identify potential adverse impacts. Mitigation plans will be prepared, as necessary, and implemented.

The *Hanford Reach Preservation Act* (PL 100-605) provides for a comprehensive river conservation study and prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years from enactment. Projects are required to be performed under the consultation and coordination of the National Park Service on any proposed remediation alternative.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.6.1 100-NR-1: Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative leaves waste in place, ARARs and TBCs relative to these standards may not be complied with, due to threat of contamination to the resources, or relative to the use of resources.

Institutional Controls Alternative. Minimal or no surface disturbances are anticipated to occur utilizing this alternative; therefore, ARARs/TBCs associated with preservation of cultural and ecological resources would be easily followed in the short term. This alternative will also afford continued protection of cultural and historical resources from public use. However, this alternative irreversibly or irretrievably commits natural resources during the remediation time frame, which can be for a very long time particularly, for the shoreline site. This alternative also has the potential for contaminating resources adjacent to the sites from contaminants remaining in place. Therefore, long-term compliance with these ARARs and TBCs cannot be ensured.

Remove/Dispose Alternative. This alternative will comply with all cultural and ecological resource ARARs and TBCs. However, this alternative has a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of areas at and adjacent to the waste sites (e.g., shoring side walls for worker safety) particularly at the shoreline site. Much more care will be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas will be required to ensure restoration of the natural resources. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas will occur once the contaminants are removed and appropriately disposed.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. This alternative will comply with all cultural and ecological resource ARARs and TBCs. However, this alternative has a high potential to impact cultural, historical, or traditional-use areas due to the need for extensive excavation of areas at and adjacent to the waste sites (e.g., shoring side walls for worker safety). Much more care will be required with this alternative for completion of preconstruction surveys and development of mitigative measures should cultural or natural resources be encountered. Recontouring and revegetation of the disturbed areas will be required to ensure restoration of the natural resources. A benefit of this option is that no future threat of recontamination of the site or contamination of adjacent areas will occur once the contaminants are removed and appropriately disposed. The treatment action, aboveground bioremediation, should not require additional actions in order to comply with these standards.

In Situ Bioremediation for Petroleum Waste Group. This alternative will comply with all cultural and ecological resource ARARs and TBCs. This alternative is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed as a result of operations. Compliance with these standards can readily be achieved through proper preconstruction surveys and mitigative measures should resources be encountered.

Containment for Radioactive Waste Group and Shoreline Site. This alternative will comply with all cultural and ecological resource ARARs and TBCs. Placement of a cap is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed as a result of operations. This alternative will protect adjacent cultural resources from becoming contaminated by retaining contaminants in place. Compliance with these standards can readily be achieved during construction of the cap through proper preconstruction surveys and mitigative measures should resources be encountered. Implementation of this alternative will most likely enhance ecological resources by eliminating the exposure of contaminants and by providing an opportunity to revegetate the surface of the cap with plant species that provide for a viable and sustainable ecological environment.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. This alternative will comply with all cultural and ecological resource ARARs and TBCs. This alternative is anticipated to cause minimal or no impacts to cultural resources since the area of concern has already been previously disturbed as a result of operations. Because this alternative will immobilize contaminants, protection of adjacent cultural resources will be ensured by contaminants remaining in place. Recontouring and revegetation efforts that could impact cultural resources would require mitigative measures. Compliance with these standards can readily be achieved through proper preconstruction surveys and mitigative measures should resources be encountered.

A1.1.6.2 100-NR-2: Groundwater Alternative Compliance with ARARs/TBCs

All 100-NR-2 groundwater alternatives require very long restoration time frames for river protection (270 to 300 years for Sr-90 cleanup). Note: Based on modeling of current well data, manganese would require over 3,000 years to meet secondary MCL standards. Because of the uncertainties with modeling to this length of time and because the manganese MCL is based on a secondary drinking water standard, the Sr-90 remediation time frame is considered the primary focus). Due to the length of remediation, waivers from ecological resource ARARs may be required. Impacts to aquatic organisms from Sr-90 and tritium contamination have not been fully defined. In order to determine whether these constituents are damaging aquatic resources to the extent that they are irretrievable and irreversible, more data will need to be gathered and assessed. One potential avenue for obtaining this information is the pending Columbia River Comprehensive Impact Assessment study (Tri-Party Agreement Milestone M-15-80, scheduled for submittal of a revised draft in March of 1998). This study is planned to further define ecological impacts, including aquatic ecosystems potentially impacted by Sr-90 along the 100-NR-2 river interface. When this information is obtained, it will become available to the public for consideration. Also, all 100-NR-2 groundwater alternatives other than the No-Action Alternative, may temporarily (for up to 300 years) restrict use of the shoreline, particularly at N-Springs.

No-Action Alternative. Because no surface disturbances would occur with this alternative, therefore ARARs and TBCs would be complied with.

Institutional Controls Alternative. Minimal or no surface disturbances are anticipated to occur using this alternative; therefore, ARARs and TBCs associated with preservation of cultural and ecological resources would be easily complied with.

Permeable Barrier for River Protection. This alternative will cause major surface disturbances in an area near the river shoreline and unrestricted land use would conflict with this option, but it is anticipated that ARARs and TBCs will be complied with during implementation and after completion of this alternative. Because this area is particularly sensitive from both an ecological and cultural perspective, particular attention to ecological reviews will be necessary, as well as development of mitigative measures during construction activities, to ensure compliance with these ARARs and TBCs.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facility. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. This alternative will cause major surface disturbances in an area near the river shoreline due to construction of a cryogenic barrier, but it is anticipated that ARARs and TBCs will be able to be complied with during implementation and after completion of this alternative. Because this area is particularly sensitive from both an ecological and cultural perspective, particular attention to ecological reviews will be necessary, as well as development of mitigative measures during construction activities to ensure compliance with these ARARs and TBCs. Minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities can be expected. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. This alternative will cause minimal surface disturbance through construction and operation of well systems and the pump-and-treat facilities. These activities are anticipated to cause minimal disturbance to cultural and ecological resources, and compliance with ARARs and TBCs is anticipated to be easily met through standard Hanford practices for cultural and ecological surveys and mitigative measures.

A1.1.7 Radiation Protection Standards

The *Atomic Energy Act* establishes radiation protection standards, limits, and program requirements for protecting individuals from ionizing radiation resulting from the conduct of DOE activities. Title 10 CFR 835 establishes limits for doses to occupational workers and visitors and also requires that measures are taken to maintain radiation exposure as low as reasonably achievable. Regulations regarding radiation protection of the public and the environment have been promulgated by the NRC in 10 CFR 20 and 10 CFR 61.

A combination of personal protective equipment, personnel training, physical design features (e.g., confinement and remote handling), and nonengineered controls (e.g., limiting time in radiation zones), for example, would be used to ensure that the requirements of 10 CFR 835 and DOE Order 5400.5 are met for all alternatives.

The following information provides an analysis of how each source-site alternative category is anticipated to comply with these ARARs and TBCs.

A1.1.7.1 100-NR-1: Source-Site Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because the No-Action Alternative would leave contamination in place, ARARs and TBCs associated with radiation protection standards may not be complied with.

Institutional Controls Alternative. Compliance with radiation worker exposure standards would be easily met with this alternative because it is anticipated that very little field-maintenance activities would be required with this alternative. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through access prevention to areas that would result in doses that exceed radiation protection standards for the public. However, because this alternative will require that controls be in place for over 200 years due to Sr-90 decay, it becomes less certain that institutional controls would be able to provide compliance with radiation protection standards. A decision for rural residential use at sites within 100-NR-1 is most probably precluded with the sole use of institutional controls where radiation protection standards are exceeded.

Remove/Dispose Alternative. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and excavation of soils in radiologically contaminated areas. Radiation protection standards for the public will be complied with during excavation of radiologically contaminated soils through adequate planning and design of the excavation and disposal activities. Upon removal of soils, these requirements will cease to be applicable at the site.

Remove/Ex Situ Bioremediation/Dispose for Petroleum Waste Group. Radiation protection standards are not anticipated to be applicable to this alternative; however, due to the lack of data on soil sites, there is a potential for these standards to apply should radionuclides be discovered within petroleum-contaminated soils.

In Situ Bioremediation of Petroleum Waste Groups. Radiation protection standards for the public are not anticipated to be applicable to this alternative; however, because of the lack of data on soil sites, there is a potential for these standards to apply should radionuclides be discovered within petroleum-contaminated soils.

Containment for Radioactive Waste Group and Shoreline Site. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and construction of a cap in radiologically contaminated areas. Compliance with radiation protection standards for the public can be achieved throughout construction and during operation and maintenance of the cap. Compliance would be achieved through access prevention to areas that would result in doses that exceed radiation protection standards for the public.

In Situ Solidification for Radioactive Waste Group and Shoreline Site. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation, construction activities, and implementation of the treatment activities in radiologically contaminated areas. In situ solidification by itself may not be able to ensure compliance with radiation protection standards for the public. Institutional controls would be required to prevent intrusion into the solidified mass and to prevent access should radiation protection standards be exceeded after solidification. In this manner, compliance with these standards can be achieved.

A1.1.7.2 100-NR-2: Groundwater Alternative Compliance with ARARs/TBCs

No-Action Alternative. Because groundwater would remain accessible and contaminated, compliance with ARARs and TBCs may not be achieved.

Institutional Controls Alternative. Compliance with radiation worker exposure standards would be easily met with this alternative because it is anticipated that very little field maintenance activities would be required with this alternative. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Permeable Barrier for River Protection. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during site preparation and construction of the permeable barrier in radiologically contaminated areas. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Hydraulic Controls for River Protection and Pump and Treat for Sr-90 in the Aquifer. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facility. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Hydraulic Controls for River Protection and Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Cryogenic Barrier for River Protection and Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Sheet Pile Barrier for River Protection and Soil Flushing/Pump and Treat for Aquifer Remediation. Compliance with radiation worker exposure standards can be attained with this alternative through compliance with the substantive requirements of 10 CFR 835 during construction and operation of wells and the pump-and-treat facilities. Compliance with radiation protection standards for the public can be achieved with this alternative through continued control of the site under the DOE or an equivalent agency. Compliance would be achieved through restrictions on groundwater use. At the end of remediation, radionuclide activity in the groundwater would have decayed to levels that would allow for unrestricted use.

Description	Citation	Requirements	Remarks	Operable Unit Affected
Atomic Energy Act of 1954, as amended	42 U.S.C. 2011 et seq.	Authorizes DOE to set standards and restrictions governing facilities used for research, development, and use of atomic energy.		
Department of Energy Occupational Radiation Protection (Final Rule)	10 CFR 835	Establishes occupational and visitor radiological exposure limits.	DOE Radiological Control Manual DOE/EH-02561, which is encompassed within the Hanford Site Radiological Control Manual adheres to these requirements.	100-NR-1 100-NR-2
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR 20, Subpart C and D	Sets occupational dose limits for adult workers. Total effect dose equivalent equal to 5 rem/year. Sets dose limits to members of the public.	Occupational dose limits will be followed during remediation in radiological areas.	100-NR-1 100-NR-2
Nuclear Regulatory Commission Licensing Requirements for Land Disposal of Radioactive Wastes	10 CFR 61	Provides regulations for the management and land disposal of radioactive wastes.	Cover performance standards are contained in this regulation.	100-NR-1
Uranium Mill Tailings Radiation Control Act of 1978	Public Law 95-604, as amended			
Standards for Uranium and Thorium Mill Tailings	40 CFR 192	Establishes standards for control, cleanup, and management of radioactive materials from inactive uranium processing sites.	May be relevant and appropriate if any radium-226 is encountered.	100-NR-1 100-NR-2
Land Cleanup Standards	40 CFR 192.10-192.12	Requires remedial actions to provide reasonable assurance that, as a result of residual radioactive materials from any designated processing site, the concentration of radium-226 in land averaged over any area of 100 m^2 shall not exceed the background level by more than 5 pCi/g, averaged over the first 15 cm of soil below the surface and 15 pCi/g, averaged over 150-cm-thick layers of soil more than 15 cm below the surface. In any habitable building, a reasonable effort shall be made during remediation to achieve an annual average (or equivalent) radon decay product concentration (including background not to exceed 0.02 Working Level (WL). In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL and the level of gamma radiation shall not exceed the background level by more than 20 microroentegens per hour.	May be relevant and appropriate if any above-background radium-226 or radon-222 is encountered during remediation. Radium-226 did not result from uranium processing; therefore, regulation is not applicable.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Implementation	40 CFR 192.20-192.23	Requires that when radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials, remedial action shall reduce other residual radioactivity to levels as low as reasonably achievable (ALARA).	May be relevant and appropriate if any radium-226 is encountered during remediation.	100-NR-1 100-NR-2
Archaeological and Historical Preservation Act of 1974	26 U.S.C. 469	Requires action to recover and preserve artifacts in areas where activity may cause irreparable harm, loss, or destruction of significant artifacts.	Applicable when remedial action threatens significant scientific, prehistorical, historical, or archeological data.	100-NR-1 100-NR-2
Archaeological Resources Protection Act of 1979	16 U.S.C. 4170aa mm (1990)	Protects archaeological and traditional cultural properties associated with archaeological sites. Requires notification of Indian Tribes of possible harm to or destruction of sites having religious or cultural significance.	Applicable when remedial action threatens archaeological and traditional cultural properties.	100-NR-1 100-NR-2
Protection of Archaeological Resources	43 CFR 7	Establishes procedures to be followed by federal land managers to protect archaeological resources on federal lands. Sets civil and criminal penalties for violations; protects confidentiality of archaeological resource information.	Applicable when remedial action threatens archaeological resources.	100-NR-1 100-NR-2
American Indian Religious Freedom Act of 1978	42 U.S.C. 1996	Provides for access by Native Americans to religious sites and development of migration measures if actions will deny such access. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	Applicable when remedial action threatens Native American religious sites.	100-NR-1 100-NR-2
The Religious Freedom Restoration Act of 1993	42 U.S.C. 2000bb; P.L. 103-141	Requires agency to demonstrate compelling need for a project that will deny the free exercise of religion by Native Americans. If activities threaten access to religious site, consultation with tribes will be necessary.	Applicable when remedial action threatens Native American religious sites.	100-NR-1 100-NR-2
Antiquities Act of 1906	16 U.S.C. 431-433	Protects all historic and prehistoric ruins and objects of antiquity located on federal lands. Provides for criminal sanctions against excavation, injury, or destruction of such resources.	Applicable when remedial action threatens historic or prehistoric ruins.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Migratory Bird Treaty Act	16 U.S.C. 703 et seq. 50 CFR 10-24	Makes it illegal to pursue, hunt, take, capture, kill, possess, trade, or transport any migratory bird, part, nest, or egg included in the terms of the conventions between the U.S. and Great Britain, the U.S. and Mexico, and the U.S. and Japan. Although this Act does not require ecological assessments be done for federal agency projects, if a disturbance is expected in an area where migratory birds may be affected, such an assessment should be done to ensure the law's intent.	If remedial actions potentially impact migrating birds, this Act is applicable.	100-NR-1 100-NR-2
Endangered Species Act of 1973	16 U.S.C. 1531 et seq.	Prohibits federal agencies from jeopardizing threatened or endangered species or adversely modifying habitats essential to their survival. If waste site remediation is within sensitive habitat or buffer zone surrounding threatened and endangered species, migration measures must be taken to protect this resource.	This law is applicable as threatened or endangered species have been identified within the 100 Area.	100-NR-1 100-NR-2
Fish and Wildlife Services List of Endangered and Threatened Wildlife and Plants	50 CFR 17, 22, 225, 226, 227, 402 and 424	Requires identification of activities that may affect listed species. Actions must not threaten the continued existence of a listed species or destroy critical habitat. Requires consultation with the Fish and Wildlife Service to determine if threatened or endangered species could be impacted by activity.	This law is applicable as threatened or endangered species have been identified within the 100 Area.	100-NR-1 100-NR-2
Historic Sites, Buildings, and Antiques Act	16 U.S.C. 461	Establishes requirements for preservation of historic sites, buildings, or objects of minimal significance. Undesirable impacts to such resources must be mitigated.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.	100-NR-1 100-NR-2
National Historic Preservation Act of 1966, as amended	16 U.S.C. 470 et seq.	Prohibits impacts on cultural resources. Where impacts are unavailable, requires impact migration through design and data recovery.	Applicable to properties listed in the National Register of Historic Places, or eligible for such listing.	100-NR-1 100-NR-2
Protection of Historic Properties	36 CFR 800	Sets criteria to assess effects, to develop migration measures to address unavoidable adverse impacts, and to address properties discovered during implementation of an undertaking.	Applicable when remedial action threatens a historic property discovered during remedial activity.	100-NR-1 100-NR-2
Historic Sites Act of 1935	16 U.S.C. 461-467 36 CFR 65	Requires action to undertake the recovery, protection, and preservation of sites, buildings, objects, and antiquities of National significance.	Applicable when remedial action threatens sites, buildings, objects, and antiquities of National significance.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Native American Graves Protection and Repatriation Act of 1990	25 U.S.C. 3001-3013 Public Las 101-601 (1993)	Requires action by federal agency when Native American human remains and associated funerary objects are inadvertently discovered during excavation. Requires work stoppage, protection of items, and notification to appropriate Indian Tribes.	Applicable if, during remedial action, Native American human remains or burial objects are discovered. Construction activities may resume 30 days after certification that agency head and Indian tribes have been notified.	100-NR-1 100-NR-2
Hanford Reach Study Act	P.L. 100-605	Provides for a comprehensive river conservation study. Prohibits the construction of any dam, channel, or navigation project by a federal agency for 8 years after enactment. New federal and nonfederal projects and activities are required, to the extent practicable, to minimize direct and adverse effects on the values for which the river is under study and to use existing structures.	This law as enacted November 4, 1988. Consultation and coordination with the National Park Service will be done to minimize and provide mitigation for any direct and adverse effects on the river.	100-NR-1 100-NR-2
Flood Plains/Wetlands Environmental Review	10 CFR 1022	Requires federal agencies to avoid, to the extent possible, adverse effects associated with the development of a floodplain or the destruction or loss of Wetlands.	Applicable if remedial activities take place in a floodplain or Wetlands.	100-NR-1 100-NR-2
Clean Air Act, as amended	42 U.S.C. 7401 et seq.	A comprehensive environmental law designed to regulate any activities that affect air quality, providing the national framework for controlling air pollution.		
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR 61	Establishes numerical standards for hazardous air pollutants.		
Radionuclide Emissions from DOE Facilities (except Airborne radon-222, and radon-230	40 CFR 61.92	Prohibits emissions of radionuclides to the ambient air exceeding an effective dose equivalent of 10 mrem/year.	Applicable to point and diffuse sources.	
Emission Standards for Asbestos for Waste Disposal Operations for Demolition and Renovation	40 CFR 61.150	States there must either be no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to recovery and handling of asbestos wastes.	100-NR-1
Asbestos Standard for Active Waste Disposal Sites	40 CFR 61.154	States there must either be no visible emissions to the outside air during the collection, processing (including incineration), packaging, or transporting of any asbestos-containing waste material generated by the source, or specified waste treatment methods must be used.	Applicable to landfill disposal of asbestos.	100-NR-1

Description	Citation	Requirements	Remarks	Operable Unit Affected
Protection of Stratospheric Ozone	40 CFR 82	Management of refrigerant systems.	Applicable to all buildings/ facilities containing refrigerant systems.	100-NR-1
Federal Water Pollution Control Act (FWPCA), as amended by the Clean Water Act of 1988 (CWA)	33 U.S.C. 1251 et seq.	Creates the basic national framework for water pollution control and water quality management in the United States.	Applicable to discharges of pollutants to navigable waters.	
Water Quality Standards	40 CFR 131	Provides federal ambient water quality criteria for use in surface water cleanup.	Also provides requirements for approving State water quality standards.	100-NR-1 100-NR-2
NPDES Criteria and Standards	40 CFR 125.104	Best management practices program shall be developed in accordance with good engineering practices.	Applicable if remediation includes wastewater discharge; also applies to storm water runoff associated with industrial activities. Effluent limitations established by EPA are included in NPDES permit.	
Discharge of Oil	40 CFR 110	Prohibits discharge of oil that violates applicable water quality standards or causes a sheen of oil on water surface. Runoff from site will need control for oily water discharge to waters of the United States.		
Safe Drinking Water Act (SDWA)	42 U.S.C. 300 et seq.	Creates the basic framework for protection of drinking water supplies from pollutants.	Applicable to remedial action objectives for soil and groundwater.	100-NR-1 100-NR-2
National Primary Drinking Water Regulations	40 CFR 141	Identifies primary contaminants and concentration levels protective of drinking water supplies	Provides MCLs for medial action objective consideration.	100-NR-1 100-NR-2
National Secondary Drinking Water Regulations	40 CFR 143	Identifies contaminants and concentration levels for aesthetic quality of drinking water supplies	Provides secondary MCLs for remedial action objective consideration	100-NR-1 100-NR-2
U.S. Army Corp of Engineers Permit Regulations	33 CFR 320-330	Establishes procedural and permit requirements of construction activities within the Columbia River. Permit programs include Section 10 Permits.	Substantive requirements are applicable if river construction activities will take place and would qualify under these permit programs.	NR-1 NR-2
Solid Waste Disposal Act, as amended by the Resource Conservation and Recovery Act (RCRA)	40 U.S.C. 6901 et seq.	Establishes the basic framework for federal regulation of solid waste. Subpart C of RCRA controls the generation, transportation, treatment, storage, and disposal of hazardous waste through a comprehensive "cradle to grave" system of hazardous waste management techniques and requirements. Subtitle D of RCRA controls the disposal of solid waste.	The State has been authorized to implement most of Subtitle C, although certain HSWA provisions (e.g., LDR requirements) have not yet been delegated. Additionally, EPA has approved the State Subtitle D Program.	

Description	Citation	Requirements	Remarks	Operable Unit Affected
Identification and Listing of Hazardous Waste	40 CFR 261 [WAC 173-303-016]	Identifies by both listing and characterization, those solid wastes subject to regulation as hazardous wastes under Parts 261-265, 268, 270, 271, and 124.	Applicable if remediation techniques result in generation of hazardous wastes, Environmental media (e.g., soil and groundwater) contaminated with RCRA listed waste must be managed as RCRA listed waste unless the regulatory agencies determine that the media no longer contains the listed waste.	100-NR-1 100-NR-2
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262 [WAC 173-303]	Describes the regulatory requirements imposed on generators of hazardous wastes who treat, store, or dispose of the waste onsite.	Applicable if remediation techniques result in generation of hazardous waste.	100-NR-1 100-NR-2
Designation & Determination of LDR Status	40 CFR 262.11 (WAC 173-303-070)	Requires generator to determine waste designation and LDR Status.	Applicable if remediation techniques result in generation of solid waste.	100-NR-1 100-NR-2
Accumulation Time	40 CFR 262.34 [WAC 173-303-200]	Allows a generator to accumulate hazardous waste on site for 90 days or less without a permit, provided that all waste is containerized and labeled.	Hazardous waste removed from the operable units, and waste treatment residues, are subject to the 90 day generator accumulation requirements if the waste is stored on site for 90 days or less. If hazardous waste is stored on site for more than 90 days, the substantive provisions of permitting standards for TSD facilities are applicable.	100-NR-1 100-NR-2
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities	40 CFR 264 WAC 173-303]	Establishes requirements for operating hazardous waste treatment, storage, and disposal facilities. Applies to facilities put in operation since November 19, 1980. Facilities in operation before that date and existing facilities handling newly regulated wastes must meet similar requirements in 40 CFR 265.	Applicable if remediation technique results in onsite treatment, storage, or disposal of hazardous waste.	100-NR-1 100-NR-2
Closure	40 CFR 264.111-264.116 [WAC 173-303-610] Subpart G	Performance standard that controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, postclosure escape of chemicals, disposal or decontamination of equipment, structures, and soils. All contaminated equipment, structures, and soils must be properly disposed.	Substantive requirements may be relevant and appropriate during remediation activities.	100-NR-1 100-NR-2
Postclosure	40 CFR 264-117-264-120 [WAC 173-303-610] Subpart G	Postclosure care must begin after completion of closure and continue for 30 years. During this period, the owner or operator must comply with all postclosure requirements, including maintenance of cover, leachate monitoring, and groundwater monitoring.	Applicable to waste remaining in place after closure. Requires postclosure care and monitoring to ensure elimination of escape of hazardous constituents, leachate, and contaminated runoff.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Container Storage	40 CFR 264.170-264-178 [WAC 173-3-3-160-173-303-161] Subpart I	Condition of containers, comparability of waste with containers, container management, containment, special requirements for ignitable or reactive wastes.	May be applicable if container storage is to occur. Inspection requirements may be in potential conflict with ALARA requirements.	100-NR-1 100-NR-2
Miscellaneous Unit	40 CFR 264-600-603 (WAC 173-303-680) Subpart X	Requires general environmental performance standards for operations including monitoring and inspections.	May be applicable if miscellaneous units occur, i.e., thermal treatment is used.	100-NR-1 100-NR-2
Waste Piles	40 CFR 264.250-259 (WAC 173-303-660) Subpart L	Design in operating requirements: monitoring, leachate system and lines.	May be applicable if waste piles occur outside area of contamination.	100-NR-1 100-NR-2
Tanks	40 CFR 264.190-199 (WAC 173-303-640)	Design operating standards for tanks including secondary containment and leak detection systems; tank management; containment; special requirements for ignitable or reactive wastes.	May be applicable if tank storage is to occur. Inspection requirements may be potential conflict with ALARA requirements. May be applicable for soil washing process.	100-NR-1 100-NR-2
Temporary Units	40 CFR 264-553 (WAC 173-3-3-645(7)	Establishes alternative performance standards for temporary tanks and containers used for treatment or storage of hazardous remediation wastes for up to one year.	Applicable if temporary unit is used.	100-NR-1 100-NR-2
Land Disposal Restrictions (LDR)	40 CFR 268 [WAC 173-303-140 WAC 173-303-141]	Generally prohibits placement of restricted RCRA hazardous wastes in land-based units such as landfills, surface impoundments, and waste piles.	Applicable unless waste has been treated, treatment has been waived, a treatment variance has been set for the waste, and equivalent treatment method has been established, or waste qualifies for delisting.	100-NR-1 100-NR-2
Dilution Prohibition	40 CFR 268.3 Subpart A	Requires remediation waste to be appropriately treated which does not include dilution. Generators are required to identify applicable treatment standards at the point of generation and prior to mixing with other remediation wastes.	Applicable if RCRA hazardous waste.	100-NR-1 100-NR-2
Debris Rule	40 CFR 268.45	Establishes the alternative treatment standards of hazardous waste debris by using technologies specified in 40 CFR 268.45, Table 1.	Applicable if RCRA hazardous waste.	100-NR-1 100-NR-2
Prohibition and Treatment Standards	40 CFR 268-30-268.48 [WAC 173-303-140]	Establishes treatment standards that must be met prior to land disposal.	Applicable if RCRA hazardous waste.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Prohibition on Storage	40 CFR 268.50 [WAC 173-303-141]	The storage of nonradioactive hazardous waste restricted from land disposal under RCRA Section 3004 and 40 CFR 268, Subpart C, is prohibited unless wastes are stored in tanks and containers by a generator or the onsite operator of a TSD facility solely for the purpose of accumulation of such quantities as to facilitate proper treatment or disposal. TSD facility operators may store wastes for up to one year under these circumstances. Radioactive mixed waste is not prohibited from storage pursuant to the Tri-Party Agreement.	Applicable only to nonradioactive hazardous waste.	100-NR-1 100-NR-2
Transportation	49 CFR 100-199	Establishes standards applicable to the offsite transportation and packaging of hazardous materials.	Applicable requirement for offsite shipments	100-NR-1 100-NR-2
Toxic Substances Control Act (TSCA), as amended	15 U.S.C. 2601 et seq.	Provides EPA with authority to regulate the production, use, distribution, and disposal of toxic substances.		
Regulation of Polychlorinated Biphenyls (PCBs)	40 CFR 761	For spills occurring after May 4, 1987, spillage or disposal must be reported to EPA. Unless otherwise approved, PCBs as concentrations of 50 ppm or greater must be treated in an incinerator. Spills that occurred before May 4, 1987, are to be decontaminated o requirements established at the discretion of the EPA.		100-NR-1 100-NR-2
Model Toxics Control Act (MTCA)	70.105 RCW	Requires remedial actions to attain a degree of cleanup protective of human health and the environment.		
Cleanup Regulations	WAC 173-340	Establishes cleanup levels and prescribes methods to calculate cleanup levels for soils, groundwater, surface water, and air.	Relevant and appropriate to remediation actions where hazardous substances have been released.	100-NR-1 100-NR-2
Soil Cleanup Standards	WAC 173-340-700-760	Establishes cleanup standards for contaminated media. These levels must be protective of the groundwater if groundwater is considered a pathway of exposure.	Applicable to remediation actions where hazardous substances have been released. Levels will be calculated based on final land use decision.	100-NR-1 100-NR-2
Selection of Cleanup Actions	WAC 173-340-360	Establishes h criteria for selection of cleanup actions.	Must be considered within feasibility of corrective measures studies.	100-NR-1 100-NR-2
Cleanup Actions	WAC 173-340-400	Ensures that the cleanup action is designed, constructed, and operated in accordance with the cleanup plan and other specified requirements.	Cleanup must follow remedial design document and remedial action work plans.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Institutional Controls	WAC 173-340-440	Requires physical measures, such as fences and signs, to limit interference with cleanup.	Physical measures may be applicable if institutional controls are used.	100-NR-1 100-NR-2
Cleanup Standards	WAC 173-340-700-750	Establishes cleanup standards for remedial and corrective actions.	Soil, groundwater, and surface water standards are contained in these requirements.	100-NR-1 100-NR-2
Radiation Protection–Air Emissions	WAC 246-247	Establishes procedures to monitor and control airborne radionuclide emissions.	Applicable if airborne radionuclide emissions are anticipated during remedial action.	100-NR-1 100-NR-2
New and Modified Sources	WAC 246-247-120 (Appendix B)	Requires the use of best available radionuclide control technology (BARCT).	Substantive requirements applicable if airborne radionuclide emissions are anticipated during remedial action.	100-NR-1 100-NR-2
Habitat Buffer Zone for Bald Eagle Rules	RCW 77.12.655			
Bald Eagle Protection Rules	WAC 232-12-292	Prescribes action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.	Applicable if the areas of remedial activities include bald eagle habitat. No habitat buffer zones at the 100-N Area.	100-NR-1 100-NR-2
The Indian Graves and Records Act of the State of Washington	RCW 27.44	Prohibits the willful removal, mutilation, defacement, or destruction of any cairn, grave, or glyphic or painted record of any Native Indian or prehistoric people. Requires agency to consult with traditional religious leaders regarding activities that might affect religious sites.	There are Native American burial grounds and cultural areas within the 100 Area Operable Units; therefore, this is applicable.	100-NR-1 100-NR-2
Department of Game State Environmental Policy Act	WAC 232-012	Requires management plans if endangered, threatened, or sensitive wildlife or habitat is affected. Washington State Department of Fish and Wildlife will be consulted to minimize ecological impacts.	Upon the determination of impacts to threatened, endangered, or sensitive species or habitat by the remedial actions, this may be applicable.	100-NR-1 100-NR-2
U.S. Department of Ecology	43.12A RCW	Vests the Washington Department of Ecology with the authority to undertake the state air regulation and management program.		
Air Pollution Regulations	WAC 173-400	Establishes requirements to control and/or prevent the emission of air contaminants.	Applicable if emission sources are created during remedial action.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Standards for Maximum Emissions	WAC 173-400-040	Requires best available control technology to used to control fugitive emissions of dust from materials handling, construction, demolition, or any other activities that are sources of fugitive emissions. Restricts emitted particulates from being deposited beyond the Hanford Site. Requires control of odors emitted from the source. Prohibits masking or concealing prohibited emissions. Requires measures to prevent fugitive dust from becoming airborne.	Applicable to dust emissions from cutting of concrete and metal and vehicular traffic during remediation.	100-NR-1
Emission Limits for Radionuclides	WAC 173-480	Controls air emissions of radionuclides from specific sources.	Applicable to remedial activities that result in air emissions.	100-NR-1 100-NR-2
New and Modified Emission Units	WAC 173-480-060	Requires the best available radionuclide control technology be used in planning constructing, installing, or establishing a new emissions unit.	Applicable to remedial actions that result in air emissions.	100-NR-1 100-NR-2
Washington Clean Air Act	RCW 70.94	Establishes a statewide framework for the planning, regulation control, and management of air pollution sources.		
Controls for New Sources of Toxic Air Pollutants	WAC 173-460	Establishes systematic control of new sources emitting toxic air pollutants.	Applicable if new sources emitting toxic air pollutants are established.	100-NR-1 100-NR-2
Decontaminating Ambient Impact Compliance	WAC 173-460-080	Requires the owner or operator of a new source to complete an acceptable source impact level analysis using dispersion modeling to estimate maximum incremental ambient impact of each Class A or B toxic air pollutant. Establishes numerical limits for small quantity emission rates.	Applicable to remedial alternatives with the potential to release toxic air pollutants.	100-NR-1 100-NR-2
Hazardous Waste Management Act of 1976, as amended in 1980 and 1983	70.105 RCW	Establishes a statewide framework for the planning, regulation, control, and management of hazardous waste.		
Dangerous Waste Regulations	WAC 173-303	Establishes the design, operation, and monitoring requirements for management of dangerous waste. Includes requirements for generators of dangerous waste. Dangerous waste includes the full universe of wastes regulated by WAC 173-303, including extremely hazardous waste.	Applicable if dangerous or extremely hazardous waste is generated and/or managed during remedial action.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Waste Designation	WAC 173-303-070, 071, 080, 082, 090, 100, 110	Exceeds federal RCRA program by requiring designation of waste including additional parameters (i.e., toxicity and persistence), additional listed wastes, and PCBs.	Applicable if remediation wastes, based on process knowledge/analysis exceed the parameters.	100-NR-1 100-NR-2
Land Disposal Restrictions	WAC 173-303-140	State LDR requirements exceed the federal requirements for nonradiological extremely hazardous, organic/carbonaceous and solid acid wastes.	Applicable if remediation wastes meet additional categories.	100-NR-1 100-NR-2
Corrective Action Management Unit (CAMU)	WAC 173-303-646(4)	Authorizes designation of a corrective action management unit, which does not constitute land disposal of dangerous waste.	May be used if dangerous waste not meeting LDR standards is placed on the land.	100-NR-1
Solid Waste Management Act	70.95 RCW	Establishes a statewide program for solid waste handling, recovery, and/or recycling.		
Minimum Functional Standards for Solid Waste Handling	WAC 173-304	Establishes requirements to be met statewide to handle all solid waste.	Applicable if management of solid waste occurs during remediation. Solid waste controlled by this Act includes garbage, industrial waste, construction waste, ashes, and swill.	100-NR-1
Onsite Containerized Storage, Collection, and Transportation Standards	WAC 173-304-200	Sets requirements for containers and vehicles to be used on site.	Applicable if containers are used during remediation.	100-NR-1
Water Pollution Control Act	90.48 RCW	Prohibits discharge of polluting matter in waters.		
Water Quality Standards for Groundwater	WAC 173-200	Establishes groundwater standards for groundwaters of the State of Washington.	Provides groundwater standards based on MCLs.	NR-1 NR-2
Water Quality Standards for Surface Waters	WAC 173-201A	Establishes water quality standards for surface waters of the State of Washington.	Defines the Columbia River as a Class A river.	NR-1 NR-2
State Waste Discharge Permit Program	WAC 173-216	Requires the use of all known available and reasonable methods of prevention, control, and treatment. Discharges must meet limits which ensure that groundwater and surface water standards are not exceeded.	Applicable for any discharges of liquids to the ground.	100-NR-1
Underground Injection Control Program	WAC 173-218	Sets requirements for injection of effluents through wells that may endanger the groundwaters of the state.	Applicable to any discharges of liquids through a well.	100-NR-2
Water Well Construction Act	18.104 RCW			
Standards for Construction and Maintenance of Wells	WAC 173-160	Establishes minimum standards for design, construction, capping, and sealing of all wells; sets additional requirements, including disinfection of equipment, abandonment of wells, and quality of drilling water.	Applicable if water supply wells, monitoring wells, or other wells are used during remediation.	100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Shoreline Management Act	90.48 RCW			
Shoreline Development Permits	WAC 173-14	Requirements associated with administration and enforcement of shoreline management permits.	Substantive compliance with this ARAR and the Shoreline Management Act is required for river construction activities.	NR-1 NR-2
Hydraulic Projects Permits	WAC 220-110	Establishes regulations for construction activities that will use, divert, obstruct, or change the natural flow of the bed of the Columbia River.	Established for the protection of fish life.	NR-1 NR-2
Benton Clean Air Authority	Regulation 1, Article 5	Establishes a regional program for open burning.	These county regulations are authorized by the state Clean Air Act.	100-NR-1
Benton Clean Air Authority	Regulation 1, Article 8	Establishes regulations relative to asbestos.	Must be considered if asbestos is found during remediation.	100-NR-1 100-NR-2
A Guide on Remedial Actions at Superfund Sites with PCB Contamination	EPA Directive 9355-.4-01FS	Provides a general framework to determine cleanup levels, identify treatment options, and assess necessary management controls for residuals of PCBs.	Must be considered if PCBs are found during remediation.	100-NR-1 100-NR-2
U.S. Department of Energy Orders		Select DOE Orders are contractual requirements of the ERC.		
Materials Transportation and Traffic Management	DOE Order 1540.1A	Establishes DOE requirements for transporting materials	For onsite shipments these requirements specify compliance with 49 CFR but allow for other means of transportation and packaging if they offer an equivalent degree of safety.	100-NR-1 100-NR-2
Radiation Dose Limit (All Pathways)	DOE-5400.5, Chapter II, Section 1a	The exposure of the public to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem from all exposure pathways, except under specified circumstances.	If remedial activities are considered "routine DOE activities," this order would be relevant and appropriate.	100-NR-1 100-NR-2
NRC Draft Radiological Criteria for Decommissioning	10 CFR 20 (proposed revision)	This rule provides a clear and consistent regulatory basis to determine the extent to which lands and structures must be remediated before a site can be considered decommissioned.	This will be applicable upon promulgation.	100-NR-1
Radioactive Waste Management	DOE Order 5820.2A	Defines waste designation for TRU, high- and low-level waste and establishes criteria for the management and disposal of LLW.		100-NR-1

Description	Citation	Requirements	Remarks	Operable Unit Affected
Radioactive Waste Management	DOE 5820.2A Chapters III and IV	Establishes policies and guidelines by which DOE manages radioactive waste, waste byproducts, and radioactive contaminated surplus facilities. Disposal shall be on the site which it was generated, if practical, or at another DOE facility. DOE waste containing byproduct material shall be stored, stabilized in place, and/or disposed of consistent with the requirements of the residual radioactive material guidelines contained in 40 CFR 192.	Must be met when managing radioactive waste created by remediation activities.	100-NR-1
Safety Requirements for the Packaging of Fissile and Other Radioactive Materials	DOE 5480.3, Sections 7 and 8	Establishes requirements for packaging and transportation of radioactive materials for DOE facilities.	Requirements must be met if radioactive material is packaged and transported to disposal facility.	100-NR-1
Draft EPA Radiation Site Cleanup Regulations	40 CFR 196 (draft notice of proposed rulemaking)	This draft notice of proposed rulemaking will set standards for the remediation of soils, groundwater, surface water, and structures at federal facilities.	These standards are intended to set limits for radiation doses to the public.	100-NR-1 100-NR-2
Draft Department of Energy Radiation Protection of the Public and the Environment	10 CFR 834	Additional requirements above 5400.5 that are more prescriptive.	Substantive requirements largely the same as 5400.5	100-NR-1
Wild and Scenic Rivers Act	16 U.S.C. 1271	Prohibits federal agencies from recommending authorization of any water resource project that would have a direct and adverse effect on the values for which a river was designated as a wild and scenic river or included as a study area.	The Hanford Reach of the Columbia River is under study for inclusion as a wild and scenic river.	100-NR-1 100-NR-2
Residual Radioactive Material as Surface Contamination	U.S. NRC Regulatory Guide 1.86	Sets contamination guidelines release equipment and building components for unrestricted use, and if buildings are demolished, shall not be exceeded for contamination in the ground.	Dependent upon land use decisions, this guide may be considered.	D&D Facilities

Description	Citation	Requirements	Remarks	Operable Unit Affected
Fish and Wildlife Coordination Act	16 U.S.C. 661 et seq.	This Act ensures that wildlife conservation is given equal consideration with other values during the planning of activities that affect water resources. The Act authorizes the Secretary of the Interior to provide assistance to federal, state, and public or private agencies in the "development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat..." The Act also requires a consultation with the U.S. Fish and Wildlife Service (USFWS) when a federal agency plans to impound, deepen, or otherwise modify a body of water.	While the recommendations by the USFWS are not legally binding, DOE is required to give them full consideration.	100-NR-1 100-NR-2
Executive Orders Protection of Wetlands	EO 11990	This Executive Order requires that each federal agency "....take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for (1) acquiring, managing, and disposing of federal lands and facilities; and (2) providing federally undertaken, financed, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulating, and licensing activities."	Must be considered if action is taken that may impact wetland area.	100-NR-1 100-NR-2
Floodplain Management	EO 11988	This Order requires federal agencies to take floodplain management into account when formulating or evaluating water or land use plans. The Order specifies that "...each agency shall...restore and reserve the natural and beneficial values served by Flood Plains in carrying out its responsibilities for (1) acquiring, managing, and disposing of federal land and facilities; (2) providing federally undertaken, financial, or assisted construction and improvements; and (3) conducting federal activities and programs affecting land use, and licensing conducting activities.□	Must be considered if actions are taken within a floodplain.	100-NR-1 100-NR-2
Protection and Enhancement of the Cultural Environment	EO 11593	Provides direction to federal agencies to preserve, restore, and maintain cultural resources.	Pertains to sites, structures, and objects of historical, archeological, or architectural significance.	100-NR-1 100-NR-2

Description	Citation	Requirements	Remarks	Operable Unit Affected
Exotic Organisms	EO 11987	This Order requires federal agencies to restrict, to the extent possible, the introduction of exotic species into the lands or waters that they own, lease, or hold for purposes of administration. It also restricts the use of federal funds and programs for importation and introduction of exotic species.	Must be considered during revegetation.	100-NR-1
Department of Ecology Liquid Effluent Consent Order	DE 91NM-177	Requires discharges of liquid effluent to the soil to column to be eliminated, treated, or otherwise minimized.	Must be considered if discharges of liquid effluent to the soil column are part of the remedial alternative.	100-NR-1
Tri-Party Agreement		Establishes requirements, guidelines, and schedules for the environmental restoration program at the Hanford Site.	Must be adhered to and complied with by all parties with regard to remedial actions at all operable units.	100-NR-1 100-NR-2

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Appendix G
Cost Estimates

Contents

Tables

Abbreviations and Acronyms

bcy	Bank cubic yards
CMS	Corrective Measures Study
Distribs	Distributables
G&A	General and Administrative
ID	Identification
MCACES	A model used to provide cost estimates for some of the remedial alternatives
MCRIS	Modified CRCIA ranger/industrial scenario
O&M	Operations and maintenance
PM/CM	Project management/construction management
RACER	A model used to provide cost estimates for some of the remedial alternatives
Sub01	Mobilization & prep work costs
Sub02	Monitoring, sampling, & analysis costs
Sub08	Solid collection & containment costs
Sub20	Site restoration costs
Sub21	Demobilization costs
Sub70	Project/construction management & support cost

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G1.0 COST ESTIMATES FOR SOURCE SITE REMEDIAL ALTERNATIVES

G1.1 COST ESTIMATES FOR THE 100-NR-1 SOURCE WASTE SITES

The cost estimates for the 100-NR-1 source wastes sites were developed using the Micro Computer Aided Cost Estimating System (MCACES) software package or the Remedial Action Cost Engineering and Requirements (RACER) software package. The MCACES package was selected for estimating costs for the Remove/Dispose Remedial Alternative (using the crib and French drain, trench, and piping models) and the Containment Remedial Alternative (using the RCRA cap model). The cost models associated with these alternatives are presented in the *100 Areas Source Operable Unit Focused Feasibility Study Cost Models* (DOE-RL1995b). The MCACES and RACER packages were used for there move/ex situ bioremediation/dispose cost estimates. The RACER package was used for estimating costs for the remaining source remedial alternatives: in situ bioremediation, in situ solidification, and capping. Cost estimates provided by these two packages are suitable for comparative analysis of remedial alternatives but are not intended for establishing definitive cost estimates. The total costs as shown do not include design costs (3 percent) or costs for collecting design data in the field (3 percent).

Attachment 1 to this Appendix is the MCACES summary report for the UPR-100-N-1 site, and it typifies the reports generated for the remainder of the sites. In this model, costs are summarized into seven categories as follows on the second page of the attachment:

Code	Cost category	Total Cost
01	Mobilization & Prep Work	14,320
02	Monitoring, Sampling, & Analysis	21,200
08	Solids Collection& Containment	34,390
18	Disposal (Other than Commercial)	11,970
20	Site Restoration	8,560
21	Demobilization	5,000
70	Project/Construction Mgmt & Supt	29,180

These costs are presented in Tables G1-1 and G1-2 for the Remove/Dispose Alternatives for both the Rural-Residential and Modified CRCIA Ranger/Industrial Exposure Scenarios.

These models rely upon a set of user-supplied input parameters as shown on the third page of the attachment. Six of these parameters (depth of excavation, top excavation length, bottom excavation length, contaminated soil volume, non-contaminated soil volume, and bottom area) are presented in Table G1-3 for the sites. The other five input parameters (hauling distance for borrow, hauling distance for contaminated soil, hauling distance for demo waste, transition zone soil percentages, and groundwater protection samples) are fixed for all the 100-NR-1 sites and areas presented on the third page of the example.

The cost estimating process for the Remove/Ex Situ Bioremediation/Dispose Remedial Alternative consisted of two steps. The initial step was to estimate the cost of removing the contaminated soil from the waste site and transporting it to the location selected for ex situ bioremediation. These costs were estimated using the MCACES program and are similar to the costs developed for similar tasks under the Remove/Dispose Alternative. The RACER program was then used to estimate the cost of the actual bioremediation. The minimum size remediation cell used in the estimate was 100 loose cubic yards (LCY) of material. Since the majority of sites were less than this volume, soils from these small sites were combined into one cell and the cost prorated on a LCY basis. These costs are presented in Tables G1-4 and 5.

The cost estimates for the Containment Remedial Alternative (capping) were determined in the same fashion as the Remove/Dispose Remedial Alternative and used the MCACES program. The cost estimates are presented in Tables G1-6 and 7. The cost estimates for in situ bioremediation and in situ solidification were determined using the RACER program and are presented in Tables G1-8 and 9, respectively.

Thecostestimateforsite100-N-45, a septic system in the HGP area, was assumed the same as site124-N-2. Site 100-N-46, an underground storage tank (UST) at HGP, was estimated following the existing practice for USTs at Hanford. A summary sheet for this estimate is on page G1-22. No estimates were made for three sites in the HGP area (100-N-50, 100-N-51a, and 100-N-51b) because of the limited data available. Cost estimates will be established during design.

The cost estimates for the river shoreline site followed Hanford cost estimating practices. These estimates are summarized, beginning on page G1-23. Institutional control costs need to be added to these numbers to reach the total costs presented in Section 8.0. No estimate was provided for site 100-N-65 (a petroleum intercepter trench) because remediation of this site depends, in part, upon the information developed during the remediation design of UPR-100-N-17, the source of this leak.

Table G1.1. 100-NR-1/2 CMS Residential Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost $
UPR-100-N-1	14,320	21,200	34,390	11,970	8,560	5,000	95,440	14,316	15,432	6,685	44,837	176,709
UPR-100-N-2	13,920	19,980	35,970	7,180	6,260	5,000	88,310	13,247	14,279	6,186	41,487	163,508
UPR-100-N-3	15,060	29,600	53,670	17,960	15,510	5,000	136,800	20,520	22,119	9,582	64,267	253,288
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	16,170	32,220	64,890	43,050	20,100	5,000	181,430	27,215	29,335	12,708	85,234	335,922
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7	15,870	36,380	93,320	30,140	22,030	5,000	202,740	30,411	32,781	14,201	95,245	375,378
UPR-100-N-8	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-11	12,650	16,150	17,100	600	270	5,000	51,770	7,766	8,371	3,626	24,321	95,853
UPR-100-N-12	16,540	42,480	115,470	41,130	27,750	5,000	248,370	37,256	40,159	17,397	116,682	459,863
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15												
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	13,070	16,970	20,060	180	1,430	5,000	56,710	8,507	9,169	3,972	26,642	105,000
UPR-100-N-19	13,140	16,970	20,180	420	1,510	5,000	57,220	8,583	9,252	4,008	26,881	105,944
UPR-100-N-20	13,000	16,700	19,120	210	1,090	5,000	55,120	8,268	8,912	3,861	25,895	102,056
UPR-100-N-21	12,730	16,420	17,620	180	530	5,000	52,480	7,872	8,485	3,676	24,655	97,168
UPR-100-N-22	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-23	13,020	16,970	19,680	110	1,170	5,000	55,950	8,393	9,047	3,919	26,285	103,593
UPR-100-N-24	13,150	16,970	20,540	810	1,590	5,000	58,060	8,709	9,388	4,067	27,276	107,499
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,980	16,700	19,120	40	1,090	5,000	54,930	8,240	8,882	3,848	25,806	101,704
UPR-100-N-30	13,350	17,520	23,020	2,000	2,470	5,000	63,360	9,504	10,245	4,438	29,766	117,313
UPR-100-N-32	13,080	16,970	20,070	210	1,430	5,000	56,760	8,514	9,178	3,976	26,665	105,092
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,710	18,890	31,310	4,690	4,170	5,000	77,770	11,666	12,575	5,447	36,536	143,993
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,150	16,970	20,220	630	1,590	5,000	57,560	8,634	9,307	4,032	27,041	106,574
100-N-1	15,960	44,750	55,390	35,810	16,420	5,000	173,330	26,000	28,026	12,141	81,429	320,925
100-N-3	14,740	23,520	42,640	19,710	11,100	5,000	116,710	17,507	18,871	8,175	54,829	216,091
100-N-4	17,540	30,760	63,520	72,450	19,630	5,000	208,900	31,335	33,777	14,632	98,139	386,783
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	13,280	17,790	23,180	140	2,690	5,000	62,080	9,312	10,038	4,348	29,165	114,943
100-N-25	13,170	16,970	21,010	810	1,670	5,000	58,630	8,795	9,480	4,107	27,544	108,555
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27												
100-N-29	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-30	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-31	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-32	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-38	13,470	18,340	29,570	670	3,640	5,000	70,690	10,604	11,430	4,951	33,209	130,884
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,350	17,790	23,620	740	2,770	5,000	63,270	9,491	10,230	4,432	29,724	117,146
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864

Site ID	Sub01 $	Sub02 $	Sub08 $	Sub18 $	Sub20 $	Sub21 $	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Tot[illegible] C[illegible]
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531
130-N-1												
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	$855,845	$2,162,119	$3,138,771		$2,375,727	$5,000	$18,601,082	$2,790,162	$3,007,609	$1,302,899	$8,738,596	$34,440,348
Totals:							$28,010,722					$51,862,521

Table G1.2. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Recalculate MCACES with 15 Percent PM/CM

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cos
UPR-100-N-1	14,020	19,710	28,920	7,980	5,500	5,000	81,130	12,170	13,118	5,683	38,114	150,214
UPR-100-N-2							-	-	-	-	-	-
UPR-100-N-3							-	-	-	-	-	-
UPR-100-N-4	12,740	16,420	17,620	320	540	5,000	52,640	7,896	8,511	3,687	24,730	97,464
UPR-100-N-5	14,960	23,120	42,680	21,530	10,970	5,000	118,260	17,739	19,121	8,283	55,557	218,961
UPR-100-N-6	13,040	16,700	19,550	740	1,170	5,000	56,200	8,430	9,087	3,936	26,402	104,056
UPR-100-N-7							-	-	-	-	-	-
UPR-100-N-8	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-9	12,980	16,700	19,040	1,610	860	5,000	56,190	8,429	9,085	3,936	26,397	104,037
UPR-100-N-10	12,610	16,150	17,450	40	270	5,000	51,520	7,728	8,330	3,609	24,204	95,391
UPR-100-N-11	12,640	16,150	17,100	600	270	5,000	51,760	7,764	8,369	3,625	24,316	95,835
UPR-100-N-12							-	-	-	-	-	-
UPR-100-N-13	10,410	16,150	16,180	110	150	5,000	48,000	7,200	7,761	3,362	22,550	88,873
UPR-100-N-14	12,620	16,150	17,450	40	270	5,000	51,530	7,730	8,332	3,609	24,208	95,409
UPR-100-N-15							-	-	-	-	-	-
UPR-100-N-17	18,100	284,460	767,570	31,920	194,150	5,000	1,301,200	195,180	210,391	91,142	611,290	2,409,203
UPR-100-N-18	12,980	16,700	19,080	140	1,090	5,000	54,990	8,249	8,891	3,852	25,834	101,815
UPR-100-N-19	13,030	16,700	19,470	350	1,170	5,000	55,720	8,358	9,009	3,903	26,177	103,167
UPR-100-N-20	12,990	16,700	19,080	210	1,090	5,000	55,070	8,261	8,904	3,857	25,871	101,963
UPR-100-N-21	12,720	16,420	17,620	180	530	5,000	52,470	7,871	8,484	3,675	24,650	97,149
UPR-100-N-22	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-23	12,930	16,700	19,040	70	1,080	5,000	54,820	8,223	8,864	3,840	25,754	101,501
UPR-100-N-24	13,110	16,970	20,190	770	1,510	5,000	57,550	8,633	9,305	4,031	27,036	106,555
UPR-100-N-25	12,770	16,420	17,660	420	540	5,000	52,810	7,922	8,539	3,699	24,810	97,779
UPR-100-N-26	12,850	16,420	18,140	810	740	5,000	53,960	8,094	8,725	3,780	25,350	99,908
UPR-100-N-29	12,920	16,700	18,690	40	1,000	5,000	54,350	8,153	8,788	3,807	25,533	100,630
UPR-100-N-30	13,270	17,250	21,590	1,680	2,120	5,000	60,910	9,137	9,849	4,266	28,615	112,776
UPR-100-N-32	12,990	16,700	19,080	180	1,090	5,000	55,040	8,256	8,899	3,855	25,857	101,908
UPR-100-N-36	12,680	16,420	17,620	40	530	5,000	52,290	7,844	8,455	3,663	24,565	96,816
UPR-100-N-37	12,420	16,150	17,030	40	120	5,000	50,760	7,614	8,207	3,555	23,847	93,983
UPR-100-N-38	12,620	16,150	17,410	110	270	5,000	51,560	7,734	8,337	3,611	24,222	95,465
UPR-100-N-39	12,880	16,420	18,480	110	740	5,000	53,630	8,045	8,671	3,756	25,195	99,297
UPR-100-N-40	13,510	18,070	23,940	3,120	3,140	5,000	66,780	10,017	10,798	4,678	31,373	123,645
UPR-100-N-41	12,570	16,150	17,060	210	190	5,000	51,180	7,677	8,275	3,585	24,044	94,761
UPR-100-N-42	19,720	326,530	891,310	67,170	225,530	5,000	1,535,260	230,289	248,236	107,536	721,249	2,842,571
UPR-100-N-43	13,080	16,970	19,710	530	1,430	5,000	56,720	8,508	9,171	3,973	26,646	105,018
100-N-1	15,660	42,710	51,540	29,820	14,430	5,000	159,160	23,874	25,735	11,148	74,772	294,689
100-N-3	14,100	19,440	28,450	11,830	5,170	5,000	83,990	12,599	13,580	5,883	39,458	155,509
100-N-4	17,450	30,760	63,520	72,450	19,630	5,000	208,810	31,322	33,762	14,626	98,097	386,617
100-N-5	20,360	44,590	49,070	54,670	14,980	5,000	188,670	28,301	30,506	13,215	88,635	349,327
100-N-6	12,420	16,150	17,030	110	120	5,000	50,830	7,625	8,219	3,560	23,879	94,113
100-N-12	12,300	16,150	17,030	40	110	5,000	50,630	7,595	8,186	3,546	23,785	93,743
100-N-13	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-14	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-16	12,510	16,150	17,030	140	180	5,000	51,010	7,652	8,248	3,573	23,964	94,446
100-N-17	12,490	16,150	17,030	40	180	5,000	50,890	7,634	8,228	3,565	23,908	94,224
100-N-18	12,410	16,150	17,030	40	120	5,000	50,750	7,613	8,206	3,555	23,842	93,965
100-N-19	12,500	16,150	17,030	180	180	5,000	51,040	7,656	8,253	3,575	23,978	94,502
100-N-22	13,510	17,790	23,700	4,870	2,790	5,000	67,660	10,149	10,940	4,739	31,786	125,274
100-N-23	12,310	16,150	17,030	110	110	5,000	50,710	7,607	8,199	3,552	23,823	93,891
100-N-24	12,940	16,700	19,040	70	1,080	5,000	54,830	8,225	8,865	3,841	25,759	101,519
100-N-25	13,100	16,970	20,190	670	1,510	5,000	57,440	8,616	9,287	4,023	26,985	106,352
100-N-26	12,940	16,700	19,040	110	1,080	5,000	54,870	8,231	8,872	3,843	25,777	101,593
100-N-27	12,950	16,700	18,690	180	1,010	5,000	54,530	8,180	8,817	3,820	25,618	100,964
100-N-29												
100-N-30												
100-N-31												
100-N-32												
100-N-33	13,250	16,970	19,710	1,510	1,230	5,000	57,670	8,651	9,325	4,039	27,093	106,777
100-N-34	12,340	16,150	17,030	40	110	5,000	50,670	7,601	8,193	3,549	23,804	93,817
100-N-35	12,820	16,420	18,050	110	660	5,000	53,060	7,959	8,579	3,717	24,927	98,242
100-N-36	12,550	16,150	17,030	250	180	5,000	51,160	7,674	8,272	3,583	24,034	94,724
100-N-37	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
100-N-39	12,830	16,150	17,500	810	360	5,000	52,650	7,898	8,513	3,688	24,734	97,483
100-N-47	15,130	36,250	29,610	14,910	5,510	5,000	106,410	15,962	17,205	7,453	49,990	197,021
120-N-3	13,070	16,700	19,540	420	1,170	5,000	55,900	8,385	9,038	3,915	26,261	103,500
124-N-2	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-3	13,510	33,990	20,750	4,870	2,790	5,000	80,910	12,137	13,082	5,667	38,011	149,807
124-N-4	21,330	75,940	125,480	143,360	43,070	5,000	414,180	62,127	66,969	29,011	194,577	766,864
128-N-1	14,740	18,580	21,500	11,550	4,530	5,000	75,900	11,385	12,272	5,316	35,657	140,531

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total
130-N-1							-	-	-	-	-	-
600-32	37,130	242,580	289,620	417,410	113,510	5,000	1,105,250	165,788	178,708	77,416	519,235	2,046,397
600-35	17,750	28,350	17,740	13,410	4,850	5,000	87,100	13,065	14,083	6,101	40,919	161,268
Pipelines	855,845	2,162,199	3,138,771		2,375,727	5,000	18,601,162	2,790,174	3,007,622	1,302,904	8,738,633	34,440,496
Totals:							$26,872,142					$49,754,413

Table G1.3. 100-NR-1 CMS MCACES Input Parameters

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
UPR-100-N-1	12.00	10.00	72.60	72.60	8,021	30,761	5,348	23,017	1,340	1,340
UPR-100-N-2	15.00		62.90	62.90	4,813	28,787				320
UPR-100-N-3	15.00		94.10	94.10	12,032	70,751				2,411
UPR-100-N-4	6.00	6.00	23.80	23.80	201	1,490	201	1,490	34	34
UPR-100-N-5	15.00	10.00	98.80	98.80	28,877	64,287	14,439	34,612	2,894	2,894
UPR-100-N-6	9.25	9.25	36.55	36.55	481	5,657	481	5,657	77	77
UPR-100-N-7	15.00		108.60	108.60	20,214	96,880				4,045
UPR-100-N-8	6.00	6.00	19.50	19.50	13	1,026	13	1,026	2	2
UPR-100-N-9	6.25	6.25	31.75	31.75	1,059	2,500	1,059	2,500	169	169
UPR-100-N-10	6.00	6.00	19.50	19.50	13	1,026	13	1,026	2	2
UPR-100-N-11	2.00	2.00	20.00	20.00	392	200	392	200	196	196
UPR-100-N-12	15.00		120.00	120.00	27,852	120,375				5,625
UPR-100-N-13	3.00	3.00	13.20	13.20	53	221	53	221	18	18
UPR-100-N-14	6.00	6.00	19.80	19.80	19	1,058	19	1,058	3	3
UPR-100-N-17	64.00	64.00	210.90	210.90	21,390	1,282,248	21,390	1,282,248	357	357
UPR-100-N-18	11.25	11.25	37.85	37.85	107	7,336	107	7,336	17	17
UPR-100-N-19	11.25	11.25	40.25	40.25	267	8,375	267	8,375	42	42
UPR-100-N-20	10.25	10.25	35.35	35.35	134	5,842	134	5,842	21	21
UPR-100-N-21	6.25	6.25	22.85	22.85	107	1,457	107	1,457	17	17
UPR-100-N-22	11.25	11.25	38.35	38.35	134	7,548	134	7,548	21	21
UPR-100-N-23	11.25	11.25	36.65	36.65	53	6,838	53	6,838	8	8
UPR-100-N-24	10.25	10.25	40.05	40.05	535	7,585	535	7,585	86	86
UPR-100-N-25	6.25	6.25	25.25	25.25	267	1,738	267	1,738	42	42
UPR-100-N-26	6.25	6.25	28.05	28.05	535	2,066	535	2,066	86	86
UPR-100-N-29	11.00	10.00	34.50	34.50	13	5,880	11	4,461	2	2
UPR-100-N-30	11.00	10.00	47.90	47.90	1,337	11,843	1,114	9,580	222	222
UPR-100-N-32	11.25	10.00	38.35	38.35	134	7,548	107	5,486	21	21
UPR-100-N-36	7.00	7.00	22.40	22.40	13	1,588	13	1,588	2	2
UPR-100-N-37	3.00	3.00	10.30	10.30	5	143	5	143	2	2
UPR-100-N-39	9.00	9.00	30.60	30.60	53	3,856	53	3,856	13	13
UPR-100-N-40	12.00	10.00	58.80	58.80	3,128	19,881	2,086	13,959	520	520
UPR-100-N-41	4.00	4.00	17.10	17.10	134	553	134	553	26	26
UPR-100-N-42	65.00	65.00	222.40	222.40	45,046	1,449,549	45,046	1,449,549	751	751
UPR-100-N-43	11.00	11.00	41.20	41.20	401	8,637	401	8,637	67	67
100-N-1	15.00	10.00	145.00	85.00	24,000	80,750	20,000	45,000	4,000	4,000
100-N-3	17.50	17.50	85.00	85.00	15,840	53,938	15,840	53,938	1,056	1,056
100-N-4	6.00	6.00	118.00	99.00	48,600	10,638	48,600	10,638	8,100	8,100
100-N-5	2.00	2.00	141.00	141.00	36,664	1,652	36,664	1,652	18,225	18,225
100-N-6	1.00	1.00	10.30	10.30	53	26	53	26	53	53
100-N-12	1.00	1.00	5.60	5.60	7	12	7	12	7	7
100-N-13	8.00	8.00	28.20	28.20	54	2,943	54	2,943	18	18
100-N-14	8.00	8.00	28.20	28.20	54	2,943	54	2,943	18	18
100-N-16	3.00	3.00	14.50	14.50	90	317	90	317	30	30
100-N-17	3.00	3.00	13.20	13.20	18	257	18	257	18	18
100-N-18	2.00	2.00	10.20	10.20	18	100	18	100	18	18
100-N-19	1.00	1.00	13.40	13.40	108	35	108	35	108	108
100-N-22	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
100-N-23	1.00	1.00	5.70	5.70	53	12	53	12	7	7
100-N-24	15.00	10.00	48.00	48.00	90	15,570	45	4,945	9	9
100-N-25	11.00	10.00	42.40	42.40	535	9,178	446	7,262	88	88
100-N-26	10.00	10.00	33.00	33.00	53	4,945	53	4,945	9	9
100-N-29	15.00		54.40	54.40	446	20,729				88
100-N-30	15.00		54.40	54.40	446	20,729				88
100-N-31	15.00		54.40	54.40	446	20,729				88
100-N-32	15.00		54.40	54.40	446	20,729				88
100-N-33	4.00	4.00	43.60	43.60	999	4,768	999	4,768	999	999
100-N-34	1.00	1.00	6.40	6.30	11	14	11	14	11	11
100-N-35	8.00	8.00	28.20	28.20	53	2,943	53	2,943	18	18
100-N-36	1.00	1.00	15.00	15.00	144	40	144	40	144	144
100-N-37	1.00	1.00	103.00	103.00	10,000	304	10,000	304	10,000	10,000
100-N-38	15.00		54.40	54.40	446	20,729				88
100-N-39	1.00	1.00	26.10	26.10	535	73	535	73	534	534
100-N-47	1.00	1.00	103.00	103.00	10,000	304	10,000	304	10,000	10,000
120-N-3	14.00	10.00	49.30	49.30	481	15,535	267	6,456	53	53
124-N-2	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
124-N-3	10.00	10.00	49.00	49.00	3,249	10,061	3,249	10,061	361	361
124-N-4	8.33	8.33	120.99	188.99	96,164	76,606	96,164	76,606	15,744	15,744
128-N-1	1.00	1.00	91.00	91.00	7,744	268	7,744	268	7,744	7,744
600-32	2.00	2.00	380.00	380.00	280,000	4,520	280,000	4,520	139,876	139,876

Site Name	Depth of Excavation Res (ft)	Depth of Excavation Rec (ft)	Top Excavation Length (ft)	Top Excavation Width (ft)	Contaminated Soil Res (bcf)	Non-Contaminated Soil Res (bcf)	Contaminated Soil Rec (bcf)	Non-Contaminated Soil Rec (bcf)	Bottom Area Rec (sq. ft.)	Bottom Area Res (sq. ft.)
600-35	1.00	1.00	98.00	98.00	9,000	289	9,000	289	9,025	9,025

Table G1.4. Ex Situ Bioremediation Costs from RACER Model

Waste Site	Volume (LCY)	Unit Cost (/LCY)	Cost ()
UPR-100-N-18	5	359.39	1,797
UPR-100-N-19	11	359.39	3,953
UPR-100-N-20	6	359.39	2,156
UPR-100-N-21	5	359.39	1,797
UPR-100-N-22	6	359.39	2,156
UPR-100-N-23	2	359.39	719
UPR-100-N-24	23	359.39	8,266
UPR-100-N-36	1	359.39	359
UPR-100-N-43	17	359.39	6,110
100-N-3	562	N/A	64,335
100-N-12	1	359.39	359
100-N-35	2	359.39	719
100-N-36	6	359.39	2,156
124-N-2	138	N/A	38,649

Table G1.5. 100-NR-1 CMS Summary of Ex Situ Bioremediation Costs

Site ID	Sub01	Sub02	Sub08	Sub18	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
UPR-100-N-18	13,070	16,970	20,060		1,430	5,000	56,530	8,480	9,140	3,960	26,557	104,667
XSITU-BIO							1,797	270	291	126	844	3,328
Total	13,070	16,970	20,060	-	1,430	5,000	58,327	8,749	9,431	4,086	27,402	107,995
UPR-100-N-19	13,140	16,970	20,180		1,510	5,000	56,800	8,520	9,184	3,979	26,684	105,167
XSITU-BIO							3,953	593	639	277	1,857	7,319
Total	13,140	16,970	20,180	-	1,510	5,000	60,753	9,113	9,823	4,256	28,541	112,486
UPR-100-N-20	13,000	16,700	19,120		1,090	5,000	54,910	8,237	8,878	3,846	25,796	101,667
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,000	16,700	19,120	-	1,090	5,000	57,066	8,560	9,227	3,997	26,809	105,660
UPR-100-N-21	12,730	16,420	17,620		530	5,000	52,300	7,845	8,456	3,663	24,570	96,835
XSITU-BIO							1,797	270	291	126	844	3,328
Total	12,730	16,420	17,620	-	530	5,000	54,097	8,115	8,747	3,789	25,414	100,163
UPR-100-N-22	13,080	16,970	20,070		1,430	5,000	56,550	8,483	9,144	3,961	26,567	104,704
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	13,080	16,970	20,070	-	1,430	5,000	58,706	8,806	9,493	4,112	27,580	108,696
UPR-100-N-23	13,020	16,970	19,680		1,170	5,000	55,840	8,376	9,029	3,911	26,233	103,389
XSITU-BIO							719	108	116	50	338	1,330
Total	13,020	16,970	19,680	-	1,170	5,000	56,559	8,484	9,145	3,961	26,571	104,720
UPR-100-N-24	13,150	16,970	20,540		1,590	5,000	57,250	8,588	9,257	4,010	26,895	106,000
XSITU-BIO							8,266	1,240	1,337	579	3,883	15,305
Total	13,150	16,970	20,540	-	1,590	5,000	65,516	9,827	10,594	4,589	30,779	121,305
UPR-100-N-36	12,680	16,420	17,620		530	5,000	52,250	7,838	8,448	3,660	24,547	96,742
XSITU-BIO							359	54	58	25	169	664
Total	12,680	16,420	17,620	-	530	5,000	52,609	7,891	8,506	3,685	24,715	97,407
UPR-100-N-43	13,150	16,970	20,220		1,590	5,000	56,930	8,540	9,205	3,988	26,745	105,407
XSITU-BIO							6,110	916	988	428	2,870	11,312
Total	13,150	16,970	20,220	-	1,590	5,000	63,040	9,456	10,193	4,416	29,615	116,720
100-N-3	15,030	27,260	52,230		14,320	5,000	113,840	17,076	18,407	7,974	53,481	210,777
XSITU-BIO							64,335	9,650	10,402	4,506	30,224	119,117
Total	15,030	27,260	52,230	-	14,320	5,000	178,175	26,726	28,809	12,480	83,705	329,894
100-N-12	12,300	16,150	17,030		110	5,000	50,590	7,589	8,180	3,544	23,767	93,669
XSITU-BIO							359	54	58	25	169	665
Total	12,300	16,150	17,030	-	110	5,000	50,949	7,643	8,238	3,569	23,935	94,333
100-N-35	12,820	16,420	18,050		660	5,000	52,950	7,943	8,561	3,709	24,875	98,038
XSITU-BIO							719	108	116	50	338	1,330
Total	12,820	16,420	18,050	-	660	5,000	53,669	8,050	8,677	3,759	25,213	99,369
100-N-36	12,550	16,150	17,030		180	5,000	50,910	7,637	8,232	3,566	23,917	94,261
XSITU-BIO							2,156	323	349	151	1,013	3,992
Total	12,550	16,150	17,030	-	180	5,000	53,066	7,960	8,581	3,717	24,930	98,253
124-N-2	13,510	33,990	20,750		2,790	5,000	76,040	11,406	12,295	5,326	35,723	140,790
XSITU-BIO							38,649	5,797	6,249	2,707	18,157	71,559
Total	13,510	33,990	20,750	-	2,790	5,000	114,689	17,203	18,544	8,033	53,880	212,349

Table G1.6. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

Site ID	Area %of Total	Sub01	Sub02	Sub08	Sub20	Sub21	Subtotal w/o PM/CM	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Cntgcy 34%	Total Cost
Unit#1Cap#1		242,000	6,918	211,765	193,308	18,236	672,227					
UPR-100-N-10	14.79%	35,792	1,023	31,320	28,590	2,697	99,422	14,913	16,076	6,964	46,708	184,083
UPR-100-N-39	85.21%	206,208	5,895	180,445	164,718	15,539	572,805	85,921	92,617	40,122	269,098	1,060,561
		242,000	6,918	211,765	193,308	18,236	672,227	100,834	108,692	47,086	315,805	1,244,644
Unit#1Cap#2		242,108	6,918	217,465	193,500	18,250	678,241					
UPR-100-N-29	0.92%	2,227	64	2,001	1,780	168	6,240	936	1,009	437	2,931	11,553
UPR-100-N-30	90.46%	219,011	6,258	196,719	175,040	16,509	613,537	92,031	99,203	42,975	288,233	1,135,978
UPR-100-N-32	8.62%	20,870	596	18,745	16,680	1,573	58,464	8,770	9,453	4,095	27,466	108,248
		242,108	6,918	217,465	193,500	18,250	678,241	101,736	109,665	47,507	318,631	1,255,779
Unit#4Cap#1		280,638	130,066	2,688,254	198,830	21,697	3,319,485					
UPR-100-N-4	0.18%	505	234	4,839	358	39	5,975	896	966	419	2,807	11,063
UPR-100-N-5	15.39%	43,190	20,017	413,722	30,600	3,339	510,869	76,630	82,602	35,783	240,001	945,886
UPR-100-N-6	0.41%	1,151	533	11,022	815	89	13,610	2,041	2,201	953	6,394	25,199
UPR-100-N-8	0.01%	28	13	269	20	2	332	50	54	23	156	615
UPR-100-N-25	0.23%	645	299	6,183	457	50	7,635	1,145	1,234	535	3,587	14,136
100-N-26	0.05%	140	65	1,344	99	11	1,660	249	268	116	780	3,073
124-N-4	83.73%	234,978	108,904	2,250,875	166,480	18,167	2,779,405	416,911	449,402	194,681	1,305,736	5,146,134
		280,638	130,066	2,688,254	198,830	21,697	3,319,485	497,923	536,728	232,511	1,559,460	6,146,106
Unit#4Cap#2		242,502	8,302	231,375	193,288	18,307	693,774					
UPR-100-N-9	98.26%	238,282	8,158	227,349	189,925	17,988	681,702	102,255	110,224	47,749	320,257	1,262,188
UPR-100-N-14	1.74%	4,220	144	4,026	3,363	319	12,072	1,811	1,952	846	5,671	22,351
		242,502	8,302	231,375	193,288	18,307	693,774	104,066	112,176	48,595	325,928	1,284,539
Unit#4Cap#3		242,195	6,918	211,877	193,306	18,279	672,575					
UPR-100-N-13	16.94%	41,028	1,172	35,892	32,746	3,096	113,934	17,090	18,422	7,980	53,525	210,952
UPR-100-N-26	83.06%	201,167	5,746	175,985	160,560	15,183	558,641	83,796	90,327	39,130	262,444	1,034,337
		242,195	6,918	211,877	193,306	18,279	672,575	100,886	108,749	47,110	315,969	1,245,289

Table G1.7. 100-NR-1 CMS Modified CRCIA Ranger/Industrial Scenario Summary of Capping Costs

Site Name	Remove/Dispose	Capping	In Situ Solidification
CAP1-1			
UPR-100-N-10	95,391	653,884	157,016
UPR-100-N-39	99,297	3,767,236	415,600
Subtotal	194,688	4,421,120	572,616
CAP1-2			
UPR-100-N-29	100,630	41,563	158,467
UPR-100-N-30	112,776	4,086,761	349,849
UPR-100-N-32	101,908	389,430	173,568
Subtotal	315,314	4,517,754	681,884
CAP4-1			
UPR-100-N-4	97,464	83,646	192,295
UPR-100-N-5	218,961	7,151,720	651,238
UPR-100-N-6	104,056	190,527	217,955
UPR-100-N-8	95,391	4,647	157,016
UPR-100-N-25	97,779	106,881	202,532
100-N-26	101,593	23,235	163,047
124-N-4	766,864	38,909,260	1,388,214
Subtotal	1,482,108	46,469,916	2,972,297
CAP4-2			
UPR-100-N-9	104,307	4,672,424	345,617
UPR-100-N-14	95,409	82,740	158,496
Subtotal	199,716	4,755,164	504,113
CAP4-3			
UPR-100-N-13	88,873	749,331	181,321
UPR-100-N-26	99,908	3,674,112	252,221
Subtotal	188,781	4,423,443	433,542
Miscellaneous In Situ Solidification			
UPR-100-N-1	150,214		386,077
UPR-100-N-11	95,835		345,010
100-N-13	98,242		340,414
100-N-14	98,242		340,414
Subtotal	442,533		1,411,915
Total for Capping and Remove/Dispose	2,380,607	64,587,397	
Total for In Situ Solidification and Remove/Dispose	2,823,140		6,576,367

[a] Costs based on the modified CRCIA ranger/industrial exposure scenario
NA-Not Applicable

Table G1.8. 100-NR-1 CMS In Situ Bioremediation

Site ID	Total Site Volume (bcy)	Time Frame Years	Task Subtotals	PM/CM 15.00%	Direct Distribs 14.06%	G&A 5.34%	Contingency 34%		Total Cost
UPR-100-N-17									
Site Restoration	1,170		1,170	176	189	82	550		3,336
Construction	77,100		77,100	11,565	12,466	5,400	36,221	Capital	219,852
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$432,930	$64,940	$70,000	$30,324	$203,386		$903,510
UPR-100-N-42									
Site Restoration	2,190		2,190	329	354	153	1,029		6,245
Construction	78,365		78,365	11,755	12,671	5,489	36,815	Capital	223,460
RACERO & M Cost	23,644	15.00	354,660	53,199	57,345	24,842	166,616	O&M	680,321
Total			$435,215	$65,282	$70,370	$30,484	$204,460		$910,026

Table G1.9. 100-NR-1/2 CMS In Situ Solidification

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-1(rec)	4963	16835	24320	RACER Model Run					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	120,699			18,105	19,516	8,454	56,703	O&M	223,477
Soil Cover Cost	4,269			640	690	299	2,006	Cover	7,905
	204,249		-	31,278	33,715	14,606	97,960		386,077
UPR-100-N-5(rec)	8926	16835	24320	UPR-100-N-1(rec) Unit cost					
RACER Fixed Cost	83,550			12,533	13,509	5,852	39,251	Capital	154,695
RACER Variable Cost	217,078			32,562	35,099	15,205	101,981	O&M	401,926
Soil Cover Cost	9,385			1,408	1,518	657	4,409	Cover	17,377
	310,014		-	46,502	50,126	21,715	145,641		573,998
UPR-100-N-30(rec)	822	1,01285	1,26746	RACER Model Run					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	104,185			15,628	16,846	7,298	48,945	O&M	192,901
Soil Cover Cost	1,511			227	244	106	710	Cover	2,798
	187,441		-	28,343	30,552	13,235	88,768		349,849
UPR-100-N-6(rec)	264	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	33,461			5,019	5,410	2,344	15,720	O&M	61,954
Soil Cover Cost	1,000			150	162	70	470	Cover	1,851
	116,717		-	17,657	19,034	8,245	55,302		217,955
UPR-100-N-32(rec)	78	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	9,886			1,483	1,598	692	4,644	O&M	18,304
Soil Cover Cost	601			90	97	42	282	Cover	1,113
	93,142		-	14,061	15,157	6,566	44,040		173,568
100-N-26(rec)	33	1,01285	1,26746	UPR-100-N-30(rec) Unit cost					
Fixed Cost	83,256			12,488	13,462	5,832	39,113	Capital	154,150
Variable Cost	4,183			627	676	293	1,965	O&M	7,744
Soil Cover Cost	622			93	101	44	292	Cover	1,152
	87,439		-	13,209	14,239	6,168	41,370		163,047
UPR-100-N-9(rec)	391	2,12834	2,61148	RACER Model Run					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	102,109			15,316	16,510	7,152	47,970	O&M	189,057
Soil Cover Cost	1,339			201	217	94	629	Cover	2,480
	185,327		-	28,000	30,182	13,075	87,694		345,617
UPR-100-N-4(rec)	76	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	19,847			2,977	3,209	1,390	9,324	O&M	36,748
Soil Cover Cost	792			119	128	55	372	Cover	1,467
	103,065		-	15,579	16,793	7,275	48,791		192,295

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
UPR-100-N-8(rec)	04	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-10(rec)	04	2,12834	2,61148	UPR-100-N-9(rec)Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,045			157	169	73	491	O&M	1,934
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	84,263		-	12,721	13,712	5,940	39,840		157,016
UPR-100-N-14(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	557			84	90	39	262	Cover	1,031
	85,046		-	12,840	13,841	5,996	40,215		158,496
UPR-100-N-25(rec)	97	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Capital Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Fixed Cost	25,331			3,800	4,096	1,774	11,900	O&M	46,902
Variable Cost	837			126	135	59	393	Cover	1,550
Soil Cover Cost	108,549		-	16,408	17,687	7,662	51,389		202,532
UPR-100-N-26(rec)	199	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
Variable Cost	51,969			7,795	8,403	3,640	24,414	O&M	96,221
Soil Cover Cost	1,037			156	168	73	487	Cover	1,920
	135,187		-	20,434	22,026	9,542	63,996		252,221
UPR-100-N-29(rec)	07	2,12834	2,61148	UPR-100-N-9(rec) Unit cost					
RACER Fixed Cost	83,218			12,483	13,456	5,829	39,095	Capital	154,080
RACER Variable Cost	1,828			274	296	128	859	O&M	3,385
Soil Cover Cost	541			81	87	38	254	Cover	1,002
	85,587		-	12,838	13,839	5,995	40,208		158,467
UPR-100-N-11(rec)	145	5,73869	7,01372	RACERModelRun					
RACER Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
RACER Variable Cost	101,699			15,255	16,444	7,123	47,777	O&M	188,298
Soil Cover Cost	1,428			214	231	100	671	Cover	2,645
	186,338		-	27,951	30,129	13,052	87,540		345,010
UPR-100-N-13(rec)	2	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	14,027			2,104	2,268	983	6,590	O&M	25,972
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	97,931		-	14,690	15,834	6,859	46,007		181,321
UPR-100-N-39(rec)	198	5,73869	7,01372	UPR-100-N-11(rec) Unit cost					
Fixed Cost	83,211			12,482	13,454	5,828	39,092	Capital	154,067
Variable Cost	138,872			20,831	22,454	9,727	65,241	O&M	257,124
Soil Cover Cost	2,381			357	385	167	1,119	Cover	4,409
	224,464		-	33,670	36,294	15,722	105,451		415,600

Site ID	Total Site Volume (bcy)	Fixed Unit Cost /bcy	Variable Unit Cost /bcy	PM/CM 1500%	Direct Distribs 1406%	G&A 534%	Contingency 34%		Total Cost $
124-N-4(rec)	48573	4380	10416	RACER Model Run					
RACER Fixed Cost	212,729			31,909	34,396	14,900	99,938	Capital	393,873
RACER Variable Cost	505,941			75,891	81,806	35,438	237,686	O&M	936,762
Soil Cover Cost	31,098			4,665	5,028	2,178	14,610	Cover	57,579
	749,768		-	112,465	121,230	52,517	352,233		1,388,214
100-N-14(rec)	53	15,29528	19,26396	RACER Model Run					
RACER Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
RACER Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414
100-N-13(rec)	53	15,29528	19,26396	100-N-14(rec) Unit cost					
Fixed Cost	81,065			12,160	13,107	5,678	38,083	Capital	150,094
Variable Cost	102,099			15,315	16,508	7,151	47,965	O&M	189,039
Soil Cover Cost	692			104	112	48	325	Cover	1,282
	183,164		-	27,578	29,728	12,878	86,374		340,414

TableG1.10. 100-N-46 Underground Fuel Storage Tank at HGP

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.0%	Home Off. 3.0%	S/C Fee 4.0%	B&O Tax 0.47%	Total Bid
Pre-Construction Activities	-	124	14,233	-	14,358	ERC Activities Include DD&G&A)				14,358
Prepare Site/ Mobilize	848	216	3,029	-	4,092	1,064	155	212	26	5,549
Removal Action	2,004	486	2,292	12,247	17,030	4,428	644	884	108	23,093
Restore Site	749	-	347	84	1,181	307	45	61	7	1,602
Tank Disposal	437	-	1,201	-	1,638	426	62	85	10	2,221
Removal Activity Closeout	-	-	1,920	-	1,920	ERC Activities (Include DD&G&A)				1,920
Subtotals:	$4,038	$826	$23,023	$12,332	$40,218	6,225	905	1,243	152	$48,743

ERC Direct Distribs @18.09% 5,873
(excludes ERC labor)

ERC G&A @4.04 1,549

(excludes ERC labor)

TOTAL: 56,165

Contingency @ 34% 19,096
TOTAL: 75,261

Pre-Construction and Close out are preformed with ERC Labor
Removal and site restoration work performed with Subcontractor (Building Trades) Labor.

Sample Analysis costs: Average ERC Cost for FY97 (Quanterra) (Inter office Memo Jan 15, 1997)

1 **Table G1.11. Rivershore Site Residential Scenario Remove/Dispose Summary**

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 26.00%	Home Office 3.00%	S/C Fee 4.00%	B&O Tax 0.47%	Total Bid
Grout Wells	-	49	450	-	499	130	19	26	3	676
Excavate Site	107,489	92,794	285,981	577,095	1,063,359	276,473	40,195	55,201	6,746	1,441,974
Restore Site	197,503	266,706	113,099	42,830	620,137	161,236	23,441	32,193	3,934	840,941
Support Facilities	-	-	-	133,920	133,920	34,819	5,062	6,952	850	181,603
Mobilization/Demobilization	29,914	4,502	136,783	-	171,199	44,512	6,471	8,887	1,086	232,155
Subtotals:	334,905	364,052	536,312	753,844	1,989,114	517,170	75,189	103,259	12,618	2,697,349

Bond		25,962
Total Subcontractor Cost	SUBTOTAL:	2,723,311
PM/CM @15%		408,497
	SUBTOTAL:	3,131,808
Haul to ERDF and Disposal		3,447,990
	SUBTOTAL:	6,579,798
	Directdistribs@18.09%	1,190,285
	G&A@4.04%	313,911
	TOTAL:	8,083,995
	Contingency@34%	2,748,558
	TOTAL:	**10,832,553**

Assumptions:
All excavation will take place above the water table.
Backfill material consists of clean natural fill material from the 100 BC Area.
Riprap material above the water line is placed with a backhoe.
Rip-rapmaterialwasassumedtoinclude4feetof+2ftmaterialrestingon2feetof12"minusmaterial.
Existing wells will be grouted closed.
Two new monitoring wells will be established through the clean cover material.
Contractor markups are taken from the 300 FFFPE.
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

2

Table G1.12. Rivershore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2 % per year and discounted at 10 % (7 % plus 3.2 %) per year for 300 years. The 3.2% is published by DOE and is an average for 300 years, and the 7% Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100 NR1 & NR2 CMS RIVERSHORE SITE RECREATIONAL SCENARIO: REMOVE/DISPOSE ALTERNATIVE WORK MUST BE REPEATED EVERY 20 YEARS

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
1	$9,738,935	$9,738,935	$9,738,935	1000	$9,738,935	100	$9,738,93500
2				1032		110	
3				1065		121	
4				1099		134	
5				1134		147	
6				1171		163	
7				1208		179	
8				1247		197	
9				1287		217	
10				1328		240	
11				1370		264	
12				1414		291	
13				1459		321	
14				1506		353	
15				1554		390	
16				1604		429	
17				1655		473	
18				1708		521	
19				1763		574	
20				1819		633	
21	$9,738,935	$9,738,935	$9,738,935	1878	$18,285,440	698	$2,621,03924
22				1938		769	
23				2000		847	
24				2064		934	
25				2130		1029	
26				2198		1134	
27				2268		1249	
28				2341		1377	
29				2416		1517	
30				2493		1672	
31				2573		1843	
32				2655		2031	
33				2740		2238	
34				2828		2466	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
35				2918		2718	
36				3012		2995	
37				3108		3300	
38				3207		3637	
39				3310		4008	
40				3416		4417	
41	$9,738,935	$9,738,935	$9,738,935	3525	$34,332,020	4867	$705,40020
42				3638		5363	
43				3754		5911	
44				3875		6513	
45				3999		7178	
46				4127		7910	
47				4259		8717	
48				4395		9606	
49				4536		10586	
50				4681		11665	
51				4830		12855	
52				4985		14166	
53				5145		15611	
54				5309		17204	
55				5479		18959	
56				5654		20892	
57				5835		23023	
58				6022		25372	
59				6215		27960	
60				6414		30812	
61	$9,738,935	$9,738,935	$9,738,935	6619	$64,460,446	33954	$189,84433
62				6831		37418	
63				7049		41234	
64				7275		45440	
65				7508		50075	
66				7748		55183	
67				7996		60811	
68				8252		67014	
69				8516		73850	
70				8788		81382	
71				9069		89683	
72				9360		98831	
73				9659		1,08912	
74				9968		1,20021	
75				10287		1,32263	
76				10616		1,45754	
77				10956		1,60621	
78				11307		1,77004	
79				11669		1,95058	
80				12042		2,14954	
81	$9,738,935	$9,738,935	$9,738,935	12427	$121,028,388	2,36880	$51,09280
82				12825		2,61041	
83				13235		2,87667	
84				13659		3,17010	

	Rate	Compounding Value	Total Net
Discount Rate % (EPA) for 300 Yrs	7%	1102	Present Worth
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
85				14096		3,49345	
86				14547		3,84978	
87				15013		4,24245	
88				15493		4,67518	
89				15989		5,15205	
90				16500		5,67756	
91				17028		6,25667	
92				17573		6,89485	
93				18136		7,59813	
94				18716		8,37314	
95				19315		9,22720	
96				19933		10,16837	
97				20571		11,20555	
98				21229		12,34851	
99				21908		13,60806	
100				22609		14,99608	
101	$9,738,935	$9,738,935	$9,738,935	23333	$227,238,125	16,52568	$13,75060
102				24080		18,21130	
103				24850		20,06886	
104				25645		22,11588	
105				26466		24,37170	
106				27313		26,85761	
107				28187		29,59709	
108				29089		32,61599	
109				30020		35,94282	
110				30980		39,60899	
111				31972		43,64911	
112				32995		48,10132	
113				34051		53,00765	
114				35140		58,41443	
115				36265		64,37271	
116				37425		70,93872	
117				38623		78,17447	
118				39859		86,14827	
119				41134		94,93539	
120				42451		104,61880	
121	$9,738,935	$9,738,935	$9,738,935	43809	$426,653,333	115,28992	$3,70070
122				45211		127,04949	
123				46658		140,00854	
124				48151		154,28941	
125				49692		170,02693	
126				51282		187,36968	
127				52923		206,48139	
128				54616		227,54249	
129				56364		250,75182	
130				58168		276,32851	
131				60029		304,51402	
132				61950		335,57445	
133				63932		369,80304	
134				65978		407,52295	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
135				68089		449,09029	
136				70268		494,89750	
137				72517		545,37704	
138				74837		601,00550	
139				77232		662,30806	
140				79704		729,86349	
141	$9,738,935	$9,738,935	$9,738,935	82254	$801,067,455	804,30956	$99597
142				84886		886,34914	
143				87603		976,75675	
144				90406		1,076,38594	
145				93299		1,186,17730	
146				96284		1,307,16739	
147				99366		1,440,49846	
148				102545		1,587,42931	
149				105827		1,749,34710	
150				109213		1,927,78050	
151				112708		2,124,41411	
152				116315		2,341,10435	
153				120037		2,579,89699	
154				123878		2,843,04649	
155				127842		3,133,03723	
156				131933		3,452,60703	
157				136155		3,804,77294	
158				140512		4,192,85978	
159				145008		4,620,53148	
160				149648		5,091,82569	
161	$9,738,935	$9,738,935	$9,738,935	154437	$1,504,052,632	5,611,19191	$26805
162				159379		6,183,53349	
163				164479		6,814,25390	
164				169743		7,509,30780	
165				175174		8,275,25720	
166				180780		9,119,33343	
167				186565		10,049,50544	
168				192535		11,074,55499	
169				198696		12,204,15960	
170				205054		13,448,98388	
171				211616		14,820,78024	
172				218388		16,332,49982	
173				225376		17,998,41481	
174				232588		19,834,25312	
175				240031		21,857,34693	
176				247712		24,086,79632	
177				255639		26,543,64955	
178				263819		29,251,10180	
179				272261		32,234,71418	
180				280974		35,522,65503	
181	$9,738,935	$9,738,935	$9,738,935	289965	$2,823,949,849	39,145,96584	$7214
182				299244		43,138,85436	
183				308820		47,539,01751	
184				318702		52,387,99729	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
185				328900		57,731,57301	
186				339425		63,620,19346	
187				350287		70,109,45320	
188				361496		77,260,61742	
189				373064		85,141,20040	
190				385002		93,825,60284	
191				397322		103,395,81433	
192				410036		113,942,18739	
193				423157		125,564,29050	
194				436698		138,371,84814	
195				450673		152,485,77664	
196				465094		168,039,32586	
197				479977		185,179,33710	
198				495337		204,067,62949	
199				511187		224,882,52769	
200				527545		247,820,54552	
201	$9,738,935	$9,738,935	$9,738,935	544427	$5,302,136,760	273,098,24116	$1941
202				561848		300,954,26176	
203				579828		331,651,59646	
204				598382		365,480,05930	
205				617530		402,759,02534	
206				637291		443,840,44593	
207				657685		489,112,17141	
208				678730		539,001,61290	
209				700450		593,979,77741	
210				722864		654,565,71471	
211				745996		721,331,41761	
212				769868		794,907,22221	
213				794504		875,987,75887	
214				819928		965,338,51028	
215				846165		1,063,803,03833	
216				873243		1,172,310,94824	
217				901186		1,291,886,66496	
218				930024		1,423,659,10478	
219				959785		1,568,872,33347	
220				990498		1,728,897,31148	
221	$9,738,935	$9,738,935	$9,738,935	1022194	$9,955,082,680	1,905,244,83725	$523
222				1054904		2,099,579,81065	
223				1088661		2,313,736,95134	
224				1123498		2,549,738,12038	
225				1159450		2,809,811,40865	
226				1196553		3,096,412,17234	
227				1234843		3,412,246,21392	
228				1274358		3,760,295,32773	
229				1315137		4,143,845,45116	
230				1357221		4,566,517,68718	
231				1400652		5,032,302,49128	
232				1445473		5,545,597,34539	
233				1491728		6,111,248,27461	
234				1539464		6,734,595,59863	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
235				1588727		7,421,524,34968	
236				1639566		8,178,519,83335	
237				1692032		9,012,728,85635	
238				1746177		9,932,027,19970	
239				1802055		10,945,093,97407	
240				1859720		12,061,493,55943	
241	$9,738,935	$9,738,935	$9,738,935	1919231	$18,691,270,263	$13,291,765,90249	$141
242				1980647		14,647,526,02454	
243				2044028		16,141,573,67905	
244				2109436		17,788,014,19431	
245				2176938		19,602,391,64213	
246				2246600		21,601,835,58963	
247				2318492		23,805,222,81977	
248				2392683		26,233,355,54739	
249				2469249		28,909,157,81322	
250				2548265		31,857,891,91017	
251				2629810		35,107,396,88500	
252				2713964		38,688,351,36727	
253				2800810		42,634,563,20674	
254				2890436		46,983,288,65382	
255				2982930		51,775,584,09651	
256				3078384		57,056,693,67436	
257				3176892		62,876,476,42914	
258				3278553		69,289,877,02491	
259				3383467		76,357,444,48146	
260				3491738		84,145,903,81856	
261	$9,738,935	$9,738,935	$9,738,935	3603473	$35,093,991,210	92,728,786,00806	$038
262				3718784		102,187,122,18088	
263				3837785		112,610,208,64333	
264				3960595		124,096,449,92495	
265				4087334		136,754,287,81729	
266				4218128		150,703,225,17466	
267				4353108		166,074,954,14247	
268				4492408		183,014,599,46501	
269				4636165		201,682,088,61044	
270				4784522		222,253,661,64870	
271				4937627		244,923,535,13687	
272				5095631		269,905,735,72083	
273				5258691		297,436,120,76435	
274				5426969		327,774,605,08232	
275				5600632		361,207,614,80071	
276				5779852		398,050,791,51039	
277				5964808		438,651,972,24445	
278				6155682		483,394,473,41338	
279				6352663		532,700,709,70154	
280				6555949		587,036,182,09110	
281	$9,738,935	$9,738,935	$9,738,935	6765739	$65,891,092,563	646,913,872,66439	$010
282				6982243		712,899,087,67616	
283				7205674		785,614,794,61913	
284				7436256		865,747,503,67028	

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs	7%	1102	
Inflation Rate % (DOE) for 300 Yrs	32%	1032	13,325,126

Yr of O & M		Total	Cash Flow in 1997 $	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs							
285				7674216		954,053,749,04465	
286				7919791		1,051,367,231,44720	
287				8173224		1,158,606,689,05482	
288				8434768		1,276,784,571,33841	
289				8704680		1,407,016,597,61493	
290				8983230		1,550,532,290,57165	
291				9270693		1,708,686,584,20996	
292				9567356		1,882,972,615,79938	
293				9873511		2,075,035,822,61091	
294				10189463		2,286,689,476,51723	
295				10515526		2,519,931,803,12198	
296				10852023		2,776,964,847,04043	
297				11199288		3,060,215,261,43855	
298				11557665		3,372,357,218,10528	
299				11927510		3,716,337,654,35202	
300				12309190		4,095,404,095,09593	
Total	$146,084,025	$146,084,025	$146,084,025		$140,964,380,098		$13,325,126

1

Table G1.13. Rivershore Site Modified CRCIA Ranger/Industrial Scenario Remove/Dispose Summary

Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Field Distribs 26.00%	Home Office 3.00%	S/C Fee 4.00%	B&O Tax 0.47%	**Total Bid $**
Grout Wells	$-	$66	$450	$-	$516	$134	$19	$27	$3	$699
Excavate Site	$93,772	$80,955	$249,486	$533,273	$957,486	$248,946	$36,193	$49,705	$6,074	$1,298,404
Restore Site	$175,411	$266,706	$98,275	$42,830	$583,222	$151,638	$22,046	$30,276	$3,700	$790,881
Support Facilities	$-	$-	$-	$133,920	$133,920	$34,819	$5,062	$6,952	$850	$181,603
Mobilization/ Demobilization	$29,914	$4,502	$136,783	$-	$171,199	$44,512	$6,471	$8,887	$1,086	$232,155
Subtotals:	$299,097	$352,230	$484,993	$710,022	$1,846,342	$480,049	$69,792	$95,847	$11,713	$2,503,743

Bond		$24,626
Total Subcontractor Cost	Subtotal:	$2,528,369
PM/CM @ 15%		$379,255
	Subtotal:	$2,907,624
Haul to ERDF& Disposal		$3,007,900
	Subtotal:	$5,915,524
	Direct distribs @ 18.09%	$1,070,118
	G&A @ 4.04%	$282,220
	TOTAL:	$7,267,862
	Contingency @ 34%	$2,471,073
	TOTAL:	**$9,738,935**

Assumptions:
All excavation will take place above the water table.
Backfill material consists of clean natural fill material from the 100 BC Area.
Riprap material above the waterline is placed with a backhoe.
Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.
Existing wells will be grouted closed.
Two new monitoring wells will be established through the clean cover material.
Contractor markups are taken from the 300 FF FPE.
PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

Table G1.14. Rivershore Site Residential Scenario Remove/Dispose Net Present Value

Calculation of Net Present Value annually escalated at 3.2 % per year and discounted at 10 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % is published by DOE and is an average for 300 years, and the 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

The cash flow is made up of the following:

100-NR1 & 100-NR2 CMS RIVER SHORE SITE, RESIDENTIAL SCENARIO: REMOVE/DISPOSE ALTERNATIVE WORK MUST BE REPEATED EVERY 20 YEARS

	Rate	Compounding Value	Total Net Present Worth
Discount Rate % (EPA) for 300 Yrs.	7%	1.102	14,821,449
Inflation Rate % (DOE) for 300 Yrs.	3.2%	1.032	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
1	10,832,553	10,832,553	10,832,553	1.000	10,832,553	1.00	10,832,553.00
2			-	1.032	-	1.10	
3			-	1.065	-	1.21	
4			-	1.099	-	1.34	
5			-	1.134	-	1.47	
6			-	1.171	-	1.63	
7			-	1.208	-	1.79	
8			-	1.247	-	1.97	
9			-	1.287	-	2.17	
10			-	1.328	-	2.40	
11			-	1.370	-	2.64	
12			-	1.414	-	2.91	
13			-	1.459	-	3.21	
14			-	1.506	-	3.53	
15			-	1.554	-	3.90	
16			-	1.604	-	4.29	
17			-	1.655	-	4.73	
18			-	1.708	-	5.21	
19			-	1.763	-	5.74	
20			-	1.819	-	6.33	
21	10,832,553	10,832,553	10,832,553	1.878	20,338,774	6.98	2,915,364.61
22			-	1.938	-	7.69	
23			-	2.000	-	8.47	
24			-	2.064	-	9.34	
25			-	2.130	-	10.29	
26			-	2.198	-	11.34	
27			-	2.268	-	12.49	
28			-	2.341	-	13.77	
29			-	2.416	-	15.17	
30			-	2.493	-	16.72	
31			-	2.573	-	18.43	
32			-	2.655	-	20.31	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
33			-	2.740	-	22.38	
34			-	2.828	-	24.66	
35			-	2.918	-	27.18	
36			-	3.012	-	29.95	
37			-	3.108	-	33.00	
38			-	3.207	-	36.37	
39			-	3.310	-	40.08	
40			-	3.416	-	44.17	
41	10,832,553	10,832,553	10,832,553	3.525	38,187,279	48.67	784,611.98
42			-	3.638	-	53.63	
43			-	3.754	-	59.11	
44			-	3.875	-	65.13	
45			-	3.999	-	71.78	
46			-	4.127	-	79.10	
47			-	4.259	-	87.17	
48			-	4.395	-	96.06	
49			-	4.536	-	105.86	
50			-	4.681	-	116.65	
51			-	4.830	-	128.55	
52			-	4.985	-	141.66	
53			-	5.145	-	156.11	
54			-	5.309	-	172.04	
55			-	5.479	-	189.59	
56			-	5.654	-	208.92	
57			-	5.835	-	230.23	
58			-	6.022	-	253.72	
59			-	6.215	-	279.60	
60			-	6.414	-	308.12	
61	10,832,553	10,832,553	10,832,553	6.619	71,698,928	339.54	211,162.59
62			-	6.831	-	374.18	
63			-	7.049	-	412.34	
64			-	7.275	-	454.40	
65			-	7.508	-	500.75	
66			-	7.748	-	551.83	
67			-	7.996	-	608.11	
68			-	8.252	-	670.14	
69			-	8.516	-	738.50	
70			-	8.788	-	813.82	
71			-	9.069	-	896.83	
72			-	9.360	-	988.31	
73			-	9.659	-	1,089.12	
74			-	9.968	-	1,200.21	
75			-	10.287	-	1,322.63	
76			-	10.616	-	1,457.54	
77			-	10.956	-	1,606.21	
78			-	11.307	-	1,770.04	
79			-	11.669	-	1,950.58	
80			-	12.042	-	2,149.54	
81	10,832,553	10,832,553	10,832,553	12.427	134,619,076	2,368.80	56,830.1
82			-	12.825	-	2,610.41	
83			-	13.235	-	2,876.67	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
84			-	13.659	-	3,170.10	
85			-	14.096	-	3,493.45	
86			-	14.547	-	3,849.78	
87			-	15.013	-	4,242.45	
88			-	15.493	-	4,675.18	
89			-	15.989	-	5,152.05	
90			-	16.500	-	5,677.56	
91			-	17.028	-	6,256.67	
92			-	17.573	-	6,894.85	
93			-	18.136	-	7,598.13	
94			-	18.716	-	8,373.14	
95			-	19.315	-	9,227.20	
96			-	19.933	-	10,168.37	
97			-	20.571	-	11,205.55	
98			-	21.229	-	12,348.51	
99			-	21.908	-	13,608.06	
100			-	22.609	-	14,996.08	
101	10,832,553	10,832,553	10,832,553	23.333	252,755,463	16,525.68	15,294.70
102			-	24.080	-	18,211.30	
103			-	24.850	-	20,068.86	
104			-	25.645	-	22,115.88	
105			-	26.466	-	24,371.70	
106			-	27.313	-	26,857.61	
107			-	28.187	-	29,597.09	
108			-	29.089	-	32,615.99	
109			-	30.020	-	35,942.82	
110			-	30.980	-	39,608.99	
111			-	31.972	-	43,649.11	
112			-	32.995	-	48,101.32	
113			-	34.051	-	53,007.65	
114			-	35.140	-	58,414.43	
115			-	36.265	-	64,372.71	
116			-	37.425	-	70,938.72	
117			-	38.623	-	78,174.47	
118			-	39.859	-	86,148.27	
119			-	41.134	-	94,935.39	
120			-	42.451	-	104,618.80	
121	10,832,553	10,832,553	10,832,553	43.809	474,563,680	115,289.92	4,116.26
122			-	45.211	-	127,049.49	-
123			-	46.658	-	140,008.54	
124			-	48.151	-	154,289.41	
125			-	49.692	-	170,026.93	
126			-	51.282	-	187,369.68	
127			-	52.923	-	206,481.39	
128			-	54.616	-	227,542.49	
129			-	56.364	-	250,751.82	
130			-	58.168	-	276,328.51	
131			-	60.029	-	304,514.02	
132			-	61.950	-	335,574.45	
133			-	63.932	-	369,803.04	
134			-	65.978	-	407,522.95	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
135			-	68.089	-	449,090.29	
136			-	70.268	-	494,897.50	
137			-	72.517	-	545,377.04	
138			-	74.837	-	601,005.50	
139			-	77.232	-	662,308.06	
140			-	79.704	-	729,863.49	
141	10,832,553	10,832,553	10,832,553	82.254	891,022,033	804,309.56	1,107.81
142			-	84.886	-	886,349.14	
143			-	87.603	-	976,756.75	
144			-	90.406	-	1,076,385.94	
145			-	93.299	-	1,186,177.30	
146			-	96.284	-	1,307,167.39	
147			-	99.366	-	1,440,498.46	
148			-	102.545	-	1,587,429.31	
149			-	105.827	-	1,749,347.10	
150			-	109.213	-	1,927,780.50	
151			-	112.708	-	2,124,414.11	
152			-	116.315	-	2,341,104.35	
153			-	120.037	-	2,579,896.99	
154			-	123.878	-	2,843,046.49	
155			-	127.842	-	3,133,037.23	
156			-	131.933	-	3,452,607.03	
157			-	136.155	-	3,804,772.94	
158			-	140.512	-	4,192,859.78	
159			-	145.008	-	4,620,531.48	
160			-	149.648	-	5,091,825.69	
161	10,832,553	10,832,553	10,832,553	154.437	1,672,947,796	5,611,191.91	298.14
162			-	159.379	-	6,183,533.49	
163			-	164.479	-	6,814,253.90	
164			-	169.743	-	7,509,307.80	
165			-	175.174	-	8,275,257.20	
166			-	180.780	-	9,119,333.43	
167			-	186.565	-	10,049,505.44	
168			-	192.535	-	11,074,554.99	
169			-	198.696	-	12,204,159.60	
170			-	205.054	-	13,448,983.88	
171			-	211.616	-	14,820,780.24	
172			-	218.388	-	16,332,499.82	
173			-	225.376	-	17,998,414.81	
174			-	232.588	-	19,834,253.12	
175			-	240.031	-	21,857,346.93	
176			-	247.712	-	24,086,796.32	
177			-	255.639	-	26,543,649.55	
178			-	263.819	-	29,251,101.80	
179			-	272.261	-	32,234,714.18	
180			-	280.974	-	35,522,655.03	
181	10,832,553	10,832,553	10,832,553	289.965	3,141,060,743	39,145,965.84	80.24
182			-	299.244	-	43,138,854.36	
183			-	308.820	-	47,539,017.51	
184			-	318.702	-	52,387,997.29	
185			-	328.900	-	57,731,573.01	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
186			-	339.425	-	63,620,193.46	
187			-	350.287	-	70,109,453.20	
188			-	361.496	-	77,260,617.42	
189			-	373.064	-	85,141,200.40	
190			-	385.002	-	93,825,602.84	
191			-	397.322	-	103,395,814.33	
192			-	410.036	-	113,942,187.39	
193			-	423.157	-	125,564,290.50	
194			-	436.698	-	138,371,848.14	
195			-	450.673	-	152,485,776.64	
196			-	465.094	-	168,039,325.86	
197			-	479.977	-	185,179,337.10	
198			-	495.337	-	204,067,629.49	
199			-	511.187	-	224,882,527.69	
200			-	527.545	-	247,820,545.52	
201	10,832,553	10,832,553	10,832,553	544.427	5,897,531,657	273,098,241.16	21.59
202			-	561.848	-	300,954,261.76	
203			-	579.828	-	331,651,596.46	
204			-	598.382	-	365,480,059.30	
205			-	617.530	-	402,759,025.34	
206			-	637.291	-	443,840,445.93	
207			-	657.685	-	489,112,171.41	
208			-	678.730	-	539,001,612.90	
209			-	700.450	-	593,979,777.41	
210			-	722.864	-	654,565,714.71	
211			-	745.996	-	721,331,417.61	
212			-	769.868	-	794,907,222.21	
213			-	794.504	-	875,987,758.87	
214			-	819.928	-	965,338,510.28	
215			-	846.165	-	1,063,803,038.33	
216			-	873.243	-	1,172,310,948.24	
217			-	901.186	-	1,291,886,664.96	
218			-	930.024	-	1,423,659,104.78	
219			-	959.785	-	1,568,872,333.47	
220			-	990.498	-	1,728,897,311.48	
221	10,832,553	10,832,553	10,832,553	1022.194	11,072,972,635	1,905,244,837.25	5.81
222			-	1054.904	-	2,099,579,810.65	
223			-	1088.661	-	2,313,736,951.34	
224			-	1123.498	-	2,549,738,120.38	
225			-	1159.450	-	2,809,811,408.65	
226			-	1196.553	-	3,096,412,172.34	
227			-	1234.843	-	3,412,246,213.92	
228			-	1274.358	-	3,760,295,327.73	
229			-	1315.137	-	4,143,845,451.16	
230			-	1357.221	-	4,566,517,687.18	
231			-	1400.652	-	5,032,302,491.28	
232			-	1445.473	-	5,545,597,345.39	
233			-	1491.728	-	6,111,248,274.61	
234			-	1539.464	-	6,734,595,598.63	
235			-	1588.727	-	7,421,524,349.68	
236			-	1639.566	-	8,178,519,833.35	

Yr of O&M		Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
Startup Capital Costs			-				
237			-	1692.032	-	9,012,728,856.35	
238			-	1746.177	-	9,932,027,199.70	
239			-	1802.055	-	10,945,093,974.07	
240			-	1859.720	-	12,061,493,559.43	
241	10,832,553	10,832,553	10,832,553	1919.231	20,790,176,315	13,291,765,902.49	1.56
242			-	1980.647	-	14,647,526,024.54	
243			-	2044.028	-	16,141,573,679.05	
244			-	2109.436	-	17,788,014,194.31	
245			-	2176.938	-	19,602,391,642.13	
246			-	2246.600	-	21,601,835,589.63	
247			-	2318.492	-	23,805,222,819.77	
248			-	2392.683	-	26,233,355,547.39	
249			-	2469.249	-	28,909,157,813.22	
250			-	2548.265	-	31,857,891,910.17	
251			-	2629.810	-	35,107,396,885.00	
252			-	2713.964	-	38,688,351,367.27	
253			-	2800.810	-	42,634,563,206.74	
254			-	2890.436	-	46,983,288,653.82	
255			-	2982.930	-	51,775,584,096.51	
256			-	3078.384	-	57,056,693,674.36	
257			-	3176.892	-	62,876,476,429.14	
258			-	3278.553	-	69,289,877,024.91	
259			-	3383.467	-	76,357,444,481.46	
260			-	3491.738	-	84,145,903,818.56	
261	10,832,553	10,832,553	10,832,553	3603.473	39,034,814,357	92,728,786,008.06	0.42
262			-	3718.784	-	102,187,122,180.88	
263			-	3837.785	-	112,610,208,643.33	
264			-	3960.595	-	124,096,449,924.95	
265			-	4087.334	-	136,754,287,817.29	
266			-	4218.128	-	150,703,225,174.66	
267			-	4353.108	-	166,074,954,142.47	
268			-	4492.408	-	183,014,599,465.01	
269			-	4636.165	-	201,682,088,610.44	
270			-	4784.522	-	222,253,661,648.70	
271			-	4937.627	-	244,923,535,136.87	
272			-	5095.631	-	269,905,735,720.83	
273			-	5258.691	-	297,436,120,764.35	
274			-	5426.969	-	327,774,605,082.32	
275			-	5600.632	-	361,207,614,800.71	
276			-	5779.852	-	398,050,791,510.39	
277			-	5964.808	-	438,651,972,244.45	
278			-	6155.682	-	483,394,473,413.38	
279			-	6352.663	-	532,700,709,701.54	
280			-	6555.949	-	587,036,182,091.10	
281	10,832,553	10,832,553	10,832,553	6765.739	73,290,226,540	646,913,872,664.39	0.11
282			-	6982.243	-	712,899,087,676.16	
283			-	7205.674	-	785,614,794,619.13	
284			-	7436.256	-	865,747,503,670.28	
285			-	7674.216	-	954,053,749,044.65	
286			-	7919.791	-	1,051,367,231,447.20	
287			-	8173.224	-	1,158,606,689,054.82	

Yr of O&M	Startup Capital Costs	Total	Cash Flow In 1997	Compounded Escalation Factor	Compounded Escalated Costs	Compounded @ Discount Rate Factor	Net Present Discounted Worth
288			-				
289			-	8434.768	-	1,276,784,571,338.41	
290			-	8704.680	-	1,407,016,597,614.93	
291			-	8983.230	-	1,550,532,290,571.65	
292			-	9270.693	-	1,708,686,584,209.96	
293			-	9567.356	-	1,882,972,615,799.38	
294			-	9873.511	-	2,075,035,822,610.91	
295			-	10189.463	-	2,286,689,476,517.23	
296			-	10515.526	-	2,519,931,803,121.98	
297			-	10852.023	-	2,776,964,847,040.43	
298			-	11199.288	-	3,060,215,261,438.55	
299			-	11557.665	-	3,372,357,218,105.28	
300			-	11927.510	-	3,716,337,654,352.02	
Total	$162,488,295	$162,488,295	$162,488,295 -	12309.190	-	4,095,404,095,095.93	
1					$156,793,747,830		$14,821,449

Table G1.15. Rivershore Site Modified CRCIA Ranger/Industrial Cover Scenario Summary

Item Description	Equipment	Materials	Labor	S/C	Subtotal Direct	Field Distribs 2600%	Home Office 300%	S/C Fee 400%	B&O Tax 047%	Total Bid
Grout Wells		590	899		1,489	387	56	77	9	2,019
Cover Construction	302,281	1,406,262	198,824	351,442	2,258,808	587,290	85,383	117,259	14,329	3,063,070
Support Facilities				45,036	45,036	11,709	1,702	2,338	286	61,071
Mobilization/ Demobilization	24,198	4,323	133,742		162,263	42,188	6,134	8,423	1,029	220,038
Subtotals:	326,479	1,411,174	333,466	396,478	2,467,596	641,575	93,275	128,098	15,654	3,346,198

Bond		30,439
	SUBTOTAL:	3,376,637
PM/CM @ 15%		506,496
	SUBTOTAL:	3,883,132

Assumptions:

Cover material consists of clean natural fill material from the 100 BC Area.

Riprap materials below the water line are placed from a barge in the river.

Riprap material above the waterline is placed with a backhoe.

Rip-rap material was assumed to include 4 feet of +2ft material resting on 2 feet of 12 " minus material.

Existing wells will be grouted closed.

Two new monitoring wells will be established through the clean cover material.

Contractor markups are taken from the 300 FF FPE.

PM/CM was included as 15% of the project direct costs to be comparable to the other estimates in the CMS.

Direct distribs @ 18.09%	$702,459
G&A @ 4.04%	$ 185,258
TOTAL:	$4,770,849
Contingency @ 34%	$1,622,089
TOTAL:	**$6,392,937**

G1.2 Attachment 1, MCACES Summary Report for the UPR-100-N-1 Site

100-N Area CMS MCACES Estimating Models Notes, Qualifications, & Assumptions, May 8, 1997

The Corrective Measures Study (CMS) used three of the generic MCACESERC baseline estimating models, including the Trench model, the Crib/French Drain model, and the Modified RCRA 'C' Barrier model. The generic models are described in the attachment.

The CMS includes 76 sites in the 100-N area. Sixteen of the 76 sites were covered by Five Modified RCRA 'C' Barriers (Caps). Differences between the CMS model estimates and the generic model estimates are as follows:

- Contingency of 34% was included in the CMS estimates.
- The HAMTC rates in the CMS estimates were updated to reflect the IOM entitled, *FY96 ERC All-in wage rates for BHI, THI, HAMTC, Building Trades by resource Code, and Field Support Heavy Equipment Pool Rates*, dated October 18, 1996 (CCN#038622).
- RA Production rates in the CMS estimates for soil excavation are about 93% of the rates in the RA baseline models, which were updated after the CMS runs were completed.
- The ERC adders in the CMS estimate are 14.06% (DD) and 5.34% (G&A) as opposed to the 1997 adders, which are 18.09% (DD) and 4.04% (G&A). The DD and G&A rates were updated after the CMS runs.
- PM/CM cost in the CMS estimates was calculated by applying 15% to the project direct cost.
- Transportation and disposal costs are included in the CMS estimates based on ERDF experience.

G1.2.1 Extract from the RD/RA Baseline Cost Estimates Notes, Qualifications, &Assumptions 1997

EXHIBIT 6
MODEL ASSUMPTIONS

1.0 GENERAL

1.1 BACKGROUND

InJune1993,RLtaskedtheU.S.ArmyCorpsofEngineers,WallaWallaDistrictwiththepreparationofpre-conceptualbaselineestimatesforRD/RAforanumberofsolidwastemanagementunits(SWMUs)attheHanfordSite.ThepurposeoftheeffortwastoassisttheRichlandERProjectinbaselineplanningforFY94throughFY2000.TheFY95-97baselineeffortsbyBHIrepresentsacontinuedrefinementoftheRemedialActionEstimatingsysteminitiatedatthebeginningofFY94.Theestimatesareconsideredpreconceptual.SignificantRemedialActionworkbeganin1996andlessonslearnedwillreflectinthemodelsinmid1997.

1.2 METHODOLOGY

Ten(10)RAestimatingmodelswerecreatedbytheUSACEusingMCACESGoldfortheFY94Baseline.ThemodelswerebasedonthetypeofsiteandtheremediationapproachTheyreflecthowworkisperformedattheHanfordSiteintermsofdivisionofworkscopeperformedbyonsiteandoffsitecontractors,laborrates,andcontractormarkups.Six(6)modelswererevisedandusedfortheBL95andeight(8)forBL97.TheadditionaltwomodelsusedintheBL97werethesiteclosuremodelandtheModifiedRCRA C Barriermodel.(See2.11formodellist).

TheMCACESmodelsareusedtocreatebaselinecostestimatesforeachwastesiteorgroupofwastesitesrequiringremediation.SubprojectestimatesarethencreatedusingEXCELSpreadsheetstorolluptheMCACESsiteremedialactionmodelestimatesbyoperableunitandSubproject.

1.3 OPERABLEUNITANDWASTESITESUMMARY

A total of 1233 waste sites were estimated in the BL 97 using MCACES generic RA and Barrier models as per the *Richland Environmental Restoration Project Baseline, Volume 2: Fiscal Year 1997 Baseline Cost Summary.*

2.0 COSTESTIMATEDEVELOPMENT

2.1 COSTESTIMATEBREAKDOWNSTRUCTURE

MCACESGoldallowsuptosixlevelsoftitlinghierarchytoorganizecostestimatedetails.ThecostestimatebreakdownstructurewasdevelopedfromtheU.S.ArmyCorpsofEngineersHTRWWBSandmodifiedforremediationworkatHanford.Thefollowingisanexampleofthebreakdownstructureused:

Level 0:	*1.4.10.1.1.5.1.2.4*	*100-BC-1 Trench 116-B-1*
Level 1:	*08*	*Solids Collection & Containment*
Level 2:	*08.01*	*Excavation*
Level 3:	*08.01.03*	*Contaminated Soil*
Level 4:	*08.01.03.01*	*Excavate/Load Contaminated Soil*
Level 5:		*Cost Details*
Level 6:		*not used and available*

2.2 CONTRACTORMARKUPS

Contractor markups were included for work performed by subcontractors to BHI. The models calculate Program Management and Construction Management by multiplying FTE's per functional group times the project duration. The ERC adders are then applied to total direct costs in the model.

2.3 SALESTAX

A8.0%WashingtonStatesalestaxisappliedtoallmaterials.

2.4 CONTINGENCY

The models include a contingency calculation. A more refined calculation maybe used in the baseline.

The FY 97 baseline contingency analysis was performed by project area. The analysis resulted in contingency rates of 15.7% for the 100 area, 30% for the 200 area, and 15.6% for the 300 area. These rates were applied to the BL 97 estimates outside of the MCACES models.

2.5 PRICELEVEL

The pricing level used in the MCACES models is:

Labor-ERC Labor Rate *BHFY96-HanfordAll-inWageRate1995.*

Equipment-*BHI-93EE, Eq. Rates EP-1110-1-8, Aug.1993*

2.7 ESCALATION

Escalation is applied outside of the MCACES models.

2.8 LABORRATES

ALaborRatedatabasewascreatedforallclassificationstobeusedontheHanfordERCProject.Theratesreflectthe ERCaveragewageratesissuedonDecember20,1996(CCN#040990).Thedatabaseincludesthelaborresourcecategoriesandorganizationalcodes,andreflectspayrolladditivesandanaverageof4%overtime.BHI sdirectdistributableandgeneralindirectcostsareappliedatthebottomlineinthemodels.Thebaselinedatabaserecomputesthesecostsusingcurrentapprovedrates.

2.9 EQUIPMENT

EquipmentpricingdataisbasedonanextractfromthelatestUSACEequipmentpricebook(EP1110-8,Aug93)whichisthebasisfortheMCACESVersion5.30equipmentratedatabase.Theratesareequivalenttoanownershiprate,andincludedepreciation,maintenance,fuel,andrepairs.Theserateswerejudgedadequateforpresentdaycosts.

2.10 CREWS

The MCACES crew database, although available, was not used in these MCACES models.

2.11 LIST OF MODELS

The following estimating models were developed based on type of waste site, size, and remediation approach:

1. Burial Ground (Small, Medium to Large)
2. Crib/French drain(Small, Medium, & Large)
3. Trench (Small, Medium, & Large)
4. Septic Tank
5. Below grade structure (Small & Medium)
6. Reactor Area Piping (Large)
7. Retention Basin (Large)
8. Site Closure (Created in 1996)
9. Modified RCRA 'C' Barrier (Createdin1996from1995crewupestimates)

A model size categories area follows.

Small-<or=4,356SF Medium-4,357SFto87, 120SF Large->87,120SF

Separate models for each size were developed in 1996 to accommodate different productivity rates, crew sizes, and equipment types.

2.12 SUMMARY OF MODEL INPUT PARAMETERS

Majorcostdriversor"parameters"formthebasisforeachmodel.Themajorquantityinputsnecessarytosupportthe parametercalculationsareasfollows:

A. EXCAVATIONMODELS:
   1. Length, width, and depth of waste site in linear feet (lf)
   2. Noncontaminated, contaminated, and demolition waste volume in bank cubic feet (bcf)
   3. Percent of Transition Soil

B. Modified RCRA 'C' Barrier Model:
   1. Barrier surface area in square feet.

3.0 NOTES AND ASSUMPTIONS

3.1 EXCAVATION MODELS

1. Remediation technology is excavation and disposal.
2. The model calculations include excavation, sampling, monitoring of the excavation, backfill, and site restoration.
3. All contaminated material was assumed to below level waste (LLW).
4. LLW samples were taken every 200L CY excavated for field monitoring and every 1,078 SF of bottom area for closure samples.
5. All LLW samples will be analyzed on site; an additional 5% for QA/QC samples will be analyzed offsite.
6. Material will be loaded into 20 cubic yard (cy) containers. Containers will be filled to approximately 15 LCY due to load restrictions on the total combined weight of the tractor, trailer, and filled container on the highways (40tons).
7. ThetransportanddisposalratepercubicyardwascalculatedbytheERDFSubprojectbasedonactualERDFcos ts.ThesecostsarenotappliedintheMCACESmodels.
8. Appropriate contractor markups were added in the MCACES models.

9. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
10. Key estimate planning quantities and notes are included under each title level with in each estimate.

3.2 RCRA 'C' Barrier Models

1. Remediationtechnologyistocoverthecontaminatedareawithasoilbarrierapprovedunder RCRAguidelines.
2. Appropriate contractor markups were added in the MCACES models.
3. Estimates include QA/Safety and Health Physics (HP) oversight by the ERC team.
4. Key estimate planning quantities and notes are included under a title level with in each estimate.

4.0 MCACES MODEL DETAILS

TheMCACESmodelsforexcavationtake11inputquantitiesandcalculate25additionalquantities,whichareused topriceallresourcesrequiredtosetup,sample,excavate,andrestoreeachwastesite.Theseestimatesaregroupedon thebaselinespreadsheetsintooperableunitsforeachSubprojectwherecontingencyisapplied.TheMCACESmod elsestimatetotalbasecost,plussubcontractoraddersandBHImarkupsandcomputedintheACCESSBaselineDat abase.

The basic input parameters include the following:

1. Noncontaminated Soil Volume in bcf
2. Contaminated Soil in bcf
3. Demolition Waste in bcf
4. Top Excavation Length in lf
5. Top Excavation Width in lf
6. Bottom Area in sf
7. Number of Groundwater Protection Samples (Small sites <10,000 sf-3 ea.; Medium sites 10,000 to 100,000 sf-21 ea.; and Large sites>100,000-60ea.)
8. Transition Zone Soil percentage
9. Hauling distance for Borrow in miles
10. Hauling distance for demolition waste in miles (not used)
11. Hauling distance for contaminated soil in miles (not used)

The models also include the following fixed values, which are used to calculate and/or convert additional quantities, and resource requirements (labor and equipment types and hours).

<u>RA Models</u>

1. Soils well factor-15%
2. Demolition wastes well factor - 60%
3. <u>Noncontaminated soil</u> excavation <u>rate</u>
   Small-56LCY/Hr (with exception of Burial Ground, which is 77 LCY/Hr)
   Medium-112LCY/Hr (with exception of Burial Ground, which is 154 LCY/Hr for Medium To Large)
   Large-224 LCY/Hr
4. <u>Transition soil</u> excavation <u>rate</u>
   Small-28LCY/Hr (withexceptionofBurialGroundwhichis30LCY/Hr)
   Medium-56LCY/Hr (withexceptionofBurialGroundwhichis60LCY/HrforMediumToLarge)
   Large-112LCY/Hr
5. <u>Contaminated soil</u> excavation <u>rate</u>
   Small-37LCY/Hr (withexceptionofBurialGroundwhichis20LCY/Hr)
   Medium-70LCY/Hr (withexceptionofBurialGroundwhichis40LCY/HrforMediumToLarge)
   Large-140LCY/Hr

6. Demolitionwasteexcavationrate-12LCY/Hr(withexceptionof16LCY/HrfortheRetentionBasinmodel)
7. Sampleanalysiscostforon-sitemobilelab-400.00/Sample
8. Sampleanalysiscostforoff-sitelaboratory-2,000/Sample

RCRA'C'BarrierModel

1. Load/HaulSoils&OtherMaterials-120LCY/Hr
2. Place Asphalt
   (Base course)-65SY/Hr
   (Permeable Layer)-57.5LCY/Hr
3. Spread/CompactSoils-120LCY/Hr
4. Spread/CompactSand/Gravel-105LCY/Hr
5. PlacePerimeterBermBackfill-60LCY/Hr

Withtheseinputs,MCACESdetermineshowmuchofeachresourceisneededforeachoperationestimatedinthemodel.Theseresourcequantitiesarethenpricedaccordingtotheratetablesprovidedwith MCACES.Thesubcontractormarkupsonthelaborandmaterial,andtheOwnermarkupswereappliedwithinMCACESmodels.TheMCACESmodelsestimateallcostswiththeexceptionofescalationandcontingency.

G1.2.2 Attachment 3, Model Assumptions for RACER-Ex Situ Bioremediation

Land Farming (Ex Situ)

Ex situ bioremediation – 1 and farming, is a process for treating contaminated soil that requires excavation and movement to a treatment cell. The contaminated soil is spread in a thin layer over an area to enhance volatilization, aeration, -biodegradation, and photolysis. This model estimates costs to construct and operate a lined treatment cell and enhance the biodegradation process. The model provides options to stimulate growth of indigenous bacteria (biostimulation) or to cultivate and add bacteria to the site (bioaugmentation).

State and local regulations often impact the location, design, and operation of a land farming treatment cell. The model assumes that the cell is located on the same property as the contaminated soil and is enclosed by a berm and covered. The model also assumes that the soil will be tilled at least once a week.

The following topics are available for the Land Farming (Ex Situ) model:

TECHNICAL HELP
- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References

SYSTEM HELP
- Button Bar
- Model Processing

Required Parameters

Required parameters are the minimum amount of information required to generate a cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Total Volume of Soil Treated
- Volume of Soil Per Batch
- Number of Temporary Holding Areas
  - Temporary Holding Area Size
- Treatment Duration per Batch
- Safety Level

Total Volume of Soil Treated

This is the total ex situ volume (in loose cubic yards) of the contaminated soil to be treated. Bank or in situ soil swells approximate) 110% to 130% when excavated. Assuming a swell factor of 1.3 (130%), a one-acre area would be needed to land farm 2500 loose cubic yards (1900.bank cubic yards) of soil 18 inches deep.

For this reason, it may be more desirable to treat larger volumes of soil in a series of successive batches rather than construct a treatment bed large-enough to treat all of the soil at one time. The valid range is 100 to 99,999 loose cubic yards.

Volume of Soil per Batch

This is the ex situ volume (in loose cubic yards) of the contaminated soil that will be treated at one time. The volume of soil per batch determines the size of the treatment cell, setup parameters, amount of tilling, quantity of nutrients, and cell parameters applicable to the site. Therefore, the largest volume of soil to be treated at one time should be entered at this parameter. In most cases, the optimum volume of soil per batch is between 1,000 and 2,000 loose cubic yards. Larger volumes would require excessively large treatment beds. The model determines the number of batches by dividing the total volume of soil treated by the volume of soil per batch, and the model will not allow any combination of input, which causes the number of batches to exceed 90. The valid range is 100 to 10,000 loose cubic yards. The volume of soil per batch cannot be less than the total volume of contaminated soil.

The primary cost driver in an ex situ land farming application is the construction of the treatment bed. Therefore, treating soil in a series of successive batches rather than treating all of the soil at one time will reduce the overall cost of treatment. In determining the total volume the optimum volume of soil per batch, the user may wish to run several different scenarios and observe the costs for each scenario.

Number of Temporary Holding Areas

The scheduling and coordination of ex situ soil remediation projects often require the contaminated soil to be temporarily stockpiled adjacent to the treatment bed. Contaminated stockpiles should be placed in lined holding areas and covered with plastic. The number of temporary holding areas should correspond to the maximum number of stockpiles, which will be present at any one time. The temporary holding area in this model is lined with a 40-mil PVC liner and is surrounded by a 1.5-foot high berm to prevent surface water intrusion. For each holding area, the model includes one pump and one holding tank for collection and containment of accumulated rainwater or leachate. The valid range is 0 to 99 areas.

Temporary Holding Area Size - If the number of temporary holding areas is 1 or more, this parameter is used to specify the size of each holding area. The model assumes that all holding areas are the same size. Assuming a stockpile height of 8 feet and a soil angle of repose of 34 degrees will yield a conservative estimate for the holding area size required for a given volume of contaminated soil. The valid range is 100 to 999,999 square feet.

Treatment Duration per Batch

The treatment duration is the total time that each batch will be in the bioremediation cell. Treatment time can be estimated from information obtained in the bench and pilot studies. The duration is dependent upon the application rates of nutrients, moisture, pH, and microorganisms, as well as the specific contamination and concentration of the contaminant. Climate and soil type also significantly impact the treatment duration. Biodegradation occurs at much slower rates in colder climates. Also, soils having high clay contents require considerably longer treatment duration than sandy soils. The user should consider the climate and the soil type when determining the treatment duration. The amount of nutrients, moisture, pH, and cultured bacteria are important but can be controlled. Total treatment duration is determined by multiplying the treatment duration per batch by the number of batches. The duration for a single treatment is usually between 8 and 20 weeks; however, longer durations are not uncommon. The valid range is 1 to 104 weeks.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSHA, 29 CFR Part 1910. The four levels are designated as A, B, C, and D where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of-safety 1evels and associated requirements is 1ocated- in the On-Line Help for Safety Levels.

Secondary Parameters

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can be used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Treatment Cell
- Maintenance

Treatment Cell

The treatment cell parameters are listed and described below.

- Cell Area
- Depth of Contaminated Soil
- Sire of French Drain
- Containment Cover
- Sump Pump Capacity
- Sump Pump Quantity

Cell Area – The model defaults to a square treatment cell. The default surface area of the remediation cell will be calculated in square yards based on two factors: the volume of soil to be treated and the depth of soil placed in the remediation cell. The valid range is 1 to 193,600 square yards. It is important to note that this model uses ex situ or loose soil volume measurements. Quantity estimates based on bank (in situ) volumes must be converted to loose volume by multiplying by the appropriate swell factor.

Depth of Contaminated Soil in the Cell – The depth of contaminated soil in the biodegradation cell depends on the capability of the aerating plow, for this model 1 to 18 inches. The depth of the soil will affect the size of the containment cell, the equipment used, and possibly the duration. The default depth is 12 inches. The valid range is 1 to 18 inches. Note: A six-inch minimum soil depth is recommended. An 18 inch depth, if soil conditions allow, will minimize the required treatment cell area, which will reduce costs.

It-is important- to- note that the cell area and depth of contaminated soil are interrelated. If one of these parameters is changed, the model will automatically re-calculate the other based on the volume of soil per batch.

Size of French Drain – The model includes a French drain for leachate collection. The leachate flows (via gravity) to a low end of the benned area and is pumped from there. Leachate is pumped back onto the soil for continued remediation. Options for leachate holding tanks are available at the assembly level. Costs for leachate treatment and disposal are not included in this model. The default French drain size is 18' x 18'. At sites with predominate dry seasons, leachate collection systems may not be required, as evapotranspiration and periodic covering of the land farm will control excess saturation.

Options:

- 12' x 12"
- 18'x18'
- 24' x 24"
- None

Containment Cover – A containment cover is recommended and is required in some states. A cover forms a barrier over the cell area to limit moisture infiltration into and out of the contaminated soil. The default is to include a cover, with 135-pound tear strength, fiberglass reinforced plastic sheet being the default cover.

Sump Pump Capacity – The default sump pump is a 75 gpm installed sump pump. The model assumes that electrical service is available at the site: Portable, gasoline powered water pumps are also available.

Note: Provisions must be made to remove excess rainwater in the cell. For cost estimating purposes, the water truck used to sprinkle the soil can be used as a pumper truck to remove water to a treatment facility or holding tank.

Options:

- 75 gpm installed
- 100 gpm installed
- 6,000 gph portable gasoline powered
- 8;000 gph portable gasoline powered o 10,000 gpm portable gasoline powered

Sump Pump Quantity – This is the quantity of pumps required. The model defaults to one 75-gpm pump. This parameter may be set to zero if no pumps are required. The valid range is 0 to 99 pumps.

Maintenance

The maintenance parameters are listed and described below.

- Tilling Frequency
- Number of Passes Per Day
- Microorganisms
- Watering Frequency
- Fertilizing. Frequency

Tilling Frequency – The tilling frequency affects the amount of aeration. The- model assumes that a D3 dozer with a tiller will be used to till the soil. The default tilling frequency1st 44 days, per month, which equates to one day per week (days per-week, days per month/4.33; rounded up-to the nearest whole number). The-model assumes that the dozer wi11 remain on-site for-the entire project duration if the tilling frequency is greater than 2 days per week and the time required for each day of tilling is greater than 4 hours. Otherwise, the model assumes that the doter will be removed from the site at the conclusion of each day of tilling. The dozer is assumed to be decontaminated prior to leaving the site. The valid range is 0 to 7 days per week.

Number of Passes Per Day – This is the number of times during each day of tilling that the tiller will pass through the soil. The default is 2 passes per day. If the tilling frequency (number of days per month of tilling) is decreased, then the number of passes should be increased. The number of passes per day directly impacts the number of hours required for each day of tilling. The number of hours required for each day of tilling depends on the cell area, number of passes per day, and the tillage productivity of the dozer. The model defaults to a minimum of 4 hours of dozer rental for each day of tilling. This 4-hour minimum is assumed to account for equipment mobilization. The valid range is 1 to 10 passes per day.

Microorganisms – Bacteria may be cultured and added to the contaminated soil. Since addition of bacteria is not common in bioremediation, as enhancement of existing bacteria, the default is not to add microorganisms. If microorganisms are added, application rates are 50 pounds per 1,000 cubic yards initially and 25 pounds per 1,000 cubic yards on a monthly basis thereafter.

Watering Frequency - The watering frequency specifies the number of times per month that water is applied to the contaminated area to retain a consistent moisture content. Maintenance of soil moisture is vital during excessive dry periods, particularly at sites in low humidity areas. On the other hand, high humidity or excessive rainfall may reduce or eliminate the requirement for watering. The model assumes that the soil moisture content of new soil put into the remediation cell is less than 80%. If the soil becomes too wet, additional plowing to enhance evaporation may be required. Also, in climates where rainfall exceeds the evaporation rate, excessive watering will result in increased amounts of leachate requiring treatment and disposal. The default watering frequency is 4 times per month, which equates to once per week. The model assumes that a water truck will be used. However, a sprinkler system is available at the assembly level. The valid range is 0 to 99 times per month.

Fertilizing Frequency – Nutrients can be added with the water. The addition of nutrients for the microorganisms, primarily in the form of nitrogen and phosphorus, along with the oxygen from soil tilling, are critical to good growth. The nutrient mix will vary from site to site, with the optimum mix determined through pilot studies and geochemical evaluations of the site. However, a default has been determined based on actual field cases. The default is 0.5 pounds of 20:20:20 fertilizer per cubic yard of contaminant. The default fertilizing frequency is once per month. The valid range is 0 to 400 times per-month.

Date 11/04/96
Time 11:57

Page 1

PROJECT SUMMARY REPORT

10ON CMS
HANFORD
Pasco Washington WA
JA LAPIERRE / B BENNETT
11/04/96

Category	Amount
PA/SI	
Site Assessment	8
Studies	0
Remedial Design	0
RA Capital	22,166
Site Work	0
Sampling and Analysis	0
RA Professional Labor	0
Subcontractor Overhead & Profit	3,584
General Conditions	10,189
Studies/Professional Labor Overhead	0
Prime Contractor Home Office	0
Subtotal	$35,939
Prime Contractor	
Profit - (Fee) (0.00%)	0
RA Operations and Maintenance	0
0&M Service Contract	
Overhead, Tax & Profit	0
Subtotal	$35,939
Escalation	2,120
Total Contract Costs	$38,059
Contingencies (0.00%)	0
Project Management (0. 00%)	0
Total Project Costs	$38,059

********** END OF REPORT *********

This System Intended for Government Use Only

Date 11/04/96
Time 11:48

PROJECT SUMMARY REPORT

10ON CMS, RUN 2
Pasco Washington WA
JAL & BRB
11/04/96

Category		Amount
PA/SI		
Site Assessment		0
Studies		0
Remedial Design		0
RA Capital		24,199
Site Work		0
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		3,870
General Conditions		10,580
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		0
Subtotal		$38,649
Prime Contractor		
Profit - (Fee) (0.00%)		0
RA Operations and Maintenance		0
0&M Service Contract		
Overhead, Tax & Profit		0
Subtotal		$38,649
Escalation		2,280
Total Contract Costs		$40,929
Contingencies	(0.00%)	0
Project Management	(0. 00%)	0
Total Project Costs		$40,929

********** END OF REPORT *********

This System Intended For Government Use Only

Date 11/04/96

Time 12:06

PROJECT SUMMARY REPORT

100N, CMS RUN 3

RUN 3

Pasco Washington WA

JAL & BRB

11/04/96

Category		Amount
PA/SI		0
Site Assessment		0
Studies		0
Remedial Design		0
RA Capital		42,741
Site Work		0
Sampling and Analysis		0
RA Professional Labor		0
Subcontractor Overhead & Profit		6,552
General Conditions		15,042
Studies/Professional Labor Overhead		0
Prime Contractor Home Office		0
Subtotal		$64,335
Prime Contractor		0
Profit - (Fee)	(0.00%)	0
RA Operations and Maintenance		0
0&M Service Contract		
Overhead, Tax & Profit		0
Subtotal		$64,335
Escalation		3,796
Total Contract Costs		$
Contingencies	(0.00%)	0
Project Management	(0. 00%)	0
Total Project Costs		$68,131

********** END OF REPORT *********

This System Intended For Government Use Only

G1.3 Attachment 4, Model Assumptions for RACER-In Situ Bioremediation

In Situ Biodegradation (Bioventing)

Bioventing can be particularly effective for removing volatile contaminants muse they are highly susceptible to physical removal. Bioventing has been .developed and applied by the petroleum industry to remediate fuel-contaminated sites. This model assumes that the contaminants of concern are petroleum hydrocarbons.

One of the main advantages of aerobic biodegradation of petroleum hydrocarbon contaminants over other techniques is that the contaminants are completely destroyed, as the byproducts axe primarily carbon dioxide, water, and biomass. Biodegradation avoids generating hazardous byproducts and additional waste streams.

The following topics are available for the In Situ Biodegradation (Bioventing) model:

TECHNICAL HELP

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables
- Algorithms

SYSTEM HELP

- Button Bar
- Model Processing

General Information

Situ biodegradation involves microbial transformation of organic contaminants to affect cleanup of soils, groundwater, and/or other contaminated media. Biodegradation of organics in soil/groundwater systems is a natural process by which indigenous microorganisms obtain energy and/or carbon through the metabolism of organic contaminants. Various designations are used to describe essentially the same remediation technology:

- In Situ Biodegradation
- In Situ Bioremediation
- In Situ Bioreclamation
- Enhanced Bioreclamation
- Bioremediation or Biodegradation

All of these designations refer to processes where contaminants are degraded by in-place biological processes.

One means of performing in situ biodegradation is through soil venting. Soil venting, also called bioventing, is similar to soil vapor extraction (see the Soil Vapor Extraction model)' except that with bioventing, in situ biodegradation is stimulated intentionally. This process utilizes one or more vacuum extraction wells screened outside the contaminated zone to direct oxygen from the surface through the subsurface. Extracted air can be pulled directly through soil pores from the atmosphere or supplied by one or more injection wells. This procedure physically removes volatile organic compounds (VOCs) in the soil gas and establishes a contaminant gradient between the solid/liquid and gas phases, thereby allowing continuous removal as contaminants redistribute into the gas phase. Pulling air through the subsurface also provides oxygen that can be used as an electron acceptor in aerobic biodegradation of organics. This oxygen, in combination with moisture, nutrients, and possibly microorganisms supplied by either sprinkler systems or infiltration trenches/galleries, stimulates in situ biodegradation of organic Contaminants.

Bioventing can be used in saturated soil columns the groundwater table is lowered to expose more of the contaminated layer. Air injected into the subsurface is drawn through the contaminated zone to stimulate biodegradation and physically strip volatile contaminants. Water and nutrients are provided via infiltration.

Growth factors, which affect the rate of microbial degradation, include:

- Soil Moisture
- Oxygen Requirements
- Soil pH
- Soil Nutrients
- Soil Temperature

Soil Moisture

Moisture control may take the form of supplemental water to the site (irrigation), removal of excess water (drainage, well points), or other methods (e.g., soil additives). Also, the addition of vegetation to a site will increase vapotranspiration of water and, therefore, assists in retarding the downward migration of water (e.g., leaching). When natural precipitation is insufficient to maintain soil moisture within an optimal range for microbial activity, irrigation may be necessary. Water can be applied by standard irrigation methods (e.g., sub-irrigation or sprinkler irrigation) in the case of shallow contamination not exceeding 10 feet. In the case of deep soil contamination, injection wells may be installed for injection of water with or without nutrients and microbial culture. The ease of controlling moisture depends on how easily water is controlled at the site and on the availability of a suitable water source (e.g., transport distance, drilling of new wells, availability, and cost of energy for pumping). Controls to manage the run-on and runoff at the site are necessary to prevent drainage end erosion problems. Costs for erosion control and runoff can be modeled using the Site Work and Utilities module of the RACER System.

Oxygen Requirements

Aerobic degradation is the most attractive of the processes for microbial transformation of petroleum hydrocarbon contaminants because it proceeds at a more rapid rate and does not produce the noxious byproducts associated with anaerobic decomposition. For petroleum hydrocarbons, approximately 3.5 pounds of oxygen are required per pound of hydrocarbon. For bioventing, however. the critical factor is making sure that the vacuum wells are keeping the subsurface aerated. Passive injection vents allow a path for air to be pulled through the subsurface.

Soil pH

Depending on the nature of the hazardous waste components contaminating the soil, it may be advantageous to optimize the soil pH for a particular segment of the microbial community because both microbial structure and activity are affected by the soil pH. Near neutral pH values are most conducive to microbial functioning in general. with a range of 7.0 to 8.5 Considered acceptable. For this model, it will be assumed that the pH does not need adjusting.

Soil Nutrients

As in the case of all living organisms, indigenous microbial populations must have specific inorganic nutrients (e.g., nitrogen. phosphorus, potassium. calcium, magnesium. etc.) and a carbon and energy source to survive. The nutrients necessary to stimulate in situ biodegradation in the subsurface should be studied and defined in a pilot study. Carbon, nitrogen. and Phosphorus amendments to the soil can be added at variable rates depending on microorganism requirements. Standard agricultural methods are used-to add nutrients to the soil. Sufficient nitrogen and phosphorus must be reapplied to ensure that these nutrients do not limit the microbial and metabolic activity.

Soil Temperature

Soil temperature is one of the most important factors controlling microbiological activity and the rate of decomposition of organic contaminants. It also influences the rate of volatilization of compounds from the soil. Optimal growth of microbial populations responsible for biodearadation of petroleum products occurs between 20 and 35° C. Because-of the insulating properties of plant cover, vegetation plays a significant role in soil temperature. Bare soil unprotected from the sun's direct rays becomes very warm during the hottest part of the day; it also loses its heat rapidly during colder seasons. A well-vegetated soil does not become as warm as a bare soil during the summer, and the vegetation acts as an insulator to reduce heat loss from the soil in the winter.

Required Parameters

Required parameters are the minimum amount of information necessary to generate a cost estimate. There are no defaults as the parameter values are specific. A reasonable cost estimate can be generated using only the required parameters. The required parameters include:

- Installation
    - Average Depth to Top of Screen (Vertical Installation)
    - Trench Depth (Horizontal Installation)
    - Screen Length (Vertical and Horizontal Installation)
- Soil Type
- Area of Contaminated Soil
- VEPs
- Blowers
- Startup Period
- O&M Period
- Safety Level

Installation

Installation refers to the type of installation, either vertical or horizontal vapor extraction point (VEP) installation.

Options:

- Vertical
- Horizontal

If vertical installation is selected, the user must provide the average depth to the top of screen, which is used to cost drilling and construction materials. The valid range is 6 to 999 feet. If horizontal installation is selected, the user must provide the trench depth, which is used to cost trenching and construction materials. The valid range is 3 to 30 feet.

The user must also provide the screen length. In the vertical bioventing system, the screen length is designed to span the vertical extent of soil contamination. The total depth of the vertical bioventing well is the sum of the depth to the top of the screen and screen length. However. the total depth of vertical VEP may not exceed 999 feet. In the horizontal installation, the screen length is designed to remediate effectively the entire site. The screen length is based on the radius of influence of the vapor extraction well and area of contaminated soil. The valid range for horizontal screen length is 1 to 999 feet.

Soil Type

The soil properties greatly affect the design of the in situ bioremediation system. The primary controlling soil parameter is soil permeability. Permeability should be sufficient to permit adequate flow of air through the contaminated matrix. The radius of influence of applied vacuum at the vapor extraction point extends over a greater distance in soils with higher permeability. The soil permeability directly relates to the soil particle size. This model classifies soil types into four groups based on particle size. Table 1 shows the range of soil permeability for different soil types.

Options

- Silty Clay, Clay
- Mixed Sandy, Silty, Clayey Soils
- Primarily Sand
- Sand and Gravel

Area of Contaminated Soil

The area of contaminated soil is the appropriate areal extent of the contamination to be remediated by bioremediation. The valid range is 1 to 1,000,000 square feet. This roughly correlates to a rectangular impact zone of 23 acres or 1,000 ft x 1,000 ft. Typically, a site with an impact area as great as this would be addressed in stages or divided into smaller areas and addressed as independent cells. If this is the case. it is advisable to execute multiple runs of the model to account for each cell.

VEPs

The number of VPs are calculated based on the default well spacing, a secondary parameter, using the equations shown in Algorithm 1. The number of VEPS cannot be directly changed on this screen. However, they may be changed at the VEP Design parameters by changing the default VEP spacing or by directly changing the number of VEPs.

Blowers

Represents the default quantity of blowers, which is determined from the secondary parameter, total flow rate (Q). The quantity of blowers cannot be directly changed on this screen. However, the quantity and type of blowers may be changed by editing the VEP Design parameters.

Startup Period

The total treatment duration is divided into startup and O&M. The coats associated with the startup period (e.g.. equipment acquisition, installation and optimization) are considered capital costs, and the O&M costs are identified separately. This parameter may be used to identify the startup period (e.g., equipment procurement, installation, and optimization) or it may cover the entire treatment period. The unit of measure for the startup period is weeks'. The valid range for this model is 4 to 999 weeks.

O&M Period

The O&M period may be 0 to 999 months. (Reference Startup Period above) safety Level.

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSIDA in 29 CFR Part 1910. The four levels are designated as A. B, C, and D; where "A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

Reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, secondary parameters can be added to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameters are divided into the following four categories:

- VEP Design
- Drill Vertical*
- Trench Horizontal**
- Soil Additives

*These parameters are only available when the type of VEP installation is vertical

**These parameters are only available when the type of VEP installation is horizontal.

VEP Design

The parameters for the design of the bioventing extraction system include:

- VEP Spacing
- Number of VEPs
- Gas Flow Rate
- Total Flow Rate
- Quantity of Blowers
- Type of Blower

VEP Spacing - The design of vapor extraction systems depends primarily on the soil type. The model defaults quantities to the design parameters based on the required parameter. soil type. Since the radius of influence depends on the soil type, the VEPS spacing, number of VEPs, gas flow rate. and blower specifications also depend on the soil type, The model design parameters for different roil' types are based on data obtained from CAM RILL soil vapor extraction projects. Table 2 shows the default values for VEP spacing and gas flow rate.

In bioventing, the purpose of vapor extraction is not to cause volatilization of organic compounds, but merely to provide sufficient vacuum to cause the infiltration of ambient air (due to the development of a pressure gradient) into the subsurface soils to promote biorespiration. Therefore, it is not advisable to apply high vacuum at the vapor extraction well because it would cause volatilization of organic compounds, thus, requiring treatment of the extracted subsurface vapors.

Number of VEPs - The number of VEPS are calculated based on well spacing using the equations shown in Algorithm 1. The number of VEPS may be changed directly by the user, or they may be calculated based on the -VEP spacing.

Gas Flow Rate - The gas flow rate is used in the calculation for total flow rate (Q), which determines the default quantity of blowers. Q is calculated from the equation shown in Algorithm 2. The valid range is .01 to 99.99.

Total Flow Rate - The total flow rate, as calculated by the model, is displayed to provide the user with off-gas treatment quantities, which can be input into other models such as carbon adsorption - gas, etc. This field cannot be edited and is displayed for information purposes only.

Quantity of Blowers - The user may change the default quantity of blower6 directly, or have the modal calculate the quantity of blowers. Table 3 shows the model defaults for type of blower and quantity of blowers. The valid range is 1 to 99 blowers.

Note: Because the quantity of blowers is determined from the total flow rate, if the user changes the default VEP spacing (which determines the number of VEPs, also used in the calculation of total flow rate) or changes the gas flow rate (also used in the calculation of total flow rate) and wants to use the default quantity of blowers, the user must re-calculate by clicking the Calculate push button.

Type of Blowers - The user is given the option of the four blowers provided below. Table 3 shows the model defaults for type of blower and quantity of blowers.

Options

- 98 SCAM. I HP
- 127 SUM. 1.5 9P
- 160 SCPM. 2 HP
- 280 SC t. S HP

Drill Vertical

The parameters for drilling vertical VEPs are listed and described below.

- Diameter
- Construction Material
- Drilling Method
- Soil Sample Collection
- Drum Drill Cuttings

Diameter - The modal defaults to 2" diameter vertical VEPS. However, an option of 4" diameter vertical VEPs is al.50 available in the model. The VEP diameter affects the diameter of borehole and cost of construction material and drill cutting containment (drumming).

Options

- 2 inch
- 4 inch

Construction Material - Vertical VEPs are typically constructed of either PVC or stainless steel screen and casing. Primary selection considerations are cost and material compatibility with the contaminant.

Options

- PVC - Schedule 40
- PVC - Schedule 80
- Stainless Steel

The model defaults to Schedule 40 PVC for the construction of all vertical VEPS less than 85 feet deep. However, when the depth of the vertical VEPs is greater than 85 feet, the model defaults to Schedule 80 PVC material.

Drilling Method – The vertical VEPs can be installed using a variety of vertical drilling techniques, depending on site hydrogeology and desired depth of the borehole. The three vertical drilling techniques included in this model are:

- Hollow Stem Auger
- Water/Mud Rotary
- Air Rotary

The model defaults to hollow 6tem auger for 2-inch and 4-inch diameter vertical VEP installation when the well depth is less than 150 feet below ground surface (bgs). The water/mud rotary method is the model default for drilling when the VEP depth is greater than 150 feet bgs. Air rotary drilling is also available a6 an option. It is assumed that drilling is in an unconsolidated formation. If the subsurface is consolidated, then the user should use water/mud rotary or air rotary rather than hollow stem augers even for depths less than 150 feet bgs. Table 4 gives the diameter of borehole for the different drilling methods.

All connection piping is assumed to be aboveground installation. The Piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPS. The amount of manifold pipe will be defaulted at half the length of the connection piping, and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well. The connection and manifold pipe size defaults for vertical VEPs are shown in Table 5.

Soil Sample Collection - Sample collection during borehole advancement allows characterization of the geology beneath the site and definition of the magnitude and extent of contaminants in the vadose zone. According to the IRP Statement of Work 1991. Soil samples shall be collected every five feet or at each change in lithology, whichever is less for lithologic description. Drill cuttings can be collected as the borehole is advanced for general geologic information. Discrete samples are collected in unconsolidated sediment using a variety of methods including split spoon, Shelby tubes, and the California brass ring.

The model defaults to collection of soil samples with a split spoon sampler with standard penetration tests at five-foot intervals during borehole advancement. Samples are screened with an organic vapor analyzer (OVA) for volatile organics and described for the lithologic log by the geologist supervising drilling.

If laboratory analysis is desired, the user must decide how many soil samples and what type of analysis will be required. The user must then add these soil analyses to the Sampling and Analysis model.

Drum Drill cuttings - The drill cuttings are generally placed in 55-gallon drums and stored until disposal options have been evaluated. The model default is to include drill cuttings containment.

The professional labor hours spent in the field supervising the installation of the vertical VEPs are passed to the RA Professional Labor model. The model makes the following assumptions for staff hydrogeoiogist hours related to vertical VEP installation:

- If sample collection is included, VEPs are drilled at a rate of 20 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.
- If sample collection is not included, VEPs are drilled at a rate of 40 feet per hour, plus 2 hours per well for well completion. Total labor hours are for drilling supervision by a staff hydrogeologist.

Decontamination procedures for the VEPs screen, riser, and caps as well as decontamination of drilling tools (e.g., hollow stem augers) will be conducted prior to and between each borehole/well installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Decontamination procedures for split spoon samplers, bailers, and hand augers were also based on AFCEE requirements and consist of:

- Clean with tap water and detergent using a brush.
- Rinse thoroughly with tap water.
- Rinse with deionized water.
- Rinse twice with pesticide-grade isopropanol.
- Rinse with organic-free deionized water.
- Allow to air dry.

Monitoring wells art usually installed on the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Trench Horizontal

Horizontal installation involves excavating a narrow trench and installing a screened or perforated pipe at a common elevation. The model defaults to a horizontal installation method depending on the depth of installation. The model defaults to the use of chain trencher when the depth of installation is less than or equal to 4 feet. The crawler mounted, hydraulic excavator is defaulted when the depth of installation is greater than 4 feet but less than or equal to 20 feet. The Horizontal Dewatering Systems, Inc- (IWSI) proprietary method (Patent *4927292) will be defaulted for depths of installation between 21 and 30 feet. The model does not consider the need for cave-in protection when installing bioventing systems in trenches exceeding.l0 feet. Additional controls such as a trench box, well points, sheeting, or side sloping maybe required due to soil conditions. If this is the case, refer to the Site Work and Utilities models.

The HDSI proprietary method uses specialized equipment to drill a 14-inch wide hole to set a vertical PVC blank pipe. After drilling, the machine dig6 in either a forward or backward direction to create a horizontal VEP. As it digs, a high-density polyethylene (HDPE) perforated pipe is laid horizontally. The pipe is simultaneously covered with a filter pack and connected to the vertical PVC pipe.

Note that the trenching methods do not permit collection of discrete soil samples for laboratory analysis. Therefore, the soil sample collection option is not provided for horizontal VEPs installation.

All connection piping is assumed to be aboveground installation. The Piping model should be run if below ground piping is desired. The amount of connection piping defaulted is the radius of influence times the number of VEPs. The amount of manifold pipe will be defaulted at half the length of the connection piping and is the same material as the connection pipe. A pressure gauge and other piping appurtenances will be defaulted as well.

The model defaults to 2-inch and 4-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 2-inch diameter screen pipe is specified. The model defaults to 4-inch and +-inch diameter schedule 40 PVC connection and manifold pipe, respectively when a 4-inch diameter screen pipe is specified, and C-inch and 8-inch diameter schedule 40 PVC connection and manifold pipe. Respectively when a C-inch diameter screen pipe is specified.

The parameters for horizontal installation are listed and described below.

- VEP Diameter
- Contaminant of Trench Cutting

VEP Diameter - The model defaults to 2• diameter horizontal VEPs for depths of installation less than or equal to 10 feet. However, an option of 4" diameter horizontal VEPs is also available in the model.

When the installation depth is greater than 20 feet, the model defaults to installation of horizontal VEPs by the HDSI proprietary method; therefore, the construction materials cannot be edited. Per this construction method, a choice of 4-inch or C-inch diameter perforated HDFE horizontal pipe is available for installation. The model defaults to 4-inch diameter horizontal VEPS for depths of installation greater than 10 feet.

Containment of Trench Cutting - The trench cuttings can be placed in 55- gallon d---J= and stored until disposal options have been evaluated. If containment is included, this option will be coated. Otherwise, it is assumed that the waste soil is backfilled into the trench to be treated, along with the in situ contaminated soil. The model default is not to include containment of trench cuttings.

Another alternative that is not included in this model would be stockpiling tie waste soil at a location near the bioventing area.

The amount of waste soil to be drummed using the HDSI proprietary method is less than that drummed using conventional excavating equipment. This is due to the minimal disturbance of subsurface soil when using the WSI method.

The professional labor hours spent in the field supervising the installation of the horizontal VEPS are included with the VEP installation costs. The model makes the following assumptions for staff hydrogeologist hours related to horizontal VEP installation:

- 45 minutes for vertical blank PVC pipe installation of a staff hydrogeologist per VEP
- 1 minute per 2 feet of horizontal screen section, installation of a staff hydrogeologist per VEP
- 1.5 hours for loading, moving, and setting up on site.

Decontamination, procedures for the VEP screen, riser, and caps, as well as decontamination of trenching tools, will be conducted prior to and between each VEP installation. Procedures consist of steam cleaning with a high-pressure steam-generating pressure washer and detergent, in accordance with AFCEE requirements.

Monitoring wells are usually Installed= the periphery of the soil contaminant plume. Monitoring wells are not included in this model, but may be estimated by using the Monitoring model.

Soil Additives

The soil additives parameters are Listed and described below.

- Watering
- Nutrients
- Microorganisms

Watering – Moisture and nutrients will generally be delivered to the soil by one of the three methods: spray irrigation (sprinkler system), infiltration gallery, or injection wells. This model assumes that if the watering Qztion is selected, a sprinkler will be wed. The model default is to include watering. The Infiltration Gallery or Injection Wells models may be used to estimate costs for the other options.

Nutrients – The most basic bioremediation processes involve the addition of oxygen and appropriate nutrients, typically nitrogen and phosphorus. The optimum nutrient mix must be determined by laboratory growth studies and geochemical evaluations of the site: however, a default has been determined for a rough estimate of nutrients and quantities. If nutrients are selected, the default is a nitrogen/ phosphorus/potassium (20:20:20) pulverized fertilizer, at an application of Boo lbs/acre. The model default is to include nutrients.

Microorganisms – When naturally occurring microorganisms are few in number or are absent, or when rapid cleanup is desired, acclimated organic matter may be added to the soil to be treated. The acclimated organic matter supplies organisms capable of initiating the degradation process. For this model, it will be assumed that microorganisms will not be added to the subsurface. The applications for the microorganisms, if chosen, will be0.5 lb bioculture per gallon of water. The monthly application is estimated to be 25 lbs of bacteria per 1.000 cubic yards of waste. This corresponds to 200 gallons of water and bioculture per month per 1.000 cubic yards of contaminated soil.

G1.3.1 Attachment 5, Model Assumptions for RACER-In Situ Solidification

In Situ Solidification

Solidification/Stabilization (S/S) is a treatment technology in which chemical gents are mixed with waste to make use of complex chemical and physical actions to improve physical properties and reduce contaminant solubility, toxicity, and/or mobility. S/S is a viable treatment for contaminated materials when the constituents cannot be treated, recovered, or destroyed by other methods because of technical or economical limitations.

The In Situ model does not include excavation, transportation, or disposal of solidified material. Solidification of in-drum waste is not addressed with this model- This model assumes that the site is fully accessible by heavy equipment (e.g., 100-ton crane, large earth moving equipment. etc.). It is also assumed that the site has been properly characterized prior to use of the In Situ Solidification model.

The following topics are available for the In Situ Solidification model:

TECHNICAL HELP

- General Information
- Required Parameters
- Secondary Parameters
- Other Related Costs
- References
- Tables

SYSTEM HELP

- Button Bar
- Model Processing

To solidification, a reagent is added to transform a liquid, sludge, sediment, roil into a Solid form. Solidification may immobilize the contaminants .within the crystalline structure of the solidified material thus reducing the contaminant leaching potential: although this varies depending upon waste, soil, and reagent characteristics. In stabilization, a reagent is added to transform the material so that the hazardous constituents are in the least mobile or toxic form. Solidification is a physical treatment, whereas, stabilization is a chemical treatment. Compatibilities of common reagents with various waste components are shown in Table 1.

A bench-scale laboratory program is usually performed to determine the type and amount of the S/S reagent required to satisfy the regulatory treatment objectives.

S/S is generally most effective for inorganic compounds and radionuclides. Solidification/stabilization is generally effective on certain contaminants, or contaminant groups: volatile and non-volatile metals (with some exceptions, anionic complexes of metals such as chromium, selenium, arsenic, cyanides, strong acids, oxidizing agents, and reducing agents); other inorganics, polychlorinated biphenyls (PCBs), and radionuclides. Treatment of some semivolatile compounds has been documented using S/S, although treatment of volatile organic compounds (VOCs) is currently the focus of research and debate.

This technology can be performed using a variety of equipment. Several methods include: Open Pit/Trench/Area Mixing, in Situ/In Drum Mixing, and Ex Situ treatment in a mixing unit. The Open Pit/Trench/Area mixing method requires a reagent to be dumped on top of the waste and mixed with conventional earth saving and earth handling equipment. The in Situ/In Drum method requires a specialized or patented piece of equipment (usually a hollow stem auger or multiple auger rig) that injects and mixes reagent into the waste in place and can be used at depths up to 120 feet below grade. The ex situ method requires excavation, conveyance, or pumping of a contaminated medium into a mixing unit where a reagent is added. Treatment would be processed through a pugmill (mixing apparatus). The process modeled herein is the In Situ process using crane-mounted mixing augers. The Ex situ process may be estimated using the Solidification/Stabilization model.

In most instances, the solidified material can be left in place and capped. However, local and state regulations should be reviewed to evaluate provisions for in-place disposal of solidified material. In Situ S/S eliminates the higher costs and additional hazards associated with excavation, handling and transport of hazardous materials associated with On-Site treatment and/or off-site disposal. In cases where the solidified material cannot be left in place, disposal options should be evaluated prior to technology selection. If land filling is the disposal option of choice, then the effectiveness of the S/S technology to meet the requirements of the Land Disposal Restrictions (LDRs) under the Resource Conservation and Recovery Act (RCRA) should be evaluated prior to proceeding. If the waste contains PCBs, then the waste disposal is regulated by the Toxic Substance Control Act (TSCF). EPA guidelines recommend a minimum unconfined compressive strength 'TTCS) of 50 pounds per square inch (psi) for treated waste that is disposed in landfill with no free liquids phase. For in Situ applications, strength should be adequate to serve the anticipated future uses of the site.

The total cost for this remediation technology will vary depending upon the chemical and physical characteristics of the waste, the site characteristics, and the treatment requirements.

Required parameters are the minimum amount of information required to generate cost estimate. There are no defaults as the values are site-specific. A reasonable cost estimate can be generated from the required parameters. The required parameters include:

- Type of Waste
- Total Volume of Waste*
- Depth of Bore*
- Boring Surface Area*
- Soil Type
- Safety Level

* Note: The user must enter two of these three required parameters. The remaining value is then calculated by the two entered values. The entered values must not allow the calculated value to exceed its valid range.

Type of Waste

The selections for type of waste are solid or sludge. It is assumed that the sludge is pumpable. The type of waste will affect the S/S mix design. It is assumed in the model that the waste is suitable for the S/S process. Waste with high concentrations of organics and other miscellaneous materials (i.e., oil and grease, loess, peat, highly plastic clays) may inhibit the effectiveness of this technology.

Options

- Solid
- Sludge

Total Volume of Waste

The volume of the waste is specified in cubic yards. The volume will be converted to weight since ratios using weight comparisons are most commonly used. The valid range is 1 to 9,999,999 cubic yards. Sludges can be converted from gallons to cubic yards by multiplying the number of gallons by 0.005.

Depth of Bore

This parameter reflects the depth of the contaminated waste to be treated. The depth of waste to be solidified drives the size of the equipment used for treatment. The valid range is 1 to 120 feet.

Boring Surface Area

This is the surface area affected by the boring for the solidification/stabilization process. The boring surface area drives the number of borings required. The valid range is 1 to 9,999,999 square feet.

1 Type

The soil type will affect the size of the boring equipment.

Options

- Silty Clay, Clay

- Mixed Sandy, Silty, Clayey Soils
- Primarily Sand
- Sand & Gravel

Safety Level

The safety level will be affected by the contaminant(s) at the site. Safety level refers to those levels as required by OSHA in 29 CFR Part 1910. The four levels are designated as A, B, C, and D; where "'A" is the most protective and "D" is the least protective. A safety level of E is also included to simulate normal construction "no hazard" conditions as prescribed by the EPA. A complete description of safety levels and associated requirements is located in the On-Line Help for Safety Levels.

Secondary Parameters

The secondary parameters are listed and described below.

A reasonable cost estimate can be created using only the required parameters. However, if more detailed information is known, the secondary parameters can used to create a more precise and site-specific estimate. Secondary parameters, unlike the required parameters, have defaults that are determined by the model. The defaults are dictated by the engineering design and model assumptions. The secondary parameter sets are:

- Secondary
- Additives

Secondary

The secondary parameters are listed and described below.

- Initial Moisture Content
- Density of Waste
- Auger Diameter

Initial Moisture Content – The initial moisture content varies depending upon the waste medium. The moisture content will aid in determining the mix design for the waste and additives. The default moisture contents are shown in Table 2. The valid range for solid waste is 0 to 30%. For sludge waste, the valid range is 31 to 70%.

Density of Waste – The density of waste is specific to the waste medium and will be presented in pounds per cubic foot (pcf). This will provide information necessary to calculate the mix design and volume expansion encountered after the solidified waste has cured. The unit weight can be adjusted to the field conditions of the waste. The default waste densities are shown in Table 3. The-valid range for solid waste is 60 to 200 pcf. For sludge waste, the valid range is 40 to 200 pcf.

Auger Diameter – The auger diameter refers to the diameter of the boring bit. The auger diameter will default based on soil type and depth of boring. The auger diameter will determine the number of borings required.

Additives

The additives parameters are listed and described below.

- Chemical Additive Ratios
- Calculate Volume of Treated Waste

Chemical Additive Ratios – There are many chemical additives that can be used effectively in the S/S process. However, additive ratios axe highly waste specific and should be determined by beach and pilot testing. The chemical additive ratio defaults provided in this model are rudimentary and are provided only to obtain estimated chemical additive costs. A more precise estimate can be provided upon completion of beach and pilot testing.

This parameter group may include such chemicals as: water, proprietary chemical binders, Portland cement, fly ash, cement kiln dust, hydrated lime, asphalt, bitumen, polyolefins, epoxy, urea formaldehyde, activated carbon, modified Clay, pumice, blast furnace slag, polycrylares, and polyacrylamides. Mix ratios will be defaulted based on the required parameter input and standard S/S mix designs.

The default additives will include: water, proprietary chemical binder, fly ash, kiln dust, and Portland cement. The mix proportions will be weight based and contingent upon the initial moisture. Content and unit weight of the waste. Table 4 provides a list of the default weight of additive to waste ratios Table 5 provides a summary of specific gravity and weight for both chemical additives and waste streams. These defaults are estimated based on information obtained from the EPA SITE program, and conversations with consultants and vendors.

Calculate Volume of Treated Waste - This is a locked field that will display the amount of waste after treatment and curing has been completed. This is displayed for informational purposes only. In general the volume of the treated waste will increase based on the amount of chemical additive that has been added for treatment. This increase in volume will raise the ground surface of the site over the aerial' limits of the untreated waste if the treated material is left in place. The-site would require grading end capping based on its future use. If the treated material were to be disposed of in a landfill, the total volume of the treated waste would indicate the amount that is to be disposed of either in a Subtitle "C" (hazardous) or Subtitle "D" (non-hazardous) landfill depending upon the outcome of the Toxicity Characteristic Leaching Procedure (TCLP) analytical results. Groundwater monitoring adjacent to the solidified material may be required and should be estimated using the Monitoring model. Well installation can be estimated using the Groundwater Monitoring Wells model.

G2.0 COST ESTIMATES FOR GROUNDWATER ALTERNATIVES

Table G2.1. Total Costs – Alternative 2

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 2

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2% (7%plus 3.2%) per year for 300 years. The 3.2% annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7% Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

START-UP CAPITAL COSTS (IN 1997 DOLLARS) IS $63,358

NET PRESENT WORTH OF OPERATIONS & MAINTENANCE AND FUTURE CAPITAL

COSTS FOR 100-NR-2 CMS ALTERNATIVE # 2 IS $699,468

The cash flow is made up of the following:

1. Install Signs Along the River @ 5,076 every 20 Years. Start at year one.
2. Sample Sr-90 to River @ 5,687/yr. for 300 Yrs. Capital Well Replacement Costs of $48,557 every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15Yrs.
4. Sample Sr-90 in Aquifer @ 13,893/yr for 300 Yrs. Capital Well Replacement Costs of $291,408 every 20 Yrs.
5. Sample Other Contaminants @ $8,314/yr. for 100 Yrs. Capital Well Replacement Costs of $58,282 every 25 Yrs.

The total inosculated capital costs is $5,068,784

The total inosculated operating cost is $6,874,535

The average annual in osculated operating cost is $6,874,535/300 YRS. = 22,915

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

Table G2.2. Total Costs – Alternative 3

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 3

Calculation of Net Present Worth of a cash flow annually escalated at 3.2% and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $8,240,697

Net present worth of operations & maintenance and future capital costs for 100-NR-2 cms alternative #3 is $1,021,528

The cash flow is made up of the following:

1. Install Clino Wall at the River 1 st yr. @ 8,182,415. This is all Capital cost with no Yearly O&M.
2. SampleSr-90 to River at Clino Wall @ 19,389/Yr. for 300 Yrs. Capital Well Replacement Costs of $321,218 Every 20 Yrs.
3. Monitor Tritium to River $11,270/yr for 15 Yrs.
4. Sample Sr-90 in Aquifer @ $13,893/Yr. for 300 Yrs. Capital Well Replacement Costs of $291,408 Every 20 Yrs.
5. Sample Other Contaminants @ 8,314/yr for 100Yrs. Capital Replacement Well Costs of $58,282 Every 25 Yrs.

The total unescalated capital costs is $16,992,315

The total unescalated operating cost is $10,985,030

The average annual unescalated operating cost is $10,985,030 /300 yrs. = 36,617

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 300 years.

Table G2.3. Total Costs – Alternative 4

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 4

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $1,754,609

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative # 4 is $12,491,105

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 yrs.
2. Monitor Tritium to River $11,270/yr. for 15 Yrs.
3. Sample Sr-90 in Aquifer @ $30,923/Yr. for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ 7,046/yr for 270 Yrs. Capital Well Replacement Costs of $194,228 Every 50 Yrs.

The total unescalated capital costs is $38,160,277

The total unescalated operating cost is $193,282,168

The average annual unescalated operating cost is $193,282,168 /270yrs.= 715,860

The actual average yearly operating costs will vary since projects requiring O&M run for 15,100, & 270 years.

Table G2.4. Total Costs – Alternative 5

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 5

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 270years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 270 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $4,580,204

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #5 is $34,585,404

The cash flow is made up of the following:

1. Pump & Treat to 200 gpm, O&M @ $674,185/yr for 270 years. Plant & well construct & replacement @ $1,20&50yrs.
2. Maintain Tritium Hydraulic Control $12,175/yr. for 15 Yrs. Capital well costs $115,796 at day one.
3. Sample Sr-90 in Aquifer @ $30,923/yr for 270 Yrs. Capital Well Replacement Costs of $524,535 Every 20 Yrs.
4. Sample Other Contaminants @ $8,314/yr for 100 Yrs. Capital Well Replacement Costs of $58,282 Every 25 Yrs.
5. Monitor Water Levels @ $7,046/yr for 270 Yrs. C Capital Well Replacement Costs of $194,228 Every 50 Yrs.
6. Others Pump & Treat to 200 gpm, O&M @ $1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20 & 50 yrs. intervals

The total unescalated capital costs is $50,409,080

The total unescalated operating cost is $315,188,703

The average annual unescalated operating cost is $315,188,703 /270yrs. = $1,167,366

The actual average yearly operating costs will vary since projects requiring O&M run for $15,90,100, & 270 years.

Table G2.5. Total Costs – Alternative 6

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 6

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 300 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 300 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $20,389,389

Net present worth of operations & maintenance and future capital

Costs for 100-nr-2 cms alternative #6 is $36,269,137

The cash flow is made up of the following:

1. Pump & Treat to 135 gpm, O&M @ $589,180/yr for 270 years. Plant & well construct & replacement @ 1, 20, & 50 years.
2. Maintain Tritium Hydraulic Control 11,270/yr for 15 years.
3. Sample Sr-90 in Aquifer @ 21,580/yr for 270 years. Capital Well Replacement Costs of 349,630 Every 20 years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 Every 25 years.
5. Monitor Water Levels @ 7,046/yr for 270 years. Capital Well Replacement Costs of 194,228 Every 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Freeze Wall at the River. O&M 212,463/yr for 300 years. Capital Installation Costs 1st .year 16,463,096.

The total unescalated capital costs is $56,753,369

The total unescalated operating cost is $353,590,138

The average annual unescalated operating cost is $353,590,138/ 300yrs. = $1,178,634.

The actual average yearly operating costs will vary since projects requiring O&M run for 15, 90, 100, 270 & 300years.

Table G2.6 Total Costs – Alternative 7

NET PRESENT WORTH FOR 100-NR-2 CMS ALTERNATIVE 7

Calculation of Net Present Worth of a cash flow annually escalated at 3.2 % and annually discounted at 10.2 % (7 % plus 3.2 %) per year for 100 years. The 3.2 % annual escalation is published by DOE (ERC rates 12/20/96) and is assumed constant for 100 years. The 7 % Discount Rate was obtained from the EPA Hotline (800) 424-9346. The first year is not escalated or discounted.

Start-up capital costs (in 1997 dollars) is $22,416,808

Net present worth of operations & maintenance and future capital costs for 100-nr-2 cms alternative # 7 is $114,113,817

The cash flow is made up of the following:

1. Pump & Treat to 250 gpm, O&M @ 4,966,263/yr for 20years. Original Capital Cost $2,048,414
2. Maintain Tritium Hydraulic Control 2175/yr for 15 years. New Well Capital Costs $115,796
3. Sample Sr-90 in Aquifer @ 13,519/yr for 20years.
4. Sample Other Contaminants @ 8,314/yr for 100 years. Capital Well Replacement Costs of 58,282 every 25 years.
5. Monitor Water Levels @ 10,404/yr for 100 years. Capital Well Replacement Costs of $294,740 @ 50 years.
6. Others Pump & Treat to 200 gpm, O&M @ 1,356,033/yr for 90 years. Plant & well construct & replacement @ 1, 20, & 50 yrs. intervals
7. Install Soil Flushing. O&M 2,953,284/yr for 20 yr. Capital Installation Costs 1st. year $8,708,080.
8. Install Sheet Piling Wall Original Capital Cost $8,776,437. Remove in 20 years @1,077,752

The total unescalated capital costs is $32,309,602

The total unescalated operating cost is $283,686,469

The average annual unescalated operating cost is $283,686,469138/ 100yrs. = 2,836,864.

The actual average yearly operating costs will vary since projects requiring O&M run for 15,20,90,100, years.

G3.0 GROUNDWATER ALTERNATIVES DESCRIPTIONS 100-NR-1/100-NR-2 CMS

G3.1 Alternative 1: No Action

PHYSICAL FEATURES

None

NOTES

- National Contingency Plan requires evaluation of the No Action alternative
- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows

ASSOCIATED ACTIVITIES

- No cleanup activities at all
- No institutional controls after DOE releases the property in 2018

CONSEQUENCES

- Tritium conc. in to river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river exceeds MCL for next 270 years
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years
- Contaminant conc. into river could change without being detected

G3.2 Alternative 2: Institutional Controls

NR-1/NR-2CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS

August 5, 1996

PHYSICAL FEATURES

- Monitoring wells
- Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
- Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years
- Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
- Signs along river

NOTES

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.

ASSOCIATED ACTIVITIES

- Access controls on river shoreline along N-Springs
- Controls on GW use for 300 years
- Limits on irrigation in the general area
- Monitoring for 300 years
- Regulatory acceptance of institutional controls

CONSEQUENCES

- No use of unconfined aquifer allowed for 300 years
- Must maintain monitoring, institutional controls, etc. for 300 years
- Risk to ecological receptors along river may occur due to strontium
- Changing groundwater conditions would be detected by monitoring
- Tritium and strontium would continue to flow into the Columbia River

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river exceeds MCL for next 270 years
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. in to river may exceed MCL sat future date for few years

G3.3 Alternative 3: Permeable Wall and Institutional Controls

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
(IC for tritium to river and all COCs in aquifer)
August 5, 1996

PHYSICAL FEATURES

- Permeable barrier, 2000 ft. long (for strontium) (top of barrier wall at least 10 ft below ground surface)
- Monitoring wells
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 2 wells plus 40 sample tubes impermeable wall, sample rate varies, test for Sr-90, for 300 yrs.
  Strontium- 5 wells, once every 2 yrs, test for Sr-90, for 300years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
- Signs along river

NOTES

- Columbia River in vicinity of N-Springs currently exceeds MCLs for tritium, strontium, and nitrate.
- Nitrate load to the Columbia River from the N-Area is very small in comparison to the load from irrigation return flows
- Permeable wall operates passively; little O&M required

ASSOCIATED ACTIVITIES

- Land use controls for area containing permeable wall
- Monitoring for permeable barrier integrity for 300 years
- Institutional controls on GW use for 300 years
- Institutional controls along river for 15 years, for tritium
- (assume other COCs pose no risk to river)
- Monitoring north and south of permeable wall for groundwater quality going in to river
- Regulatory acceptance of institutional controls

CONSEQUENCES

- No use of unconfined aquifer allowed for 300 years
- Must maintain monitoring and institutional controls for 300 years
- Permeable wall reduces risk to ecological receptors along river that is due to strontium

Also:

- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 300 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years

G3.4 Alternative4: Hydraulic Controls And Pump and Treat for Strontium, Institutional Controls for Tritium to River and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

PHYSICALFEATURES

- Sr-90Hyd.Control and P&T: 9 extraction wells, 5 of 9 new
  3 injection wells, 1 of 3 new
  1 Treat Plant expand existing plant)
  Pumping rate- 15 gpm for 9 extraction wells
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench

NOTES

- Hydraulic controls for Sr-90 will partly control tritium to river

ASSOCIATED ACTIVITIES

- Institutional controls on GW for 270 years
- Institutional controls of land use where wells and treatment plant are located
- Monitor groundwater for 270 years
- O&M of treatment plant for 270 years
- O&M of wells and pipelines for 270 years
- Regulatory acceptance of institutional controls rather than significant expense of remediation
- Treatment plant residuals disposed at ERDF

CONSEQUENCES

- No use of unconfined aquifer allowed for 270 years
- Must maintain monitoring and institutional controls for 270 years
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years
- Manganese conc. into river may exceed MCL sat future date for few years

G3.5 Alternative 5: Hydraulic Controls for Tritium and Strontium to River Pump and Treat Strontium and Other COCs in Aquifer

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5,1996

PHYSICAL FEATURES

- Sr-90 Hyd. Control and P&T:
  - 9 extraction wells, 5 of 9 new
  - 3 injection wells, 1 of 3 new
  - 1 Treat. Plant (expand existing plant and modify for nitrate treat.)
  - Pumping rate-six well sat 15 gpm
    - three well sat 20 gpm
- Tritium-Hyd. Control
  - 2 extraction wells, both new
  - 0 injection wells (use new Sr-90 well)
  - 0 Treat. Plant
- "Others"-P&T
  - 8 extraction wells, 4 of 8 new
  - 3 injection wells, all new
  - 1 Treat. Plant-new
- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 300 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

NOTES
- Hydraulic controls for Sr-90 will partly control tritium to river
- Pump and treat for "Others" will retard their migration to the river

ASSOCIATED ACTIVITIES
- Institutional controls on GW for 270 years
- Institutional controls of land use where wells and treatment plant are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

CONSEQUENCES
- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminant migration south of Sr-90 plume would be retarded by the pump and treat actions, so river will be protected
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. in to river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few years

G3.6 Alternative 6: Impermeable Barrier for Strontium, Institutional Controls for Tritium, Pump and Treat All Groundwater COCs

NR-1/NR-2 CMS GROUNDWATER ALTERNATIVES – DESCRIPTIONS
August 5, 1996

PHYSICALFEATURES

- Sr-90-P&T — 6 extraction wells, 4 of 6 new
  3 injection wells, 1 of 3 new
  1 Treat. Plant (expand existing plant and modify to treat nitrate)
- "Others"-P&T — 8 extraction wells, 4 of 8 new
  3 injection wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Tritium- 4 wells, sample 1/yr, test for tritium, for 15 years
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 270 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench (Sr and NO3)
- Treatment facility NE of 1324-N for "Others"

NOTES

- Impermeable barrier for Sr-90 will partly control tritium to river
- Columbia River tritium concentrations near Richland water intake are higher than at the N-Springs area. Health risks under current conditions are acceptable to the City of Richland and the Regulators.

ASSOCIATED ACTIVITIES

- Institutional controls on GW for 270 years
- Institutional controls of land use where impermeable barrier, wells and treatment plants are located
- Monitor groundwater for 270 years
- O&M of wells, pipelines, & treatment plant for strontium for 270 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

CONSEQUENCES

- No use of unconfined aquifer for 270 years
- Must maintain wells, piping systems, and treatment plant for strontium for 270 years
- Wells, piping systems, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Contaminants north and south of Sr-90 plume would continue going into the river.
- Tritium conc. into river exceeds MCL for next 10-15 years
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
- Strontium conc. in aquifer exceeds MCL for next 270 years
- Other contaminants in aquifer will exceed MCLs for few to 90 years

G3.7 Alternative 7: Impermeable Barrier for Strontium to River, Impermeable Barrier and Hydraulic Controls for Tritium to River, Soil Flushing for Strontium in the Aquifer, Pump and Treat for Other COCs in Aquifer

100-NR-1/NR-2 CMS Groundwater Alternatives – Descriptions
(May 11, 1997)

PHYSICAL FEATURES

- Tritium-Hyd .Control — 2 extraction wells, both new
  0 Treat. Plant
- Soil Flushing — 9 extraction wells, 8 new
  1 Treat. Plant (expand existing plant and modified to treat nitrate)
  3 injection wells, 1 new
- Others-P&T — 8 extraction wells, 4 of 8 new
  3 injections wells, all new
  1 Treat. Plant-new
- Monitoring wells along river
  Strontium- 9 wells, sample rate varies, test for Sr-90, for 20 years
  Others- 3 wells, sample 1/yr, test for 5 analytes, for 20 to 100 years
  Water levels- 11 wells + 1 river stage, sample 4 wells/year, for 270 years
- Treatment facility at north end of 1301-N trench
- Treatment facility NE of 1324-N for "Others"
- Operate a sheet pile barrier for 20 years and remove

NOTES
- Impermeable barrier and hydraulic controls will control strontium and tritium to river
- Pump and treat for "Others" will retard their migration to the river

ASSOCIATED ACTIVITIES
- Institutional controls on groundwater for 100 years
- Institutional controls of land use where well sand treatment plant are located
- Monitor groundwater for 100 years
- O&M of wells, pipelines, & treatment plant for strontium for 20 years
- O&M of wells, pipelines, & treatment plant for "Others" for up to 90 years

CONSEQUENCES
- No use of unconfined aquifer for 100 years
- Must maintain wells, piping systems, and treatment plant for strontium for 20 years
- Wells, piping system, and treatment plant for "Others" will be shutdown as contaminant concentrations fall below MCLs
- Tritium conc. in aquifer exceeds MCL for next 25 years
- Strontium conc. into river will be less than MCL
  - Strontium conc. in aquifer exceeds MCL for next 20 years
  - Other contaminants in aquifer will exceed MCLs for few years

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