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Simulated High Level Waste Slurry Treatment and Storage (SHLWS) T/S Unit Closure Plan

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United States
Department of Energy
Richland, Washington

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CLOSURE PLAN

SIMULATED HIGH LEVEL WASTE SLURRY TREATMENT AND STORAGE (SHLWS T/S) UNIT

June 25, 1990

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1.0 PART A APPLICATION

1.1 INTRODUCTION

The Simulated High-Level Waste Slurry (SHLWS) Treatment and Storage (T/S) unit is an open, fenced-in area that was used to store containerized simulated high-level waste slurry. The unit was also used to treat this waste in a grout/stabilization process. The untreated slurry was originally considered to be a radioactive mixed waste because, in addition to being designated a dangerous waste, it contained elevated levels of natural radioactivity. Analysis of the waste later indicated that the radioactivity of the waste is low enough to be managed as a nonradioactive waste. The slurry was designated as a dangerous waste because it contained toxic constituents, was corrosive, was ignitable, and contained dissolved metals above the limits given in the Extraction Procedure (EP) Toxicity test. The treated slurry is not dangerous waste. The levels of radioactivity in the treated waste are low enough for the waste to be managed at the Hanford Site as nonradioactive solid waste.

The SHLWS was procured for a research demonstration program that was subsequently cancelled. While some of the slurry was used in other programs, the remaining material was declared surplus and thereby became a solid waste requiring management in compliance with the Washington Dangerous Waste Regulations (WAC 173-303). A Part A permit application was submitted for the SHLWS T/S unit for treatment of the SHLWS, as well as for storage of the containerized slurry prior to treatment. The permit application included only the inventory of wastes in storage at the time the permit was submitted; no other wastes were or will be stored or treated under this permit. The Part A Permit Application for this unit was submitted May 23, 1988, by the U.S. Department of Energy-Richland Operations Office (DOE-RL) to the Washington State Department of Ecology (Ecology) and to Region X of the U.S. Environmental Protection Agency (EPA).

1.2 PART A APPLICATION

The following Dangerous Waste Permit Application, Form 3, Rev 1 contains a description of waste treatment and storage conditions and designation codes for the wastes at the SHLWS T/S unit.

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PART A
DANGEROUS WASTE PERMIT APPLICATION
(FORM 3)

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Department of Energy
Richland Operations Office
P.O. Box 550
Richland, Washington 99352

JUN 21 1990

Mr. Timothy L. Nord, Hanford Project Manager
State of Washington
Department of Ecology
Mail Stop PV-11
Olympia, Washington 98504-8711

Dear Mr. Nord:

REVISION TO THE DANGEROUS WASTE PART A PERMIT APPLICATION FOR THE SIMULATED HIGH LEVEL WASTE SLURRY TREATMENT/STORAGE UNIT (WA7890008967)

Enclosed is the Dangerous Waste Part A Permit Application Form 3, Revision 1, for the Simulated High Level Waste Slurry (SHLWS) Treatment/Storage facility. The facility was used to store simulated high level waste and to treat the waste using a grout/stabilization process.

The Form 3, Revision 1, for the SHLWS has been revised to incorporate additional information. The need for this information was identified during review of the closure plan by the Washington Department of Ecology and Pacific Northwest Laboratory. Revisions include the additional designation of the slurry as an extremely hazardous waste mixture, a revised process description reflecting the grouting process employed in treating the waste, and further definition of the low level of radioactivity present in the slurry.

If you have any questions regarding the enclosed permit application revision, please contact Mr. C. E. Clark of the U.S. Department of Energy, Richland Operations Office on (509) 376-9333 or Mr. H. W. Slater, Pacific Northwest Laboratory on (509) 376-0575.

Sincerely,

R. D. Izatt, Director
Environmental Restoration Division
Richland Operations Office

T. D. Chikalla, Director
Facilities and Operations
Pacific Northwest Laboratory

Enclosures: Dangerous Waste Part A Permit Application for the Simulated High Level Waste Slurry Treatment/Storage Unit

cc w/encl: P. T. Day, EPA
D. L. Duncan, EPA
J. L. McElroy, PNL

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(Shaded areas are spaced for elite type, i.e., 12 characters/inch)

FORM 3

DANGEROUS WASTE PERMIT APPLICATION

I. EPA/STATE I.D. NUMBER: W A 7 8 9 0 0 0 8 9 6 7

FOR OFFICIAL USE ONLY

APPLICATION APPROVED	DATE RECEIVED (mo., day, & yr.)	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 | YR — FOR EXISTING FACILITIES, PROVIDE THE DATE (mo., day, & yr.) OPERATION BEGAN OR THE DATE CONSTRUCTION COMMENCED (use the boxes to the left)

☐ 2. NEW FACILITY (Complete item below.)

MO | DAY | YR — FOR NEW FACILITIES, PROVIDE THE 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 code(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
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

PROCESS	PROCESS CODE	APPROPRIATE UNITS OF MEASURE FOR PROCESS DESIGN CAPACITY
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
GALLONS	G
LITERS	L
CUBIC YARDS	Y
CUBIC METERS	C
GALLONS PER DAY	U
LITERS PER DAY	V
TONS PER HOUR	D
METRIC TONS PER HOUR	W
GALLONS PER HOUR	E
LITERS PER HOUR	H
ACRE-FEET	A
HECTARE-METER	F
ACRES	B
HECTARES	Q

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 NUMBER	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	S02	600	G	
X-2	T03	20	E	
1	S01	20,000	G	
2	4	550	U	
3				
4				

LINE NUMBER	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
5				
6				
7				
8				
9				
10				

Continued from the front

III. PROCESSES (continued)

C. SPACE FOR ADDITIONAL PROCESS CODES OR FOR DESCRIBING OTHER PROCESS (code "T04"). FOR EACH PROCESS ENTERED HERE INCLUDE DESIGN CAPACITY.

T04, S01--This permit covered a one-time proposal to immobilize approximately 200 55-gallon drums of a simulated high level waste slurry (formerly known as "PW-0" and "PW7/7A" material). The program that originally procured this specialty chemical was eliminated before the material was used for R&D purposes. Although the material had been used intermittently, all remaining material with no future use was treated.

The treatment process consisted of neutralization and mixing with a grout within lined 55-gallon, DOT 17H containers. The treatment eliminated the characteristics of ignitability, corrosivity and EP Toxicity. Photographs of the treatment equipment and area are attached.

The grouted slurry was stored in drums at the site of treatment (1100 Area, see attached drawing) until tests (EP Toxicity, Acute Fish and Rat Toxicity) were completed. These tests verified that the treated waste exhibits no dangerous waste characteristics.

IV. DESCRIPTION OF DANGEROUS WASTES

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

B. ESTIMATED ANNUAL QUANTITY — For each listed waste entered in column A estimate the quantity of that waste that will be handled on an annual basis. For each characteristic or toxic contaminant entered in column A estimate the total annual quantity of all the non—listed waste(s) that will be handled which possess that characteristic or contaminant.

C. UNIT OF MEASURE — For each quantity entered in column B enter the unit of measure code. Units of measure which must be used and the appropriate codes are:

ENGLISH UNIT OF MEASURE	CODE	METRIC UNIT OF MEASURE	CODE
POUNDS	P	KILOGRAMS	K
TONS	T	METRIC TONS	M

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

D. PROCESSES

1. PROCESS CODES:

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

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

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

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

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

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. The other waste is corrosive and ignitable and there will be an estimated 100 pounds per year of that waste. Treatment will be in an incinerator and disposal will be in a landfill.

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))
X-1	K054	900	P	T03 D80	
X-2	D002	400	P	T03 D80	
X-3	D001	100	P	T03 D80	
X-4	D002			T03 D80	included with above

Continued from page 2.

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

I.D. NUMBER (enter from page 1): W 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	D001	150,000	P	S01 T04	Storage/Treatment
2	D002	Includes the above			
3	D005				
4	D006				
5	D007				
6	D011				
7	WT01				
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					

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IV. DESCRIPTION OF DANGEROUS WASTES *(continued)*

E USE THIS SPACE TO LIST ADDITIONAL PROCESS CODES FROM SECTION D(1) ON PAGE 3.

Material to be treated was designated as ignitable (D001), corrosive (D002) due to pH ≤2.0 and EP Toxic due to barium (D005), cadmium (D006), chromium (D007), and silver (D011), and was also slightly radioactive (<2000pCi/g) due to naturally-occurring elements present. (This level of natural occurring radiation is not sufficient to designate the material as radioactive mixed waste [RMW].) The waste slurries were designated as extremely hazardous waste (EHW) toxic mixtures (WT01). This designation was due to the concentration and toxicity of nitric acid and metallic nitrate salts (i.e., silver nitrate, ferric nitrate) present in the wastes.

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V. FACILITY DRAWING

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 * This information appears on the attached drawing and photographs.

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 attached drawings and photos

LATITUDE *(degrees, minutes, & seconds)*	LONGITUDE *(degrees, minutes, & seconds)*

VIII. FACILITY OWNER

[X] 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 IX 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 NO. *(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
Michael J. Lawrence Manager, Richland Operations United States Department of Energy	Michael J. Lawrence	6-21-90

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		

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.

Michael J. Lawrence 6-21-90

Michael J. Lawrence, Manager — Date
Department of Energy
Richland Operations Office

6/4/90

William R. Wiley, Director — Date
Pacific Northwest Laboratory

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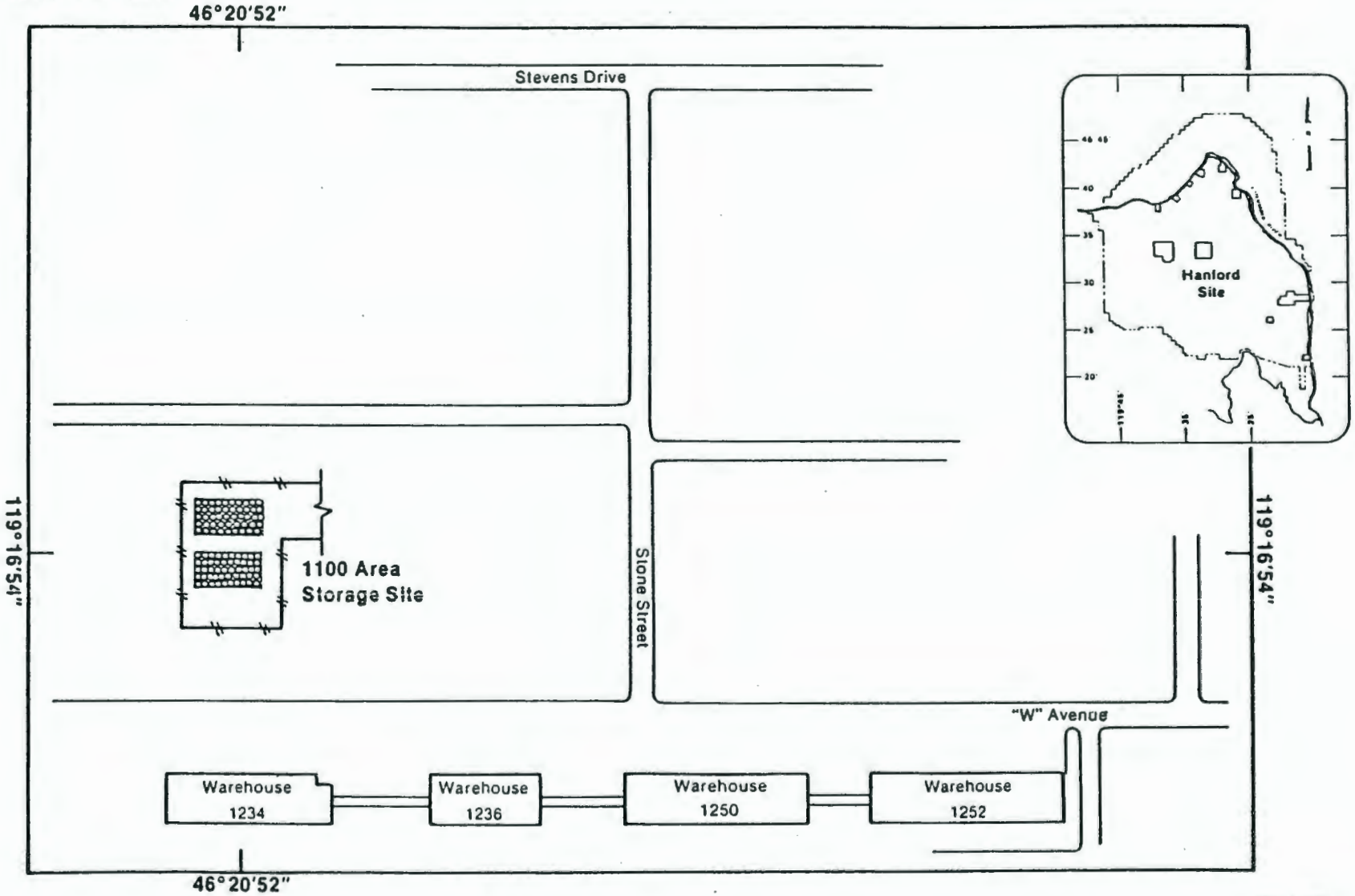
Simulated High-Level Waste Slurry Treatment/Storage

Site Plan



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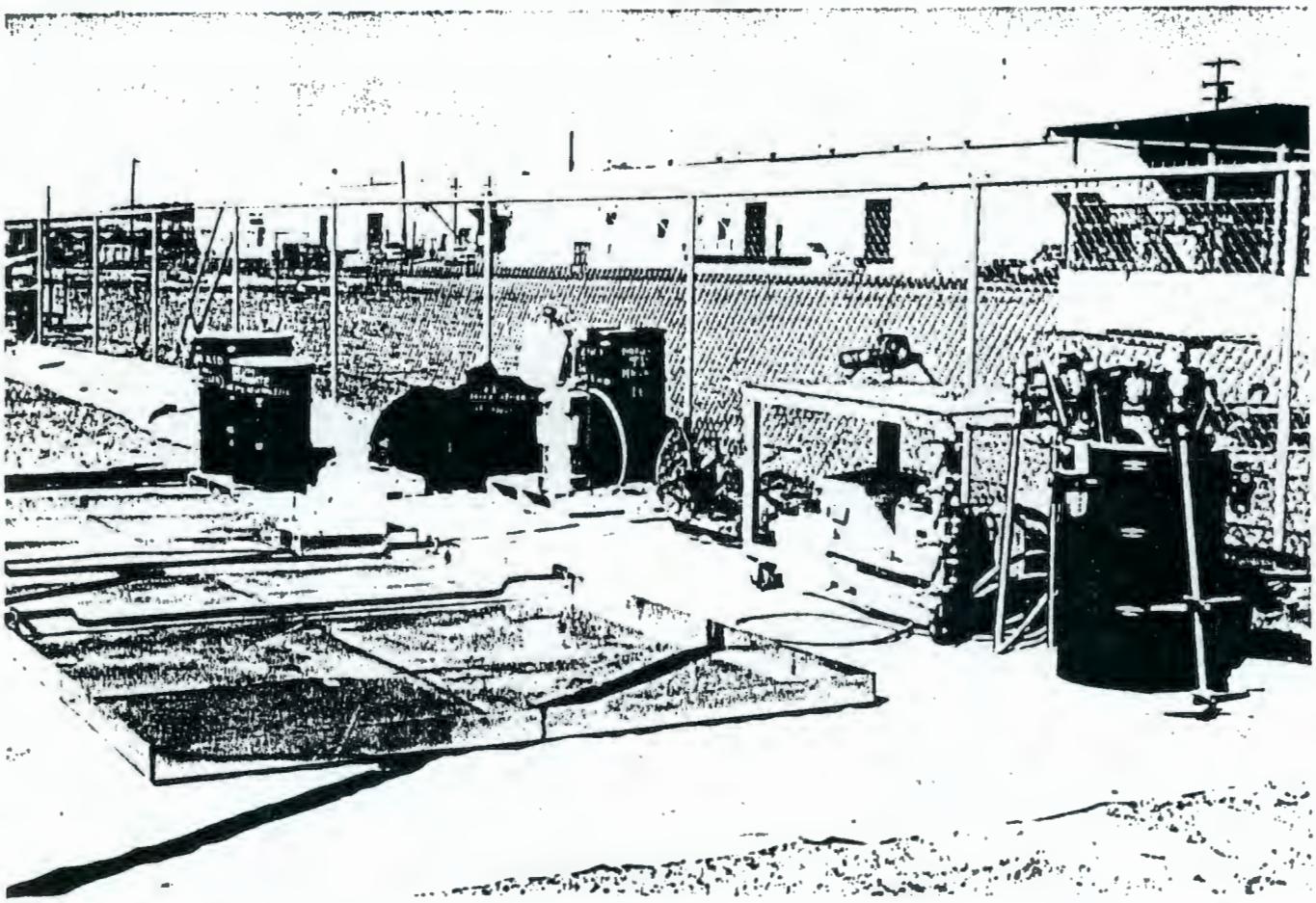
Simulated High-Level Waste Slurry Treatment/Storage
Treatment Site and Equipment



Longitude 119° 16'37"
Latitude 46° 22'20"

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Photo Taken 1988

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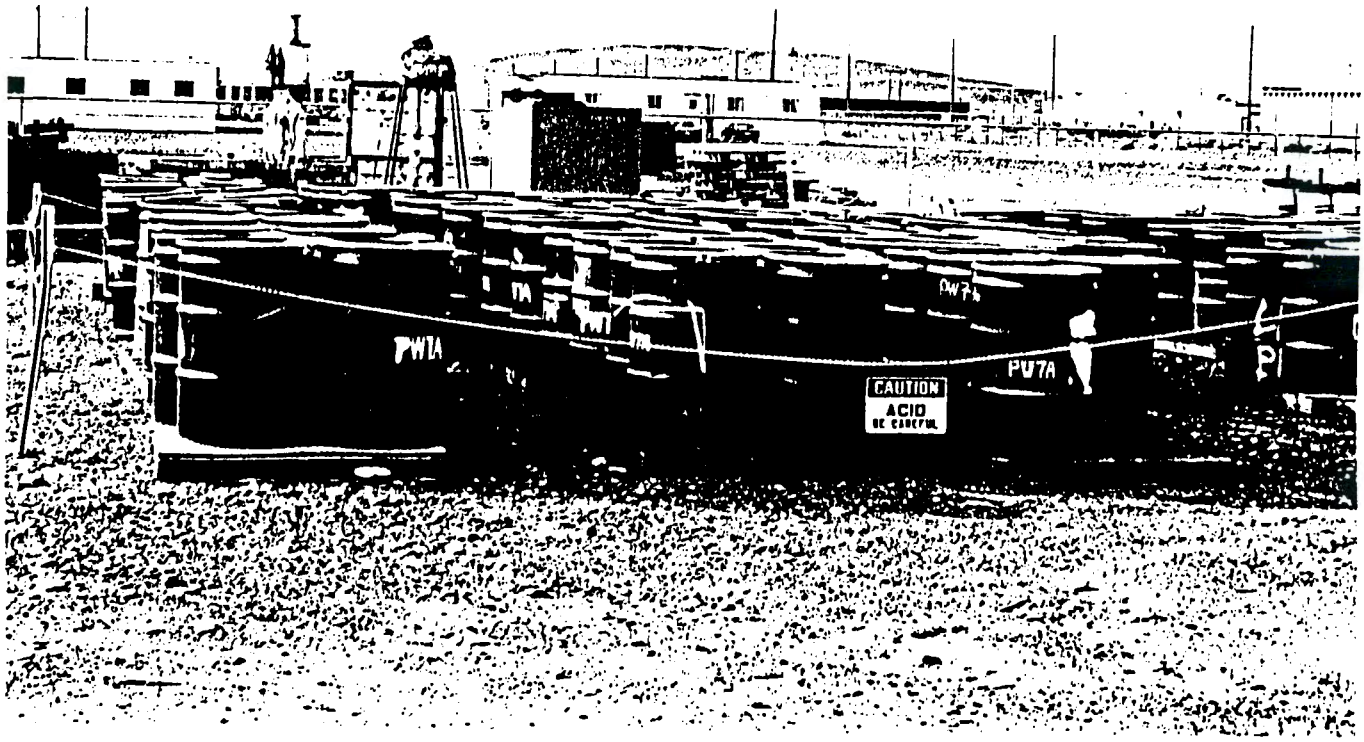
Simulated High-Level Waste Slurry Treatment/Storage



Longitude 119°16'54"
Latitude 46°20'52"

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Photo Taken 1988

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2.0 FACILITY DESCRIPTION

This section provides a general description of the DOE Hanford Site and the dangerous waste management unit discussed in this Closure Plan, and is intended to provide the permit application reviewer/permit writer with an overview of the operation.

2.1 GENERAL DESCRIPTION

The DOE Hanford Site consists of approximately 560 square mi (1,450 square km) of semiarid land that is owned and operated by the DOE. This site is located northwest of the City of Richland, Washington, along the Columbia River. The City of Richland lies approximately 3 mi (4.8 km) from the southernmost portion of the Hanford Site boundary and is the nearest population center (Figure 2-1). In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for reactor, chemical separation, and related facilities for the production and purification of plutonium. A total of eight graphite-moderated reactors using Columbia River water for once-through cooling were built along the Columbia River. These reactors were operated from 1944 to 1971.

N Reactor, a dual-purpose reactor for production of plutonium and generation of steam for production of electricity, uses recirculating water coolant. N Reactor began operating in 1963 and is being placed into cold standby status.

Activities are centralized in numerically designated areas on the Hanford Site. The reactor facilities (active and decommissioned) are located along the Columbia River in the 100 Areas. The reactor fuel processing and waste management facilities are located in the 200 Areas, situated on a plateau about 7 mi (11.2 km) from the river. The 300 Area, located north of

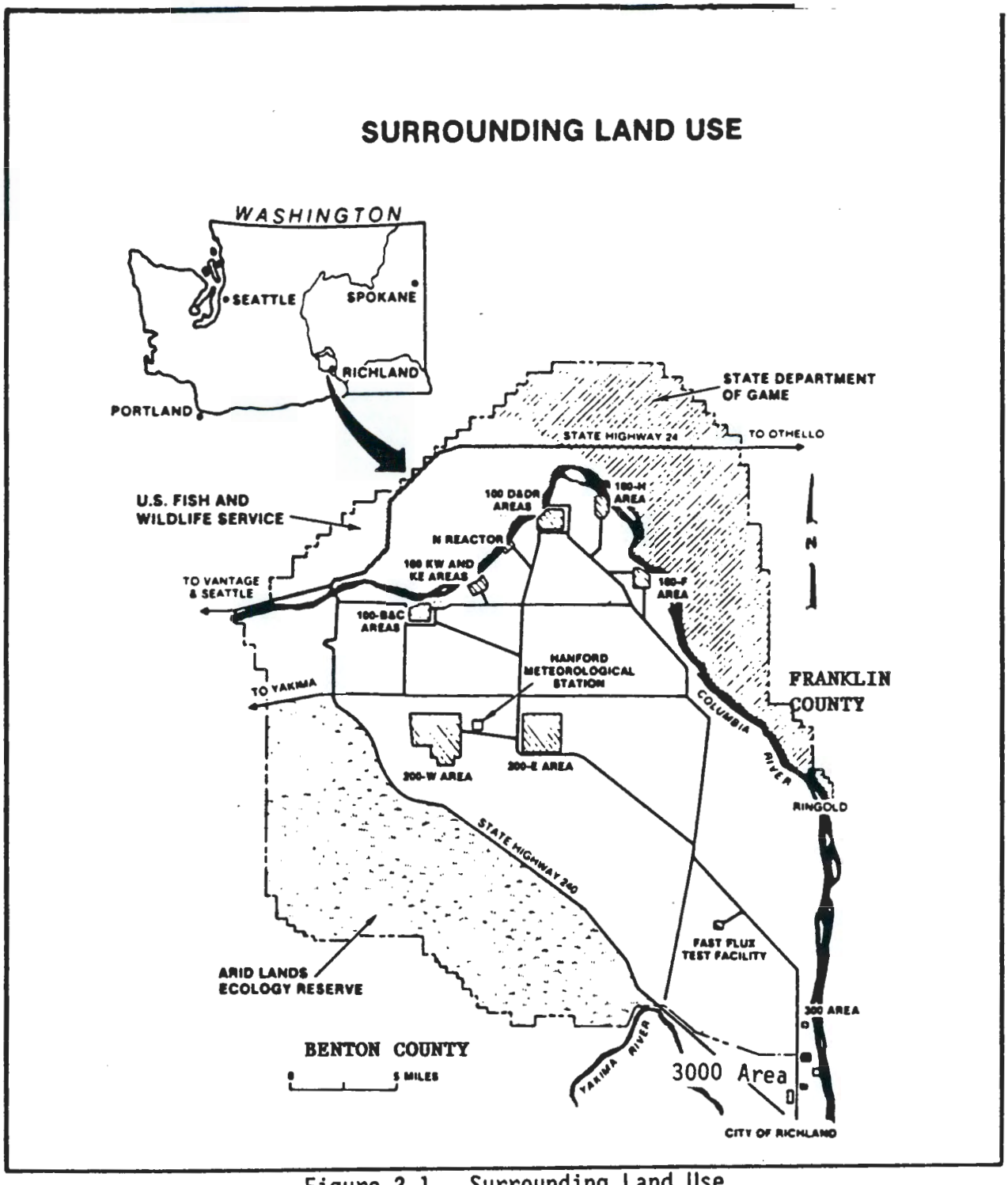

Figure 2-1. Surrounding Land Use

Richland, contains the reactor fuel manufacturing facilities and the research and development laboratories. The 400 Area, 5 mi (8 km) northwest of the 300 Area, contains the Fast Flux Test Facility. The 1100 Area, north of Richland, contains buildings associated with maintenance and transportation functions for the Hanford Site.

2.2 SHLWS T/S UNIT

The SHLWS T/S unit is an open, fenced-in area located in the 1100 Area of the Hanford Site at approximately 46°20′52" latitude and 119°16′54" longitude. The general location of the SHLWS T/S unit is shown in Figure 2-2. The location of the SHLWS T/S unit within the 1100 Area is shown in Figure 2-3.

The SHLWS T/S unit encompasses approximately 93,000 square ft (8,600 square m) in the shape of two joined rectangles. The larger rectangle is aligned north-south and has a length of 449.5 ft (137 m) and width of 187.5 ft (57 m), while the smaller joins the larger on the southeast corner and is aligned east-west with a length of 114.0 ft (35 m) and a width of 77.5 ft (24 m). The unit is surrounded by a 6-ft chain-link fence. The fence is topped with barbed wire on the western side, which is the only boundary with public access. Access is gained through a single 6-ft locked gate, located on the eastern edge of the unit. Keys to the locked gate are controlled by Mr. H. Wayne Slater (509-376-0575), who is the PNL SHLWS T/S Project Manager.

The interior of the unit is divided among roped-off areas, including one area used for storage of SHLWS in drums, another used for SHLWS treatment, and one used for less-than-90-day storage of containerized dangerous wastes, as shown in Figure 2-4. Other areas of the unit are used for nonregulated

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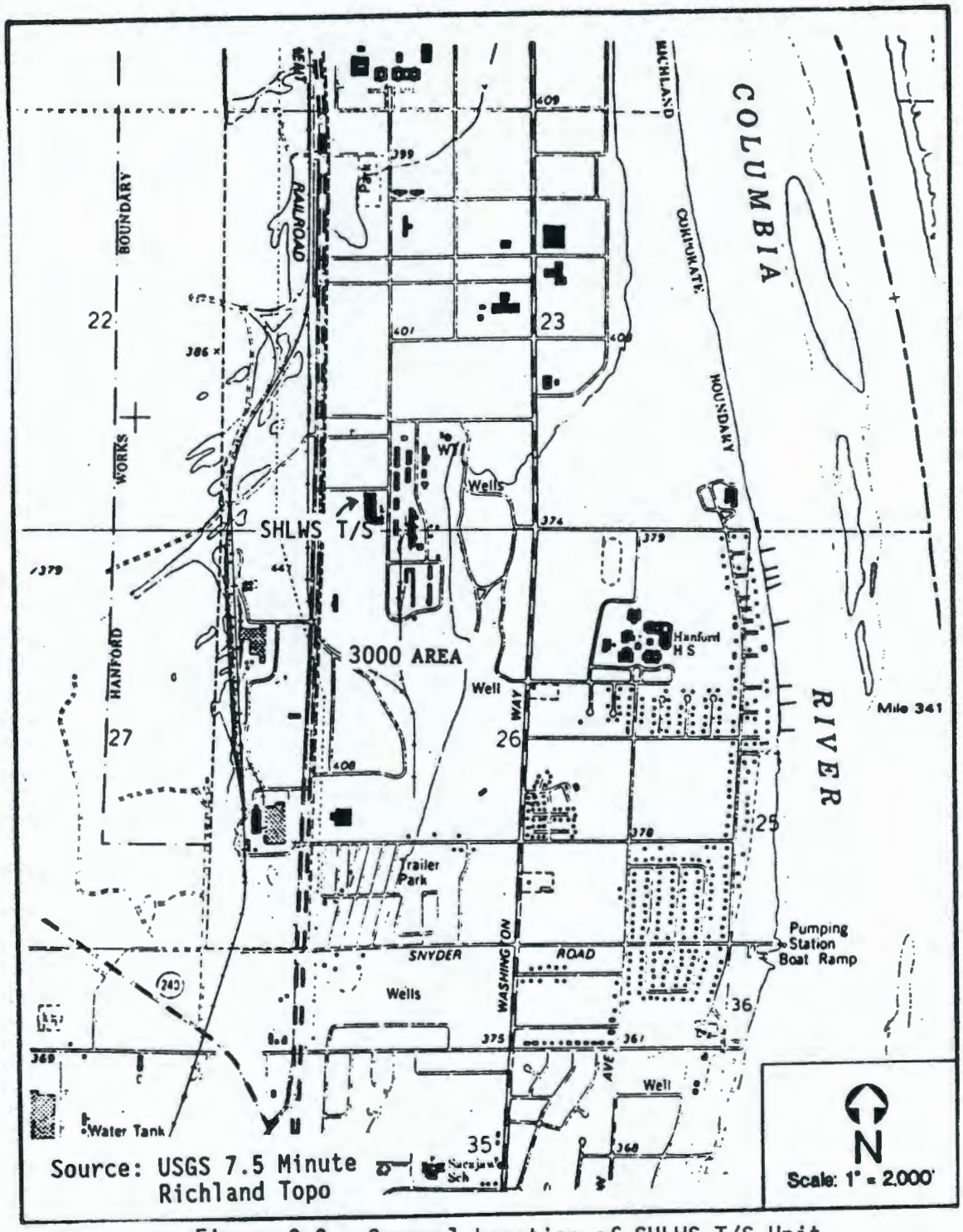

Figure 2-2. General Location of SHLWS T/S Unit

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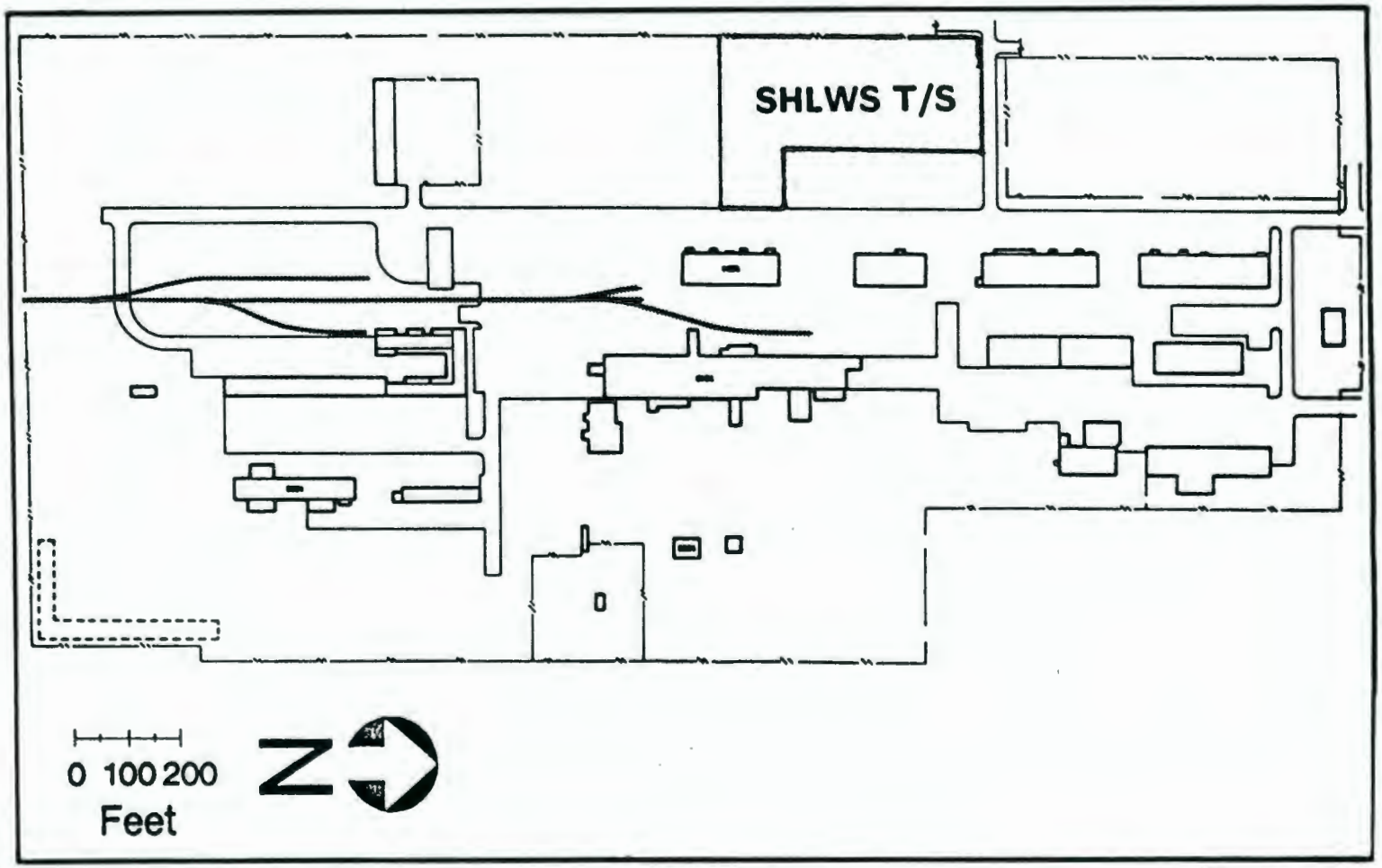

Figure 2-3. Location of SHLWS T/S Unit Within 3000 Area

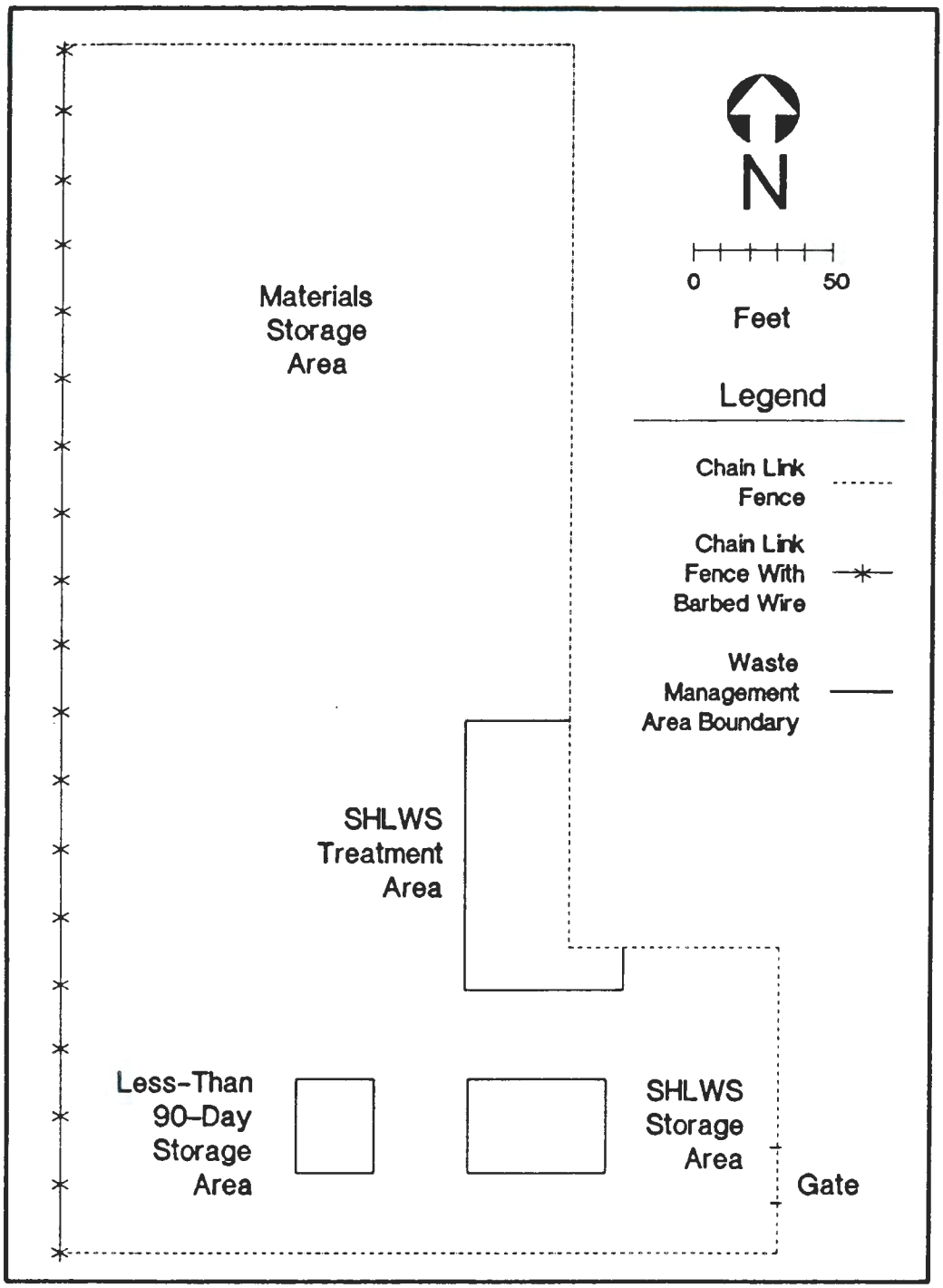

Figure 2-4. Layout of SHLWS T/S Unit

activities, including storage of raw materials and structural materials. Raw materials stored in the unit included the grout-forming chemicals used for treatment (fly ash, blast furnace slag, and Portland cement).

2.3 PHYSIOGRAPHY

Figure 2-1 is a general overview map of the entire Hanford Site property and the surrounding countryside. It provides information on major features and illustrates the facility boundary and surrounding land use, including the U.S. Fish and Wildlife Service Saddle Mountain National Wildlife Refuge and the Washington State Game Reserve to the north, and the Arid Lands Ecological Reserve to the west. Land east of the Hanford Site across the Columbia River is primarily farmland or a part of the Washington State Game Reserve.

A topographic map of the area around the SHLWS T/S unit is shown in Figure 2-5. A number of elevation references points in the area of concern confirms the flatness of the area within 1000 feet of the unit.

A more detailed layout of nearby buildings is provided in Figures 2-2 and 2-3. Figure 2-6 provides the wind roses for various locations on the Hanford Site based on information from the meteorological stations operated by PNL. The wind roses show the relative proportion of time that winds blow from various directions and indicate that winds on the Hanford Site are predominantly from the west.

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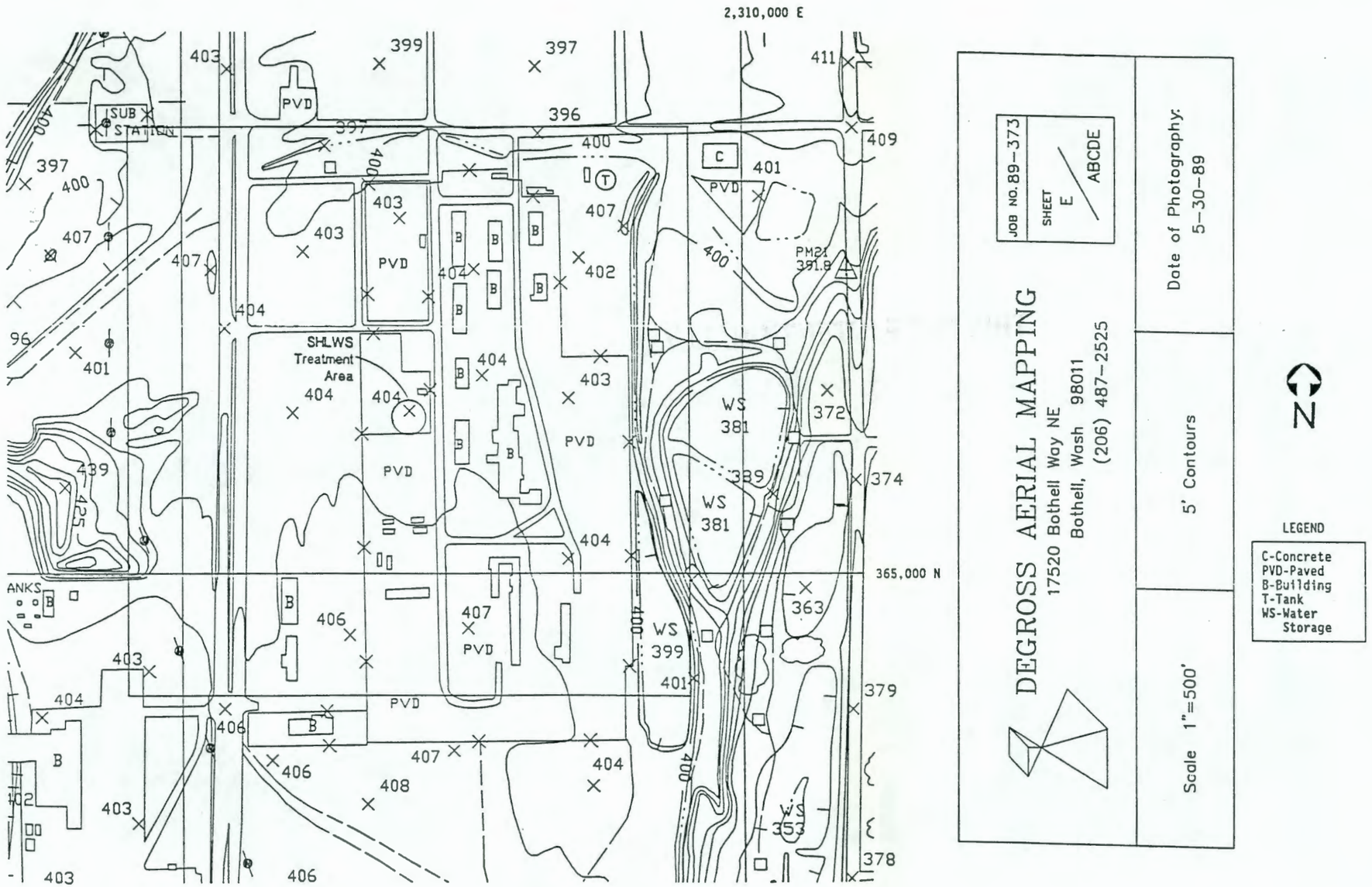

Figure 2-5. Topographic Map for Area Near SHLWS T/S Unit

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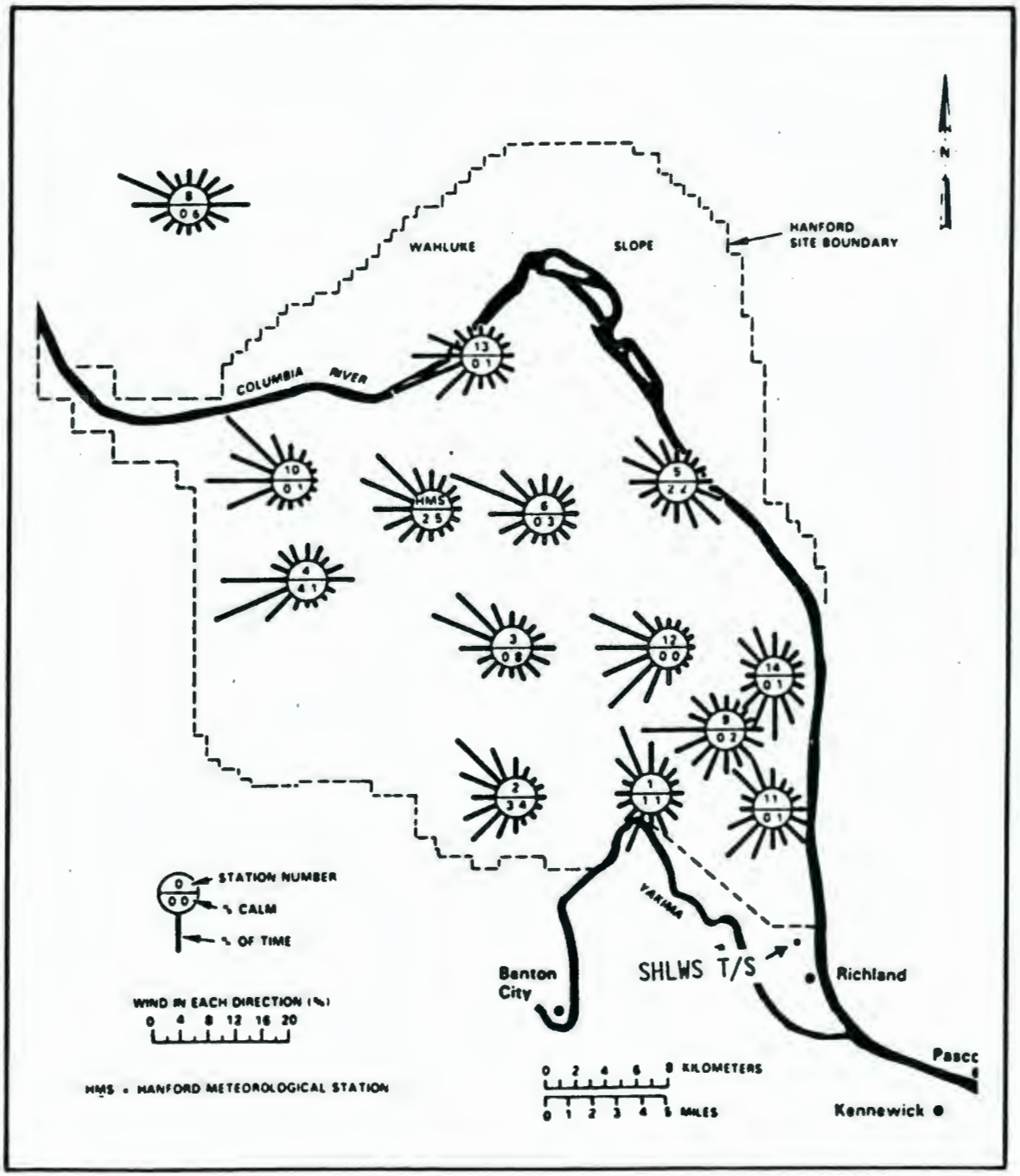

Figure 2-6. Wind Roses for the Hanford Site

2.4 LOCATION INFORMATION

2.4.1 Seismic Consideration

The Hanford Site is not located within any of the counties identified in Appendix VI of 40 CFR 264 and WAC 173-303-420(3)(c) that are considered to be seismically active.

2.4.2 Floodplain Standard

The U.S. Army Corps 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 maximum run-off (USCOE, 1969). The probable maximum flood for the Columbia River below Priest Rapids Dam has been calculated to be 1.4 million cubic ft/s (40,000 cubic m/s). This flow would result in estimated flood elevations of 423 ft (129 m) at the 100-N Area and 384 ft (117 m) at the 300 Area. The area near the 3000 Area estimated to be inundated by this flood is shown in Figure 2-7. The elevation of the SHLWS T/S unit is approximately 404 ft (123 m); the unit would not be inundated by this flood. It is noted that the area which would be inundated by this maximum probable flood is greater than that which would be inundated during a 100-yr flood event.

2.5 TRAFFIC INFORMATION

The SHLWS T/S unit is located in the 3000 Area, which is south of the Controlled Access Area of the Hanford Site. The roadways in this area are owned by the U.S. DOE and public use is generally allowed by the DOE. The roadways providing access to the 3000 Area largely receive Hanford employee

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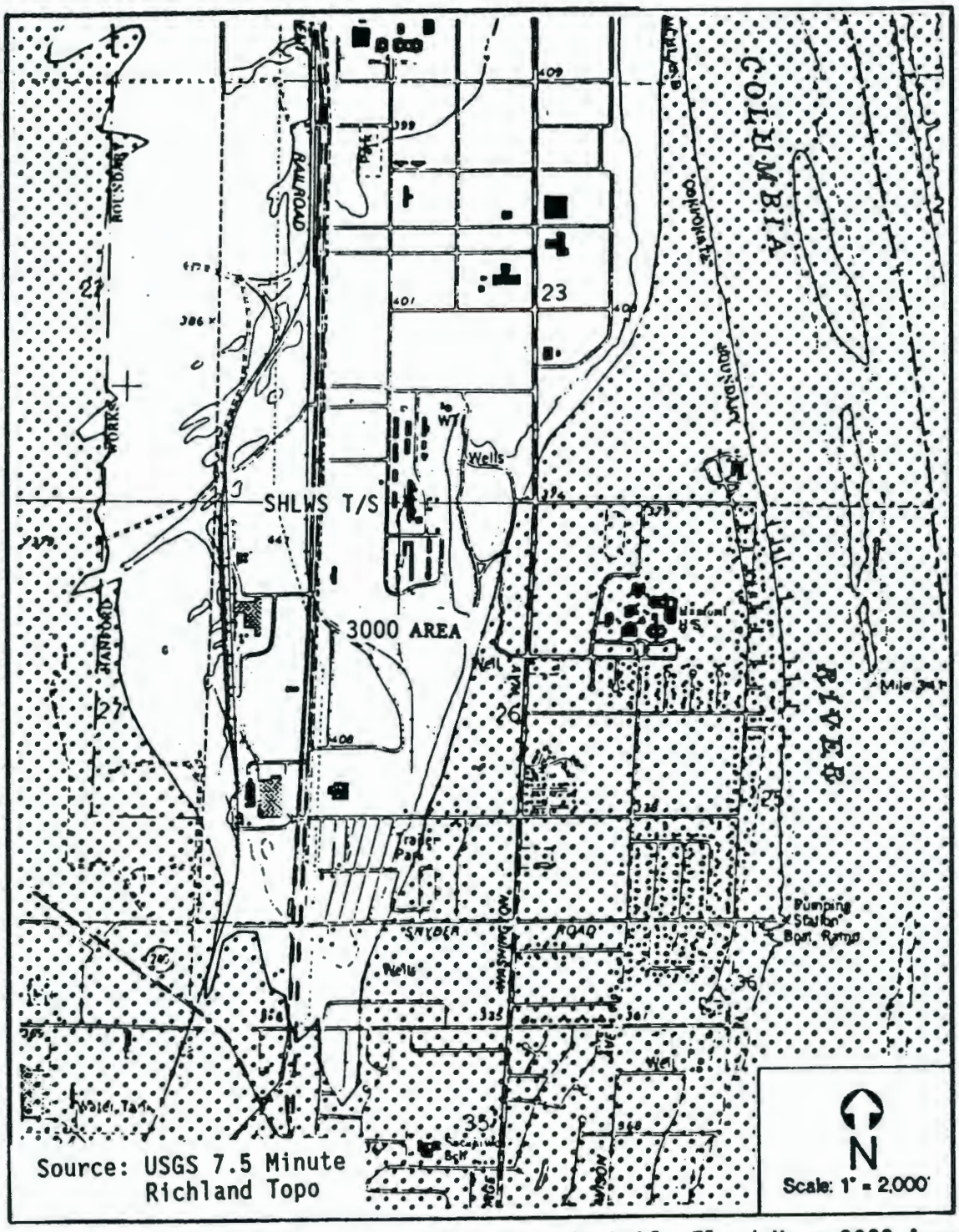

Figure 2-7. Estimated Extent of Maximum Probable Flood Near 3000 Area

traffic because of the lack of non-Hanford-related facilities in the zone between the 1100 Area and the Controlled Access Area. As a consequence, traffic consists of light-duty vehicles and employee buses. The unit itself lies within the fenced-in area managed for DOE by Kaiser Engineers Hanford (KEH) on a dead-end access road (Stone Street). Access to the KEH-managed area is not controlled during normal working hours, but is limited to authorized personnel during off-hours. The SHLWS T/S unit is removed from the major thoroughfare in the vicinity (primarily Route 4S) and does not border on general public traffic lanes. Stone Street and Stevens Drive (Route 4S) are constructed of bituminous asphalt (usually 2 in. [5 cm] thick) with an underlying aggregate base. The aggregate base consists of various types and sizes of rock found on the Hanford Site.

2.6 REFERENCES

U. S. Corps of Engineers. 1969. Memorandum Report - Lower Columbia River Standard Flood Project and Probable Maximum Flood. U.S Army Engineer Division, Portland, Oregon.

3.0 WASTE CHARACTERISTICS

This section describes the characteristics of the SHLWS stored and treated at the SHLWS T/S unit.

3.1 UNTREATED WASTE CHARACTERISTICS

The SHLWS was created by blending virgin chemical products to simulate high-level wastes for use in experimental waste treatment programs. Two separate compositions of material were created by a chemical supplier, Research Chemical, P.O. Box 14588, Phoenix, Arizona, 85031. These compositions were designated as PW-0 and PW-7A. A third composition consisting of 50% PW-0 and 50% PW-7A was created after receipt of the SHLWS from the supplier. The compositions of the three mixtures are given in Table 3-1. The compositions shown in Table 3-1 for PW-0 and PW-7A are the specifications that the manufacturer was required to meet. Random samples of the PW-0 and PW-7A supplied by the manufacturer were collected and analyzed by inductively coupled plasma spectroscopy (ICP) and atomic absorption (AA) spectroscopy. Analytical results are shown in Table 3-2. The results in Table 3-2 identify several elements which are not included in Table 3-1. These elements reflect impurities in the chemicals used to form the mixtures. The rare earth mixture used consisted of a naturally occurring mineral containing a variety of impurities. The pH of all three compositions was below 1.

The SHLWS met several of the criteria and characteristics for designation of dangerous wastes, as defined by Ecology. The slurries were dangerous waste mixtures (WAC 173-303-084) because of the toxicity and concentrations of the chemical compounds used to prepare the simulated wastes. The wastes also met dangerous waste characteristics (WAC 173-303-090).

Table 3-1. Composition of SHLWS as Procured

Compound	Concentration (g/L)		
	PW-0	PW-7A	50/50
$AgNO_3$	1.80	0	0.90
$BaNO_3$	37.28	0	18.64
$Cd(NO_3)_2 \cdot 4H_2O$	3.26	0	1.63
$Co(NO_3)_2 \cdot 6H_2O$	15.38	0	7.69
$Cr(NO_3)_3 \cdot 9H_2O$	25.37	0	12.69
$Fe(NO_3)_3 \cdot 9H_2O$	232.66	106.72	169.69
KNO_3	34.18	0	17.09
$NaNO_3$	0	263.15	131.58
$Ni(NO_3)_2 \cdot 6H_2O$	56.85	0	28.43
$Sr(NO_3)_2$	30.19	0	15.10
$ZrO(NO_3)_2 \cdot 2H_2O$	149.68	0	74.84
MoO_3	88.95	0	44.48
Ce	45.90	73.29	61.10
Rare Earths	301.53	279.47	290.50
HNO_3	39	120	77

Note: Compositions of PW-0 and PW-7A are as specified by supplier. Composition of 50/50 mixture is as mixed after receipt from supplier.

Table 3-2. Analyzed Composition of SHLWS

Constituent	Concentration (mg/L) PW-0	PW-7A
Al	3300	6300
Ag	530	<10[a]
As	<0.2	<10
B	(70)[b]	(70)
Ba	4700	210
Ca	2200	2300
Cd	900	<10
Ce	40000	67000
Co	2390	90
Cr	2600	190
Cu	150	160
Dy	9500	12200
Eu	200	190
Fe	24000	13900
Gd	4000	3300
Hg	0.4	0.4
K	14000	5700
La	27000	26000
Mg	340	870
Mn	80	67
Mo	44000	80
Na	900	59500
Nd	21400	26800
Ni	8500	100
Pb	(560)	(600)
Sb	(240)	(200)
Se	<0.022	<10
Si	780	450
Sr	9000	50
Te	(500)	(600)
Ti	120	80
Y	4400	5600
Zr	36800	2000

(a) "Less than" values represent analytical detection limits.
(b) Values in parentheses are near the detection limits.

The wastes were ignitable because the high concentration of nitric acids caused them to be classified as oxidizers. The wastes were corrosive because their pH was less than 2. The wastes were EP toxic due to the concentrations of silver, barium, cadmium, and chromium. The SHLWS also met the federal criteria for land disposal restrictions [RCRA Section 3004(d)(2)] because of pH and concentrations of cadmium and nickel.

The SHLWS was also slightly radioactive because of naturally occurring radioactivity in the rare earth minerals used to prepare the mixtures. At the time that the SHLWS became a waste, it was considered to be a radioactive mixed waste since radiological surveys of the wastes identified levels of radioactivity above background. The exact nature of the radioactivity was not determined until the waste was sampled. Waste sampling and analysis, as described below, determined that the radioactivity was due to naturally occurring radionuclides and that the total specific activity was less than 2,000 pCi/g. Wastes at Hanford that contain naturally occurring radionuclides whose specific activity is less than 2,000 pCi/g are not considered to be radioactive wastes. As a result of the waste analysis, the SHLWS was considered to be dangerous waste rather than mixed waste.

Samples of the mixtures were analyzed for gross alpha activity, gross beta activity, and gamma-emitting radionuclides. The gross beta activity was calculated assuming energies similar to ^{90}Sr-^{90}Y. The gross alpha activity was calculated by spiking replicate samples with a known amount of ^{242}Pu to determine absorption effects from residual salts. Results of this analysis are given in Table 3-3. The sample used to determine the radioactive constituents for the 50:50 mixture consisted primarily of sludge, which accounts for the higher values. Individual samples of PW-0 and PW-7A were homogenous.

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Table 3-3. Radiation Resulting from Radioactive Constituents in Untreated SHLWS

Constituent	Concentration (pCi/g)		
	PW-0	PW-7A	50/50
Gross Beta	82.9	66.9	129
Gross Alpha	389	150	600
Gross Gamma(1)			
^{228}Ac(2)	7.21	1.85	13.1
^{214}Bi(3)	2.21	0.70	8.23
^{232}Ra(4)	33.8	40.8	71.1
^{40}K	14.8	<0.81	6.85
Total	529.92	<261.06	828.28

(1) Gamma radiation resulting from other radioisotopes within the chains noted was below background.

(2) Thorium-232 decay chain, parent is radium-228.

(3) Uranium-238 decay chain.

(4) Uranium-235 decay chain, parent is actinium-227

3.2 TREATED WASTE CHARACTERISTICS

Samples of treated SHLWS were collected during treatment and tested following completion of the curing period. The samples were analyzed for unconfined compressive strength, EP toxicity, corrosivity, and acute fish and rat toxicity. Testing of the treated SHLWS was documented in response to Ecology requests for information concerning the treatment. Sampling and testing are described in detail in the document provided Ecology (Lokken, 1989).

A sampling plan was developed for the treated SHLWS to ensure that at least 99.9% of the treated drums were below dangerous waste designation limits for EP toxicity and corrosivity (with 95% confidence). The number of drums to be sampled was identified based on statistical analysis of the expected variance in pH and toxic metals concentration. This analysis indicated that a minimum of 6 random samples would be required for EP toxicity analysis and 12 random samples would be required for pH analysis. The sampling plan called for sampling 24 drums at random. Half of the samples (12) were to be archived in the event that the wastes had greater variability than expected and additional analyses were required to obtain the desired confidence interval. Of the 12 samples not archived, all 12 were to be analyzed for pH and 6 for EP toxicity.

During treatment, 306 drums of treated waste were generated. Twenty-three of these drums were sampled, 11 PW-7A and 12 PW-0. The total number of samples taken from these drums was 58, consisting of 22 PW-7A and 36 PW-0. The number of samples analyzed was 12 PW-7A (from 6 drums) and 12 PW-0 (from 6 drums). All drums were analyzed for both EP toxicity and pH. The total number of drums sampled for pH, therefore, was equal to the required number of 12 and the total number of drums sampled for EP toxicity was twice the required number of 6. The results of this sampling and analysis procedure, as summarized in the following subsections, indicate that the grouted wastes in each waste category are well below designation limits for EP toxicity and corrosivity.

3.2.1 Compressive Strength

Three samples each of solidified PW-0 and PW-7A were prepared and tested for unconfined compressive strength according to ASTM Method C-39 (ASTM 1985). Treated SHLWS samples were collected from drums after the grout chemicals had been added and blended. These samples were then poured into plastic bottles and allowed to cure for approximately 2 months before

testing. The length-to-diameter ratio for each sample was 2, with nominal diameters of 1.2 in. (3.0 cm) and 1.6 in. (4.1 cm) for the PW-0 and PW-7A samples, respectively. The compressive strength of the samples averaged 770 psi (5,300 kPa) for the PW-0 samples and 540 psi (3,700 kPa) for the PW-7A samples. The Nuclear Regulatory Commission (NRC) requires a minimum compressive strength of 50 psi (340 kPa) for solidified low-level waste to ensure that the waste forms will be physically stable under lithostatic pressures exerted by the solidified waste and any cover materials. The treated SHLWS meets this requirement.

3.2.2 EP Toxicity

Six samples each of solidified PW-0 and PW-7A were subjected to the EP Toxicity test using a dilute acetic acid extraction (EPA Method 1310). The extracts were analyzed by ICP and AA spectroscopy. The analytical results are given in Table 3-4. These results indicate that the treated SHLWS is not a dangerous waste because of the EP Toxicity characteristic.

3.2.3 Corrosivity

The corrosivity of six samples each of solidified PW-0 and PW-7A was determined by adding the samples to equal weights of deionized water, mixing for thirty minutes, and measuring the pH of the resultant liquid (WAC 83-13, "Chemical Testing Methods for Complying with the Dangerous Waste Regulations," Appendix B, Attachment 3). The results of this testing are

Table 3-4. EP Toxicity Results for Solidified SHLWS

	Concentration (mg/L)							
Sample ID	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
PW-0 7-3	<0.06	2.1	0.13	0.01	<0.03	<0.005	0.05	<0.02
PW-0 42-3	<0.06	2.7	0.21	0.01	<0.03	<0.005	0.04	<0.02
PW-0 75-3	<0.06	1.9	<0.005	0.02	<0.03	<0.005	0.08	<0.02
PW-0 87-3	<0.06	1.5	<0.005	0.02	<0.03	<0.005	0.08	<0.02
PW-0 104-3	<0.06	1.3	<0.005	0.02	<0.03	<0.005	0.06	<0.02
PW-0 144-3	<0.06	2.4	0.20	0.02	<0.03	<0.005	0.04	<0.02
PW-7A 171-2	<0.06	1.7	<0.005	<0.01	<0.03	<0.005	0.05	<0.02
PW-7A 191-2	<0.06	2.4	<0.005	0.01	<0.03	<0.005	0.06	<0.02
PW-7A 220-2	<0.06	1.6	<0.005	<0.01	<0.03	<0.005	0.05	<0.02
PW-7A 231-2	<0.06	1.3	<0.005	<0.01	<0.03	<0.005	0.04	<0.02
PW-7A 273-2	<0.06	2.5	<0.005	<0.01	0.04	<0.005	<0.03	<0.02
PW-7A 276-2	<0.06	2.1	<0.005	<0.01	0.04	<0.005	<0.03	<0.02
EP Toxicity Limits	5	100	1	5	5	0.2	1	5

given in Table 3-5. All results are within the allowable pH range of 2 to 12.5. These results indicate that the treated SHLWS is not dangerous because of the corrosivity characteristic.

Table 3-5. Corrosivity Test Results for Solidified SHLWS

Sample ID	pH
PW-0 7-2	11.6, 11.6, 11.6
PW-0 42-2	11.5, 11.5, 11.5
PW-0 75-2	11.5, 11.6, 11.5
PW-0 87-2	11.5, 11.5, 11.5
PW-0 104-2	11.3, 11.3, 11.3
PW-0 144-2	11.3, 11.3, 11.3
PW-7A 171-1	11.5, 11.5, 11.5
PW-7A 191-1	11.4, 11.3, 11.3
PW-7A 220-1	11.5, 11.5, 11.5
PW-7A 231-1	11.6, 11.6, 11.6
PW-7A 273-1	11.5, 11.5, 11.5
PW-7A 276-1	11.5, 11.5, 11.5

3.2.4 Acute Toxicity

Acute fish toxicity (Biological Testing Method No. WDOE 80-12) was determined for a composite sample of solidified PW-0. The lethal concentration (LC_{50}) for this material was greater than 1,000 mg/L.

Acute rat toxicity (Biological Testing Method No. WDOE 80-12 Part B) was determined for two composite samples of solidified PW-0. The results demonstrated that the lethal dose (LD_{50}) for this material was greater than 5000 mg/kg of rat body weight.

3.2.5 Radioactivity

The radioactivity (gross gamma) of the treated PW-0 and PW-7A was calculated to be 35 pCi/g and 18 pCi/g, respectively. This is significantly less than the gross gamma of the untreated slurry (see Table 3-3) because of dilution provided by addition of the grout-formers and neutralizing material. In addition, the effective radiation dose from alpha and beta emitters within the waste is reduced significantly by treatment because of the self-shielding effect of the grout. As shown in Table 3-3, radiation from naturally occurring radionuclides in the untreated SHLWS is well below 2,000 pCi/g. Due to dilution, the concentrations of radionuclides in the treated waste are lower than those in the untreated waste. Wastes containing naturally occurring radionuclides below the 2,000 pCi/g threshold may be disposed of as nonradioactive solid waste.

3.3 REFERENCES

ASTM. 1985. "C-39-84, Standard Test Methods for Compressive Strength of Cylindrical Concrete Specimens." 1985 Annual Book of ASTM Standards, Volume 04.02 Concrete and Mineral Aggregates, American Society for Testing and Materials, Philadelphia, PA.

Lokken, R. O. 1989. Treatment of Excess Process Chemicals (Simulated High-Level Waste Slurry. PNL-6915, Pacific Northwest Laboratory, Richland, Washington.

4.0 PROCESS INFORMATION

The SHLWS T/S area was used for storage of containers of waste and for treatment of this waste by solidification/stabilization. The area is now used for storage of drums of treated SHLWS. The waste storage and treatment areas are separate, as shown in Figure 4-1. Details of the SHLWS storage area, less-than-90-day waste storage area, and treatment area are provided in Figures 4-2 through 4-4, respectively. The untreated SHLWS containers consisted of 55-gal (208-liter), polyethylene-lined, carbon steel drums, which were stored on pallets. The palletized drums were stored in two vinyl-lined storage areas having 4-in. spill containment curbs, as shown in Figure 4-2. Because of the corrosive nature of the SHLWS, some of the drums had corroded. Secondary containment was provided for these corroded drums by wrapping them with polyethylene and placing them in "Spil-Tainer" polyethylene containers. Each "Spil-Tainer" contained one drum; these were stored in a separate, unlined area as shown in Figure 4-2.

The SHLWS treatment was conducted in a separate area that is roped off and identified by warning signs. The SHLWS treatment process is summarized as follows.

1) A full pallet of four (4) SHLWS drums was transferred by fork-lift truck from the storage area to the treatment area and placed in a stainless steel spill containment pan.

2) The lids of the drums were removed and the contents homogenized by mixing with an air-driven drum mixer. The contents of each drum were adjusted to approximately 34 gal (130 liters) by pumping excess homogenized mixture into empty or partially filled polyethylene-lined drums.

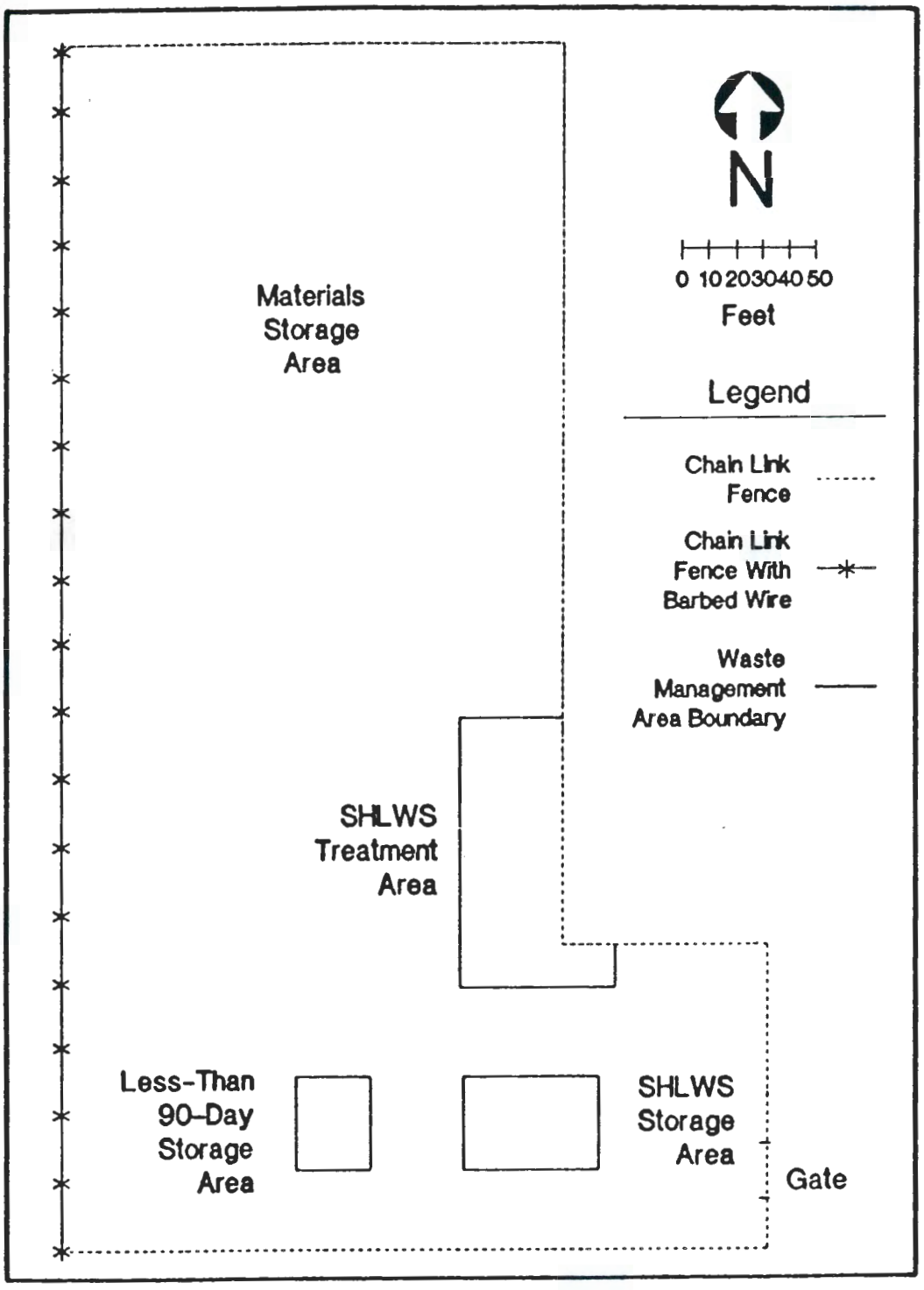

Figure 4-1. Layout of SHLWS Storage and Treatment Areas

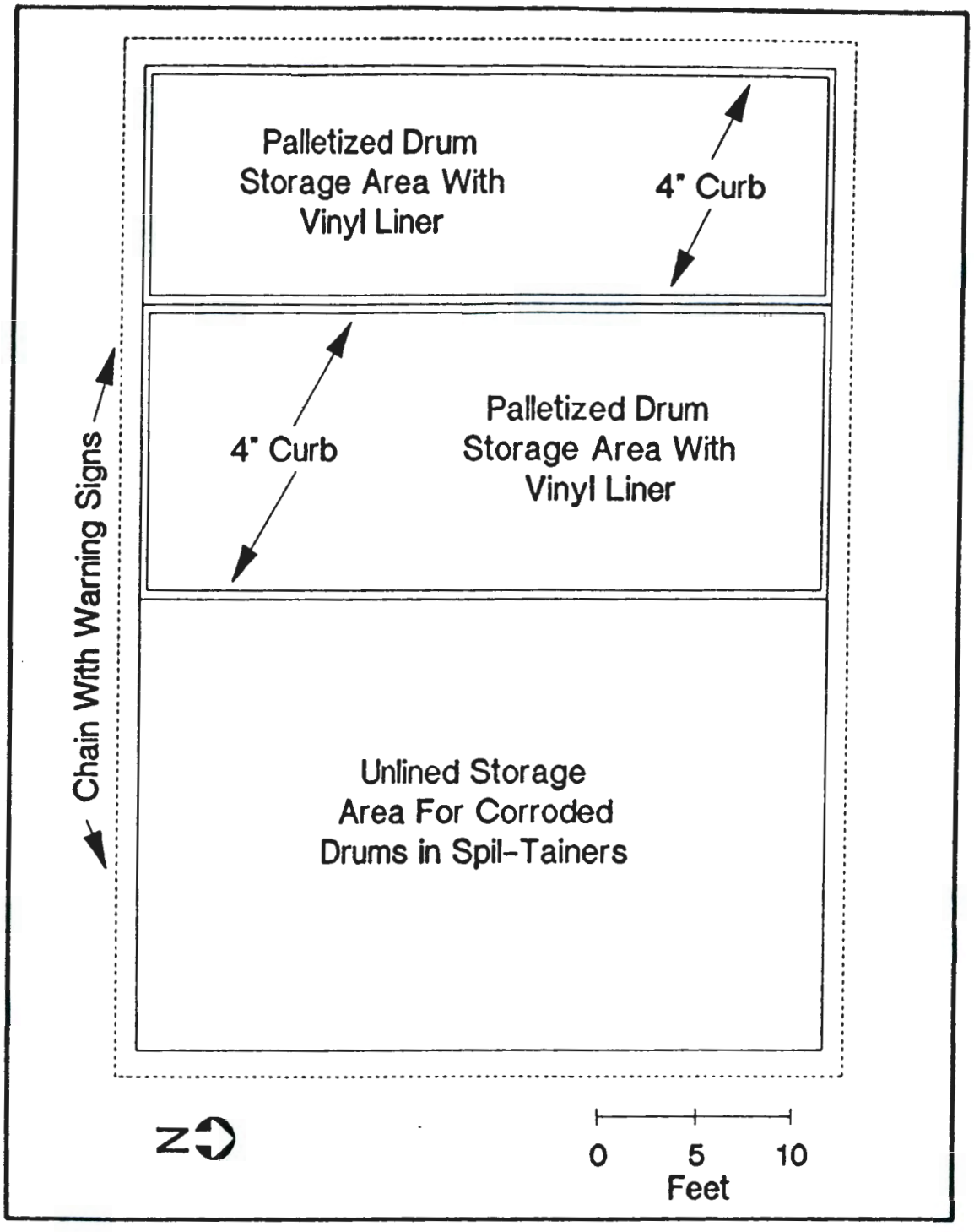

Figure 4-2. Details of the SHLWS Storage Area

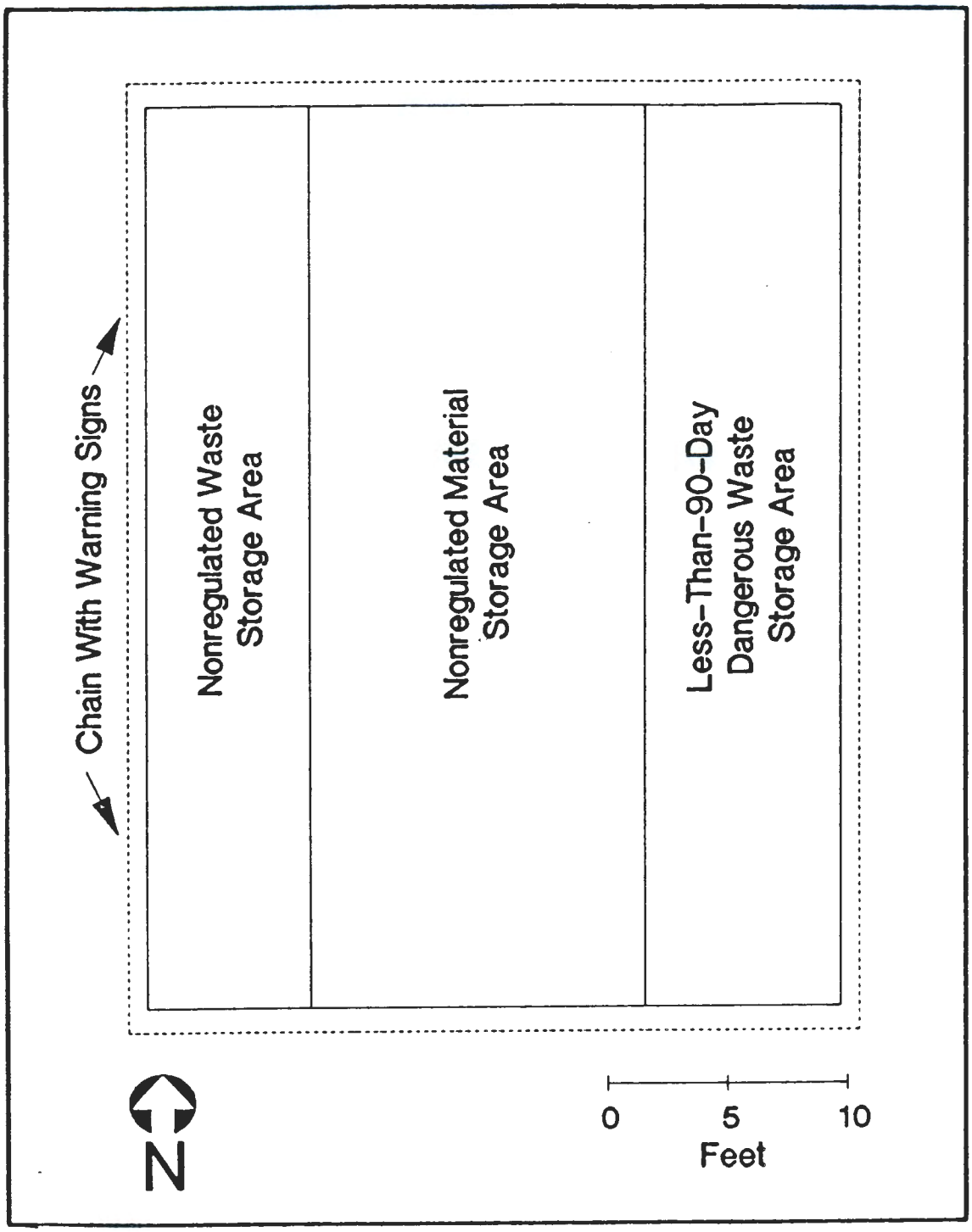

Figure 4-3. Details of the Less-Than-90-Day Waste Storage Area

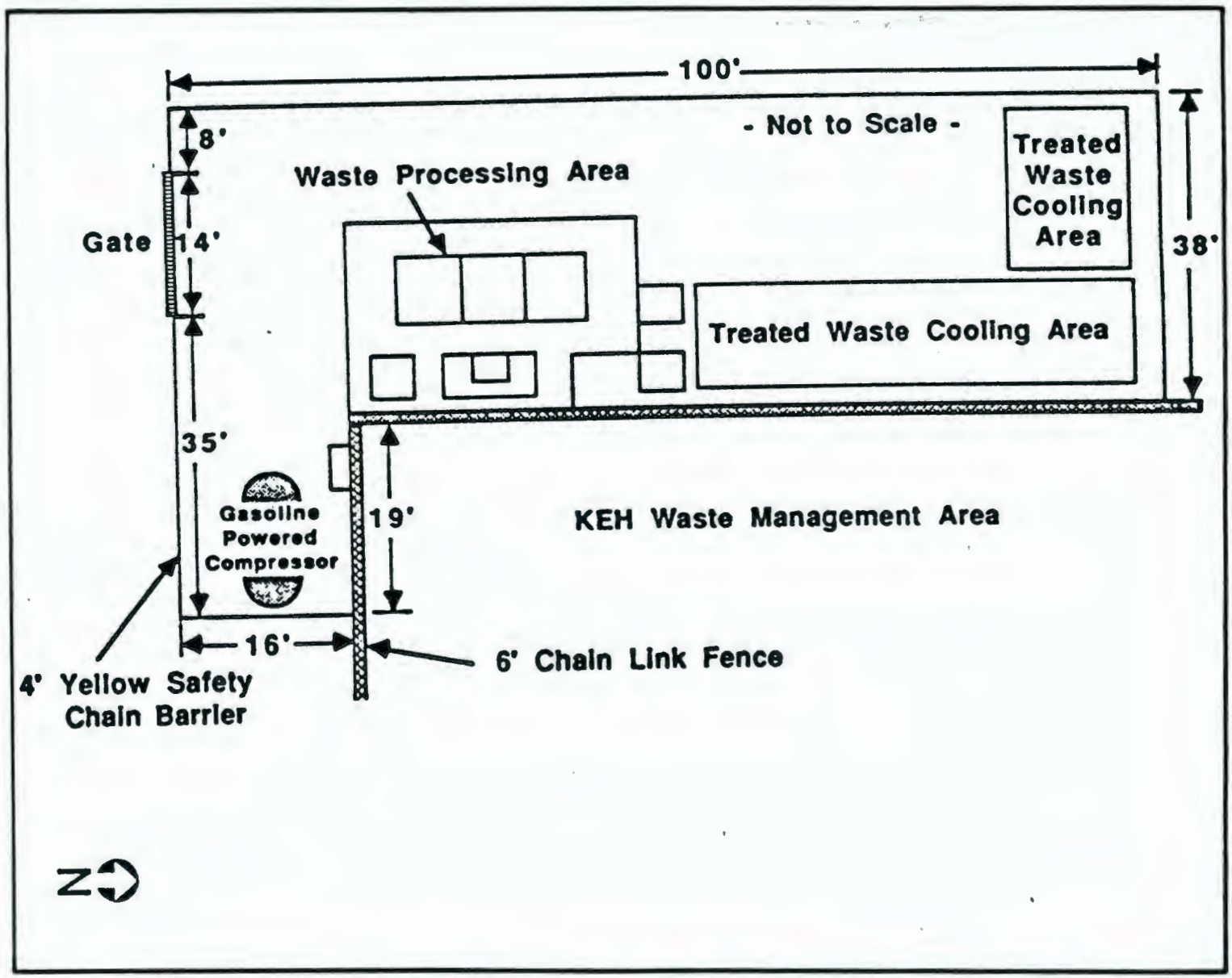

Figure 4-4. Details of the SHLWS Treatment Area

3) The pH of the waste mixture was adjusted to pH 6±0.5 by addition of 50% NaOH (19M). The caustic was added at a rate of approximately 0.5 gal/min (2 L/min) while mixing the slurry with an air-driven drum mixer. During caustic addition, the temperature of the slurry was monitored and caustic addition stopped if the temperature reached 85°C.

4) Following neutralization, the lid of the drum was replaced. When a pallet of drums had been neutralized, the pallet was transferred to a temporary storage area to allow the drums to cool to below 45°C (approximately 24 hours). The temporary storage area is adjacent to the mixing area and is lined with a 30-mil (0.076 cm) polyvinyl chloride (PVC) liner, which is curbed to provide spill containment and to control run-on and run-off.

5) Once the drums had cooled, the pallet was transferred back to the mixing area and placed in the spill pan. The drum lid was removed and the contents of the drum mixed with the air-driven drum mixer. The grout was formed by addition of one 80-lb (36-kg) bag of fly ash, one 90-lb (41 kg) bag of blast furnace slag, and one 94-lb (43-kg) bag of Portland cement.

6) A sample of grout was obtained at random from approximately one of every 12 drums of grout. The sampling frequency was selected based on a statistical analysis of sample rates necessary to provide 95% confidence that 99.9% of the treated drum contents would have the same characteristics as the analyzed samples. Samples were collected using a composite liquid waste sampler (COLIWASA). After sampling, the slurry samples were poured into plastic bottles for curing prior to testing. These samples were tested for EP toxicity, corrosivity, and acute fish and rat toxicity to verify that stabilization of the wastes had occurred and that hazardous constituents were not leachable from the treated wastes at levels of concern.

7) Following addition of the grout-forming chemicals, the drums were resealed and transferred to the temporary storage area for curing. The lids were temporarily left unsealed to eliminate the potential for pressure buildup caused by volume changes during curing.

8) Once the treated slurry was hardened, the drum lids were secured and the pallet of drums was transferred back to the SHLWS storage area.

Additional information describing the waste treatment process and related activities is contained in the "RCRA Plans 'Compliance Notebook' for Simulated High-Level Waste Treatment/Storage." This document contains plans for the SHLWS T/S unit required under WAC 173-303, including a waste analysis plan, security plan, general inspection plan, training plan, preparedness and prevention plan, contingency plan, emergency plan, facility recordkeeping plan, and facility reporting plan. A copy of this document is maintained at the SHLWS T/S unit and is available for review through the PNL Project Manager, Mr. H. W. Slater.

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5.0 GROUNDWATER MONITORING

Groundwater monitoring is not presently applicable to the SHLWS T/S unit. 40 CFR 265 Subpart F requires groundwater monitoring for landfills, impoundments, and land treatment sites only. As a container storage unit and treatment unit, the SHLWS T/S unit does not meet any of the three designations.

The need for groundwater monitoring at the SHLWS T/S unit will be determined as part of the closure activities described in Section 6.0 of this Plan. A soil sampling and analysis program will be implemented to verify removal of any contamination above the closure performance standard. The results of this sampling and analysis program will be used to determine if groundwater monitoring is necessary. If sampling and analysis results indicate that activities at the SHLWS T/S unit have resulted in groundwater contamination, a groundwater monitoring program will be implemented.

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6.0 CLOSURE AND POST-CLOSURE REQUIREMENTS

The SHLWS T/S unit currently contains drums of SHLWS that have undergone treatment by solidification/stabilization. Because the untreated SHLWS was originally designated as a radioactive mixed waste and later as a dangerous waste, a Part A permit application was submitted and the unit operated under interim status standards. As required under Section 6.3 of the Hanford Federal Facility Agreement and Consent Order Action Plan, the SHLWS T/S unit will be closed under final status standards in WAC 173-303-610. The treated wastes will be removed from the unit for disposal and the unit will not be used for any additional dangerous or radioactive mixed waste management activities.

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The purpose of this section is to demonstrate that the DOE-RL and PNL have developed a plan to ensure safe closure of the unit and adequate post-closure care in accordance with applicable regulations.

To aid in the evaluation of this Closure Plan, it has been organized corresponding to the headings of the closure/post-closure checklist given in Protocol for Evaluating Interim Status Closure/Post-Closure Plans, U.S. EPA, Office of Solid Waste. Reference is made to applicable sections of WAC 173-303 and 40 CFR 265.

6.1 GENERAL CLOSURE REQUIREMENTS

6.1.1 Partial and/or Final Closure Activities [40 CFR 265.111 and 265.112, WAC 173-303-610(2),(3)]

This Plan presents the activities required for final closure of the SHLWS T/S unit at its maximum extent of operation. Partial closure will not be conducted. Closure activities are presented in sufficient detail so that the closure process is understandable and a closure schedule can be developed.

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6.1.1.1 Closure Performance Standard [40 CFR 265.111, WAC 173-303-610(2)]

The SHLWS T/S unit will be closed in a manner that will minimize the need for further maintenance and minimize or eliminate post-closure release of dangerous/mixed wastes or dangerous/mixed waste constituents that could pose a risk to human health or the environment. This standard will be met by removal of all dangerous/mixed wastes and dangerous/mixed waste residuals from the site. All SHLWS stored at the unit has been treated using the process described in Section 4.0 of this Plan, and the treated waste will be removed from the unit for final disposition prior to beginning closure. All equipment at the unit will be decontaminated using the procedures described in Sections 6.3.2 and 6.11.2 of this Plan or removed from the unit for final disposition. All residuals resulting from decontamination will be removed from the unit for final disposition. Contaminated soils will be removed from the unit so that dangerous waste residuals in soils remaining on site are below the levels given in WAC 173-303-610(2)(b). The requirements of WAC 173-303-610(2)(b) dictate that residuals in soil do not exceed

> (i) background environmental levels for any dangerous waste managed at the facility that either is listed under WAC 173-303-081 or 173-303-082 or is designated by the characteristics of WAC 173-303-090; and
>
> (ii) at least the designation limits of WAC 173-303-084, or 173-303-101 through 173-303-103 for any dangerous waste managed at the facility that is not listed under WAC 173-303-081 or 173-303-082 and is not designated by the characteristics of WAC 173-303-090.

Determination of background levels of contaminants in soils will be made through sampling and analysis as described in the Sampling and Analysis Plan (SAP, Appendix A). These levels will be used to determine whether the

closure performance standards under WAC 173-3-3-610(2)(b)(i) has been met. If it is determined to be impractical to remove all such contaminated soils or other dangerous waste residuals such that the requirements of WAC 173-303-610(2)(b) are met, post closure care will be required in accordance with WAC 173-303-610(7). In this case, the Closure Plan will be amended, as described in Section 6.1.1.3, and a Post-Closure Plan will be prepared as described in Section 6.2.

6.1.1.2 Contents of Plan [40 CFR 265.112(b), WAC 173-303-610(3)(a)]

This Plan identifies the steps necessary to perform final closure of the unit. The Plan identifies how the SHLWS T/S unit will be closed in order to meet the closure performance standard given in Section 6.1.1.1. Section 6.1 addresses general regulatory requirements for closure of treatment, storage, and disposal (TSD) units. Section 6.2 addresses general post-closure requirements, which are not currently applicable because it is not planned to close the SHLWS T/S unit as a unit requiring post-closure care. Section 6.3 describes the procedures that will be undertaken to close the container storage areas at the SHLWS T/S unit, including removal of containers, decontamination of equipment, and removal of any contaminated soils. Section 6.11 describes the procedures that will be undertaken to close the treatment area at the SHLWS T/S unit, including decontamination of equipment and disposal of decontamination wastes. Sections 6.4 through 6.10 are not applicable because they address closure requirements of other types of TSD units.

6.1.1.2.1 Maximum Inventory of Wastes, Removal of Wastes [40 CFR 265.112(b)(3), WAC 173-303-610(3)(a)(iii),(iv)]

Before treatment operations began, the SHLWS T/S unit contained 100 drums of PW-0 waste, 98 drums of PW-7A waste, 1 drum of 50% PW-0 and 50% PW-7A waste, and 11 drums of secondary waste, including drum liners,

absorbent, and soil. Because of the volume addition associated with treatment, the 199 drums of SHLWS resulted in a total of 306 drums of treated waste. No additional wastes will be added to this inventory. This inventory represents the maximum inventory of dangerous/mixed wastes on site in the SHLWS container storage area during the active life of the unit. The SHLWS T/S unit also contains a less-than-90-day dangerous waste storage area that was formerly used to accumulate drummed dangerous wastes. The maximum inventory of wastes stored in this area at any one time was 79 drums. The less-than-90-day storage area is currently inactive and all wastes accumulated in this area have been removed to the 305-B Storage Building, which is permitted under interim status for storage of dangerous and mixed wastes. The SHLWS storage area, SHLWS treatment area, and less-than-90-day waste storage area (see Figure 2-4) represent the maximum extent of the unit (used for dangerous/mixed waste management) operational during its active life.

The process used to treat the SHLWS is described in Section 4.0. Methods to be used for removing, transporting, storing, or disposing of all dangerous/mixed wastes at the time of closure are described in Sections 6.3 and 6.11 for the container storage areas and treatment area, respectively.

6.1.1.2.2 Removal and Decontamination Procedures [40 CFR 265.112(b)(4)), WAC 173-303-610(3)(a)(v)]

Steps for removing or decontaminating all dangerous/mixed waste residues and contaminated equipment are described in Sections 6.3 and 6.11 for the container storage areas and treatment area, respectively.

6.1.1.2.3 Other Activities During Closure Period [40 CFR 265.112(b)(5); WAC 173-303-610(3)(a)(vi)]

This Closure Plan for the SHLWS T/S unit is based upon removal of all dangerous/mixed wastes and dangerous/mixed waste residues. Control of run-on

and run-off will be accomplished by performing closure activities (e.g., equipment decontamination) within bermed collection areas. All liquids collected in the bermed collection areas will be managed as liquid decontamination wastes, as described in Section 6.3.2.2. Other activities such as groundwater monitoring and leachate collection are currently deemed unnecessary. Groundwater monitoring and leachate collection are not required for container storage areas under WAC 173-303-645 and WAC 173-303-630, respectively. If, during implementation of this Closure Plan, it becomes evident that all dangerous/mixed waste residuals cannot be practicably removed, other closure activities will be identified and the Closure Plan will be amended.

6.1.1.2.4 Closure Schedule [40 CFR 265.112(b)(6),(7), WAC 173-303-610(3)(a)(vii)]

Closure of the SHLWS T/S unit is scheduled to begin in 1990. A detailed schedule of closure activities is presented in Sections 6.3.1.8 and 6.11.1.8 for the container storage areas and treatment area, respectively.

6.1.1.3 Amendment of Closure Plan [40 CFR 265.112(c), WAC 173-303-610(3)(b)]

No changes in unit design or year of closure are expected that would require amendment to the Closure Plan. Unexpected events (e.g., discovery of dangerous/mixed waste residuals that cannot be removed) could be encountered during implementation of closure activities. If so, the Closure Plan will be amended and resubmitted to EPA and Ecology within 30 days of encountering such an unexpected event. The PNL Project Manager, Mr. H. W. Slater, will be responsible for amendment of the Plan. The amended plan will be resubmitted to EPA and Ecology by PNL and DOE-RL.

6.1.1.4 Notification of Closure [40 CFR 265.112(d), WAC 173-303-610(3)(c)]

This Closure Plan was submitted to EPA and Ecology in September 1989. This deadline for submission corresponds to Interim Milestone M-20-19 of the Action Plan for Implementation of the Hanford Consent Order and Compliance Agreement (Action Plan).

Ecology will be notified in writing by the Project Manager at least 45 days prior to beginning final closure.

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6.1.1.5. Closure Activities Performed Prior to Notification of Closure [40 CFR 265.112(e), WAC 173-303-610(3)(c)(iv)]

No closure activities described in this Plan will be undertaken prior to approval of the Closure Plan and notification of EPA and Ecology. The only activities at the unit which may be performed prior to initiation of final closure are removal and disposal of treated SHLWS wastes that are no longer dangerous wastes and the T/S area liner material and establishment of background concentrations of contaminants in soil. The treated SHLWS wastes will be removed and disposed of at a facility authorized to receive wastes. The T/S area liner material has been drummed and transported to the 305B Building for disposal as a hazardous material. Information concerning treatment of the SHLWS and the characteristics of the treated wastes was submitted by PNL and DOE-RL to Ecology in June 1989. Approval was received from the Washington Department of Ecology on September 25, 1989 and April 17, 1990 to disposal of the grouted material as unregulated material. Approval was also received from Ecology to dispose of the liner material as hazardous waste on April 11, 1990.

Prior to initiating closure activities, background concentrations of contaminants will be determined for the purpose of establishing soil cleanup levels for certain contaminants. These background levels will be established

by sampling and analysis as described in the SAP (Appendix A). The background concentrations to be used as cleanup levels will be submitted to Ecology for approval before beginning final closure. Final closure will not begin until these levels have been approved by Ecology.

6.1.2 Time Allowed for Closure [40 CFR 265.113, WAC 173-303-610(4)]

6.1.2.1 Extension of Closure Timeframe [40 CFR 265.113(a),(b), WAC 173-303-610(4)(a)(b)]

All dangerous wastes have been treated and rendered nondangerous or removed from the unit. There are, therefore, no dangerous or mixed wastes requiring treatment or removal within 90 days after the start date specified in the notification letter to Ecology. The closure activities described in this Plan is expected to be completed within 180 days of the start date specified in the notification letter to Ecology. No extension to the timeframe for initiation and completion of closure is currently expected to be necessary. If a an extension is requested, it will be made consistent with WAC 173-303-610(4)(b).

6.1.2.2 Timeframes for Demonstrations for Extensions [40 CFR 265.113(c), WAC 173-303-610(4)(c)]

Extensions to the timeframes for closure would only be necessary if unexpected conditions were encountered during closure of the unit. If it becomes apparent that closure cannot be completed within 180 days after the start date specified in the notification letter, EPA and Ecology will be so notified at least 30 days prior to expiration of the 180 day period. This notification will demonstrate why more than 180 days is required for closure and will demonstrate that steps have been taken to prevent threats to human health and the environment and that the unit is in compliance with applicable interim status standards. The PNL Project Manager, Mr. H. W. Slater, will be

responsible for preparing the notification, that will be submitted by PNL and DOE-RL.

6.1.3 Disposal or Decontamination of Equipment, Structures, and Soils [40 CFR 265.114, WAC 173-303-610(5)]

Steps for disposing of or decontaminating all contaminated equipment, structures, and soils are described in Sections 6.3.2 and 6.11.2 for the container storage areas and treatment area, respectively.

6.1.4 Certification of Closure [40 CFR 265.115, WAC 173-303-610(6)]

Within 60 days of completion of the final closure activities described in this Plan, a certification of closure will be submitted to EPA and Ecology. This certification will indicate that the SHLWS T/S unit has been closed as described in this Plan and that the closure performance standards given in Section 6.1.1.1 have been met. The certification will be submitted by registered mail and will be signed by the Manager of DOE-RL (or his authorized representative) and an independent professional engineer registered in the State of Washington.

6.1.4.1 Owner/Operator Closure Certification

The DOE-RL will self-certify with the following document or a document similar to it:

> I, (name), an authorized representative of the U.S. Department of Energy-Richland Operations Office located at the Federal Building, 825 Jadwin Avenue, Richland, Washington, hereby state and certify that the Simulated High-Level Waste Slurry Treatment and Storage Unit at the 3000 Area, to the best of my knowledge and belief, has been closed in accordance with the attached approved Closure Plan, and that the closure was completed on (date). (Signature and date).

6.1.4.2 Professional Engineer Closure Certification

The DOE-RL will engage an independent Professional Engineer registered in the State of Washington to certify that the SHLWS T/S unit has been closed in accordance with this Closure Plan. The DOE-RL will require the engineer to sign the following document or a document similar to it:

> I, (name), a certified Professional Engineer, hereby certify, to the best of my knowledge and belief, that I have made visual inspection(s) of the Simulated High Level Waste Slurry Treatment and Storage Unit at the 3000 Area and that closure of the aforementioned unit has been performed in accordance with the attached approved Closure Plan. (Signature, date, state Professional Engineer license number, business address, and phone number).

6.1.5 Survey Plat [40 CFR 265.116, WAC 173-303-610(9)]

This Closure Plan does not presently call for the SHLWS T/S unit to be closed as a dangerous/mixed waste disposal unit. As a result, submission of a survey plat indicating the location of disposal areas is not required. If, during closure, it is determined that it is necessary to close any areas as dangerous/mixed waste disposal units, the Closure Plan will be amended. The amended Plan would include surveying all areas to be closed as disposal units and submitting a survey plat indicating the location of these units to Ecology, EPA, the City of Richland, and Benton County.

The survey plat will indicate the locations and dimensions of the disposal units with respect to permanently surveyed benchmarks. This plat will be prepared by a certified professional land surveyor. The following notice is to accompany the survey plat:

"This plat describes real property in which dangerous wastes have been disposed of in accordance with the requirements of WAC 173-303-610(9) and WAC 173-303-610(10). Although this dangerous waste disposal unit is now closed, regulations issued by the State of Washington in WAC 173-303-610(9) and WAC 173-303-610(10) require that the post-closure use of the property never be allowed to disturb the integrity of the final cover unless it can be demonstrated that any proposed disturbance will not increase the risk to human health and the environment."

6.1.6 Post-Closure Notices [40 CFR 265.119, WAC 173-303-610(10)]

6.1.6.1 Record of Wastes [40 CFR 265.119(a), WAC 173-303-610(10)(a)]

This Closure Plan does not presently call for the SHLWS T/S unit to be closed as a dangerous/mixed waste disposal unit, therefore, submission of records of the types, locations, and quantities of dangerous/mixed wastes disposed of is not required. If, during closure, it is determined that it is necessary to close any areas as dangerous/mixed waste disposal units, the Closure Plan will be amended. Under the amended Plan, the PNL Project Manager, Mr. H. W. Slater, would be responsible for assembling and maintaining such records. These records would be submitted by PNL and DOE-RL to Ecology, EPA, the City of Richland, and Benton County.

6.1.6.2 Notice in Deed [40 CFR 265.119(b), WAC 173-303-610(10)(b)]

This Closure Plan does not presently call for the SHLWS T/S unit to be closed as a dangerous/mixed waste disposal unit; therefore, submission of notice to be placed in the deed of the property describing use of the land for disposal of dangerous/mixed wastes is not required. If, during closure, it is determined that it is necessary to close any areas as dangerous/mixed waste disposal units, the Closure Plan will be amended. The amended Plan

would include preparation of an appropriate notice for the property deed to ensure that future land uses are compatible with the maintenance of the integrity of the closed disposal units. This notice would be similar to the survey plat notice previously identified in Section 6.1.5.

6.1.6.3 Certification of Notice [40 CFR 265.119(b)(2), WAC 173-303-610(10)(b)(ii)]

If a notice to the property deed is required under an amended Closure Plan, as described in Section 6.1.6.2, a certification will be made upon preparation of this notice. This certification will include a copy of the property deed containing the notice. The certification will be signed by DOE-RL and submitted to Ecology and EPA.

6.1.7 Closure Cost Estimate [40 CFR 265.142, WAC 173-303-620(3)]

In accordance with 40 CFR 264. 140 (c) and WAC 173-303, this section is not required for federal facilities. The Hanford Site is a federally owned facility for which the federal government is an operator and this section is therefore not applicable to the SHLWS T/S unit.

6.1.8 Financial Assurance for Closure [40 CFR 265.143, WAC 173-303-620(4)]

In accordance with 40 CFR 264. 140 (c) and WAC 173-303, this section is not required for federal facilities. The Hanford Site is a federally owned facility for which the federal government is an operator and this section is therefore not applicable to the SHLWS T/S unit.

6.1.9 Liability Requirements [40 CFR 265.147, WAC 173-303-620(8)]

In accordance with 40 CFR 264. 140 (c) and WAC 173-303, this section is not required for federal facilities. The Hanford Site is a federally owned

facility for which the federal government is an operator and this section is therefore not applicable to the SHLWS T/S unit.

6.2 GENERAL POST-CLOSURE CARE REQUIREMENTS [40 CFR 265.117 - 265.120, 265.144, 265.145; WAC 173-303-610(7),(8),(11), -620(5),(6)]

As currently described in this Closure Plan, the SHLWS T/S unit will not be closed as a dangerous/mixed waste disposal unit. As a result, post-closure care requirements are not applicable per 40 CFR 265.110(b) and WAC 173-303-610(1)(b). If, during closure, it is determined that all dangerous/mixed waste residues cannot practicably be removed, the Closure Plan will be amended and additional procedures developed for meeting the closure performance standard given in Section 6.1.1.1. These additional procedures may require post-closure care. If so, a post-closure plan will be prepared that addresses the applicable requirements of 40 CFR 265.117 through 40 CFR 265.120 and WAC 173-303-610(7) through WAC 173-303-610(11). The post-closure plan will be prepared, reviewed by the City of Richland, and submitted to EPA and Ecology within 90 days of determination of the need for such a plan. Preparation of the plan will be the responsibility of the PNL Waste Technology Center and DOE-RL.

It is noted that if a post-closure plan is necessary, a post-closure cost estimate (40 CFR 265.144) and a financial assurance mechanism for post-closure care (40 CFR 265.145) will not be required because federal facilities are exempted from those requirements per 40 CFR 265.140(c).

6.3 CLOSURE OF CONTAINER STORAGE AREAS

6.3.1 Contents of Plan [40 CFR 265.112(b), WAC 173-303-610(3)(a)]

This Plan addresses closure activities for the SHLWS container storage area and the less-than-90-day waste accumulation area at the SHLWS T/S unit.

It is noted that a closure plan is not strictly required for the less-than-90-day waste accumulation area. This accumulation area does, however, constitute a solid waste management unit (SWMU) under RCRA Section 3004(u). This Plan, therefore, will address removal of dangerous/mixed wastes and dangerous/mixed waste residuals from both of these container storage areas.

6.3.1.1 Description of How Each Unit Will Be Closed [40 CFR 265.112(b)(1), WAC 173-303-610(3)(a)(i)]

The container storage areas at the SHLWS T/S unit will be closed by removal of all dangerous/mixed wastes and dangerous/mixed waste residues. All SHLWS was been treated and the treated wastes will be removed for disposal prior to beginning closure. The vinyl liner beneath the drum storage area was removed and disposed of as a dangerous waste.

All dangerous waste containers at the less-than-90-day storage area were removed from the SHLWS T/S unit prior to beginning closure.

All soils beneath the SHLWS drum storage area or less-than-90-day storage area having visual appearance of contamination by past waste leakage or spillage will be removed and disposed of as dangerous waste or mixed waste. Removal of all contaminated soils will be verified by sampling and analysis, as described in the SAP (Appendix A). If, during closure, it is determined that all dangerous/mixed waste residues cannot practicably be removed, the Closure Plan will be amended and additional procedures will be developed for meeting the closure performance standard given in Section 6.1.1.1.

Performance of these closure activities will be the responsibility of the PNL Waste Technology Center. The activities will be completed by staff who have undergone 40-hour hazardous waste health and safety training meeting the requirements of 29 CFR 1910.120. Staff on-site will wear personnel protective equipment specified in the Health and Safety Plan to be prepared

and approved by the PNL Laboratory Safety Department prior to beginning closure.

6.3.1.2 Description Of How Final Closure Will Be Conducted [40 CFR 265.112(b)(2), WAC 173-303-610(3)(a)(ii)]

Because of the condition of the vinyl liner at the SHLWS storage area and difficulty associated with decontamination, the liner material was disposed of rather than decontaminated. For disposal, the liner was cut into strips approximately 30 in. (76 cm) wide. The strips were rolled to fit into an open-top 55-gal (208-L) drum. Each drum was filled with liner material, sealed, labeled, manifested, and transported to a permitted TSD unit.

Removal of contaminated soils is described in Section 6.3.1.6.

Following completion of all closure activities, closure will be certified as described in Section 6.1.4.

6.3.1.3 Identification of the Maximum Extent of Operation [40 CFR 265.112(b)(2), WAC 173-303-610(3)(a)(ii)]

The SHLWS storage area and less-than-90-day waste storage area (see Figure 2-4) represent the maximum extent of the unit used for storage of dangerous and mixed waste containers. These two areas occupy approximately 1,800 and 1,100 square ft (160 and 100 square m), respectively.

6.3.1.4 Estimate of the Maximum Inventory of Dangerous Wastes [40 CFR 265.112(b)(3), WAC 173-303-610(3)(a)(iii)]

Prior to beginning treatment, the SHLWS container storage area contained 100 drums of PW-0, 98 drums of PW-7A, 1 drum of 50% PW-0 and 50% PW-7A, and 11 drums of secondary waste (drum liners, absorbent, soil). The

199 drums of SHLWS and 11 drums of secondary waste have been solidified within 306 drums. The characteristics of these wastes are described in Section 3.0. These characteristics indicate that the solidified wastes are not dangerous. No additional wastes are to be added to this inventory prior to closure. This inventory (43.7 M^3 liters) represents the maximum inventory of dangerous/mixed wastes stored at the SHLWS container storage area during the active life of the unit. The maximum inventory of dangerous wastes stored in the less-than-90-day storage area was 79 drums (13,500 liters). All wastes have been removed from the less-than-90-day area. The less-than-90-day area is currently inactive.

6.3.1.5 Detailed Description of Removal of Waste Inventory [40 CFR 265.112(b)(3), WAC 173-303-610(3)(a)(iv)]

Drums of treated SHLWS will be removed from the storage area prior to beginning final closure. The treated wastes will be loaded onto a truck and transported to a solid waste landfill authorized to receive such wastes.

All drums at the less-than-90-day storage area have been transferred to the 305-B Building, which is permitted under interim status for storage of dangerous and mixed wastes. These drums were sealed and labeled according to the requirements of WHC-CM-5-16, Nonradioactive Dangerous Waste Packaging and Disposal Requirements, and were transported by truck to 305-B.

During closure activities, drums of liquid decontamination wastes and other wastes (e.g., protective clothing, contaminated soil) will be generated. Removal and management of these wastes is described in Section 6.3.2.2.

6.3.1.6 Detailed Description Of Removal Of Waste Residues [40 CFR 265.112(b)(4), 265.114, WAC 173-303-610(3)(a)(v)]

Dangerous/mixed waste residues at the SHLWS container storage areas are expected to consist of soils contaminated by past leakage from containers. Identification of soils to be removed will be based on visual inspection for evidence of contamination. All soils which are visibly contaminated will be removed. A statistical sampling program, as described in the SAP, will be used to determine whether the remaining soils (i.e., those without visible contamination) meet the closure performance standard given in Section 6.1.1.1. It is currently expected, based on observations of the areas, that any significant contamination will be limited to surface soils. Shallow contaminated soils will be excavated by hand or using a backhoe, depending on extent, and transferred to 55-gal (208-L) open-top drums. Drum loading operations will be conducted over reinforced polyethylene tarps to contain any soil that may be spilled and to avoid further soil contamination. After all drums are loaded, the tarps and any soil residuals on them will be drummed. All drums will be sealed; labeled; manifested according to the requirements of WHC-CM-5-16, Nonradioactive Dangerous Waste Packaging and Disposal Requirements and WAC-173-240-270; and transferred to a permitted TSD unit. Prior to excavation, the soils will be given a radiological survey to determine whether they will be managed as dangerous wastes or RMW. Radiation surveys will be conducted in accordance with PNL-MA-6, Radiation Protection and PNL-MA-507, Procedures for Radiation Protection Technologists. Removal of contaminated soil sufficient to meet the closure performance standard will be verified through the sampling and analysis program described in Appendix A. Sampling and analysis will be conducted according to a Quality Assurance Project Plan (QAPjP) (see Appendix B) prepared in accordance with "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," QAM-005/80.

Following confirmation analysis, exhumed soil will be replaced with clean fill and the site graded to return it to its original state.

If the analyses indicate that the closure performance standard has not been met, the Closure Plan will be amended. The amended Plan will include methods for further characterizing the extent of soil contamination and for removal or stabilization of the contaminated soil to meet the closure performance standard given in Section 6.1.1.1. If sampling and analysis results are suggestive of the potential for deep soil contamination, the amended plan will also address characterization of possible groundwater contamination, and will include a groundwater monitoring plan to assess groundwater contamination if necessary.

6.3.1.7 Detailed Description of Other Necessary Activities [40 CFR 265.112(b)(5), WAC 173-303-610(3)(a)(vi)]

The closure of the container storage areas is based upon removal of all dangerous/mixed wastes and dangerous/mixed waste residues. Other activities such as groundwater monitoring, leachate collection, and run-on and run-off control are not expected to be necessary based on current knowledge. If, during implementation of the Closure Plan, it becomes evident that all dangerous/mixed waste residuals cannot be practicably removed, the Closure Plan will be amended and other closure activities will be identified.

6.3.1.8 Schedule for Closure of Each Unit [40 CFR 265.112(b)(6), WAC 173-303-610(a)(vii)]

A detailed schedule for closure is presented in Figure 6-1.

6.3.2 Decontamination Procedures [40 CFR 265.112(b)(4), 265.114, WAC 173-303-610(3)(a)(v), (5)]

Decontamination efforts during closure of the container storage areas will involve decontamination of sampling equipment and soil excavation equipment. Removal of contaminated soil was previously described in Section 6.3.1.6.

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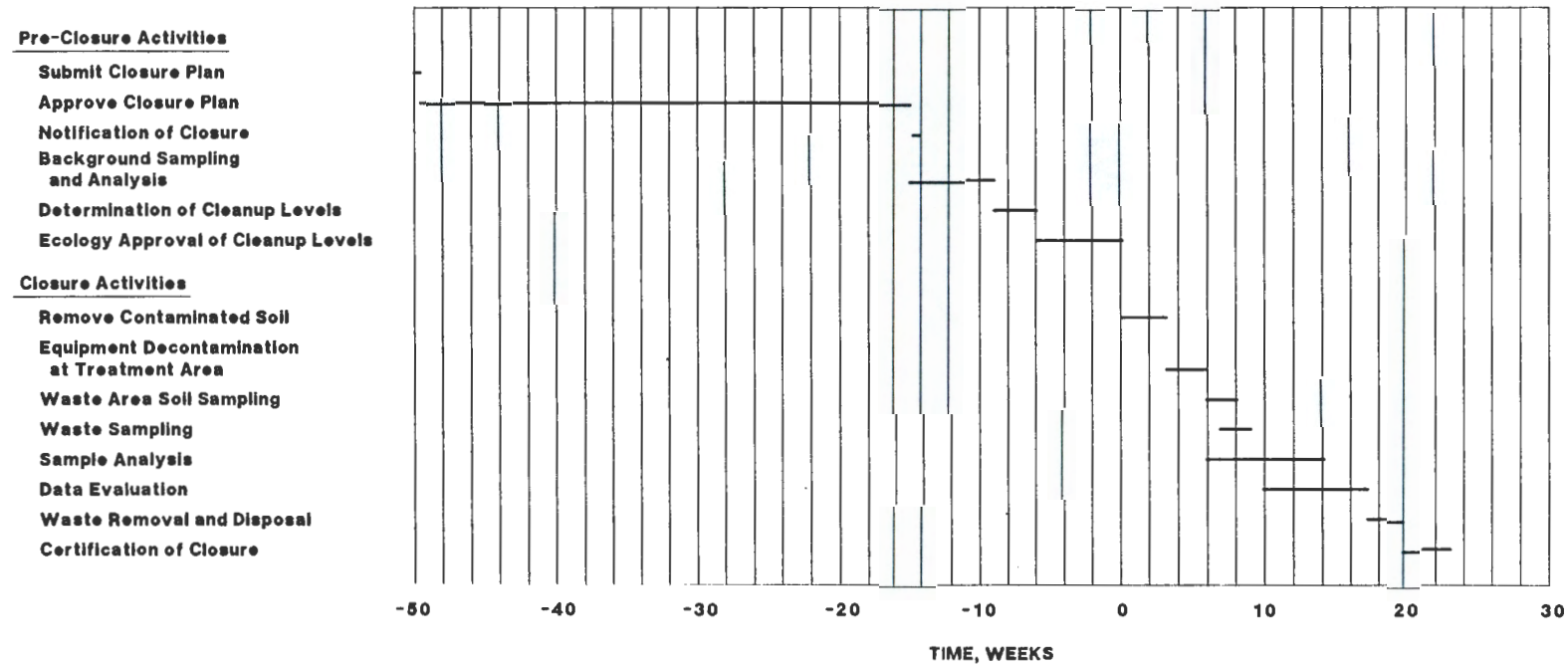

Figure 6-1. Closure Schedule

6.3.2.1 Procedures for Cleaning Equipment and Removing Contaminated Soils [40 CFR 265.112(b)(4), WAC 173-303-610(3)(a)(v)]

Nondisposable sampling equipment, and any other small nondisposable equipment which comes into contact with dangerous/mixed wastes, will be decontaminated at the container storage areas immediately after use. Decontamination will be performed as follows:

1) Equipment will be given a radiological survey to determine whether it is radioactively contaminated. Radiological surveys will be performed using procedures specified in PNL-MA-507, Procedures for Radiation Protection Technologists. Separate decontamination lines will be used for radioactively contaminated equipment and other equipment, and decontamination wastes from these two lines will be segregated. The two lines will use identical decontamination procedures.

2) Equipment will be thoroughly scrubbed using a laboratory nonphosphate detergent such as Alconox until all signs of contamination are removed.

3) Equipment will be thoroughly rinsed with clean tap water, being certain that no detergent is left on the equipment.

4) Equipment used for collection of samples for organic analysis will be thoroughly rinsed with pesticide-grade hexane and allowed to air dry.

5) Equipment will be given a final rinse with deionized water. Samples of rinse water will be periodically collected for equipment blanks to verify decontamination.

6) If the equipment is not to be used immediately, it will be allowed to air dry and will be wrapped with aluminum foil, with the dull side of the foil toward the equipment.

7) All equipment will be surveyed by a radiation protection technologist (RPT) to confirm radiologic decontamination.

All decontamination wastes will be collected in polyethylene-lined drums or polyethlene carboys. Polyethylene is compatible with the dilute detergent and hexane which will be present in the decontamination wastes. Prior to decontamination, equipment will be radiologically surveyed to determine if radioactive contamination is present. Decontamination wastes from radioactively contaminated equipment will be kept separate from wastes from nonradioactively contaminated equipment. Decontamination wastes (e.g., rinse water, spent hexane) will also be segregated and placed in separate containers.

Large contaminated equipment from the container storage areas (e.g., excavation equipment) will be decontaminated at the SHLWS treatment area over stainless steel drip pans. For equipment too large for the drip pans, a bermed area will be formed within the temporary drum storage area. These activities are described in Section 6.11.2.1.

To minimize generation of decontamination wastes, disposable tools and equipment will be used to the extent possible. The disposable equipment will be collected in polyethylene-lines drums or roll-off boxes for disposal as dangerous waste or mixed waste, depending on the results of radiological surveys.

Removal of contaminated soils was described previously in Section 6.3.1.6.

6.3.2.2 Management of Generated Wastes [40 CFR 265.114, WAC 173-303-610(5)]

Wastes that may be generated during closure of the container storage areas include personnel protective clothing, liners used to control spills

during decontamination and drum loading operations, soil contaminated with dangerous/mixed waste constituents, disposable equipment, liquid decontamination wastes, and pallets. Soils and liquid decontamination wastes will be sampled according to the Sampling and Analysis Plan (Appendix A) to determine whether they are dangerous wastes. Wastes that are designated as dangerous wastes will be drummed, properly labeled and manifested, and shipped to a permitted storage area (i.e., 616 Building or 305-B Building). All wastes that are determined to be Radioactive Mixed Waste (RMW) will be drummed and labeled, manifested, and shipped to an appropriate storage area. Container management procedures for dangerous and mixed wastes will be according to the requirements of WHC-CM-5-16, Nonradioactive Dangerous Waste Packaging and Disposal Requirements, which complies with 40 CFR 262 and WAC 173-303-170 through -190. Solid wastes that are determined to be contaminated only with radioactivity will be managed as low-level radioactive wastes and shipped to the 200 Area Burial Grounds. Liquid wastes that are nondangerous but radioactively contaminated will be drummed and transferred to an appropriate liquid low-level waste (LLLW) management unit in the 200 Area or 300 Area. Solid wastes which are nondangerous and nonradioactive will be disposed of at a facility authorized to receive such waste. Liquid wastes which are nondangerous and nonradioactive may be disposed of to the City of Richland sewer system with prior approval of the City. A request for such disposal, including an analysis of the wastes, will be made to the City. If such approval is not granted, the wastes will be disposed of to the 300 Area process sewer.

Personnel protective clothing will be collected in drums. Prior to placement in drums, the clothing will be radiologically surveyed to determine if it is radioactively contaminated. Radioactive and nonradioactive clothing will be segregated. All waste protective clothing will be handled as dangerous waste or RMW.

Disposal of the liner from the drum storage area was previously described in Section 6.3.1.2.

The pallets will be disposed of as dangerous waste or sampled to determine their designation status.

Soils contaminated with dangerous waste residues will be drummed and disposed of as dangerous waste, RMW, or solid waste, depending on the waste designation. The designation of soil wastes will be based on the results of the soil sampling and analysis described in Appendix A.

Liquid decontamination wastes will be sampled and analyzed as described in Appendix A to determine the proper method of management. Sampling will not be performed if it is possible to designate the wastes as dangerous wastes by some other means. These wastes may be managed as dangerous, RMW, LLLW, or nondangerous-nonradioactive. All liquid wastes from decontamination of radioactively contaminated equipment will be disposed of as RMW or LLLW.

6.3.2.3 Methods for Sampling and Testing to Demonstrate Success of Decontamination [40 CFR 265.112(b)(4), WAC 173-303-610(3)(a)(v)]

Decontaminated equipment will be sampled to determine the effectiveness of chemical decontamination. Swipe samples will be collected from the surface of decontaminated equipment, as described in the SAP (Appendix A). These swipe samples will be analyzed to verify that all surface contamination has been removed from equipment. Decontamination of sampling equipment will also be verified by analysis of the final decontamination rinse water, as described in Appendix A. All equipment will be radiologically surveyed following decontamination to verify that all radioactivity is below release limits given in PNL-MA-6, Radiation Protection.

The effectiveness of the removal of contaminated soils will be based on sampling and analysis, as described in Appendix A.

6.3.2.4 Criteria for Determining the Extent of Decontamination Necessary [40 CFR 265.112(b)(4), WAC 173-303-610(3)(a)(v)]

Criteria for decontamination will depend on the type of material being decontaminated. All nondisposable sampling equipment will be decontaminated following use, primarily to avoid cross-contamination of samples. All other equipment which comes into contact with dangerous/mixed wastes will be decontaminated. Soils beneath the drum storage areas having visual evidence of contamination will be removed. In addition, all soils shown by sampling and analysis to be contaminated will be removed.

6.4 CLOSURE OF TANKS

These requirements are not applicable to the SHLWS T/S unit.

6.5 CLOSURE OF SURFACE IMPOUNDMENTS

These requirements are not applicable to the SHLWS T/S unit.

6.6 CLOSURE OF WASTE PILES

These requirements are not applicable to the SHLWS T/S unit.

6.7 CLOSURE OF LAND TREATMENT UNITS

These requirements are not applicable to the SHLWS T/S unit.

6.8 CLOSURE OF LANDFILLS

These requirements are not applicable to the SHLWS T/S unit.

6.9 CLOSURE OF INCINERATORS

These requirements are not applicable to the SHLWS T/S unit.

6.10 CLOSURE OF THERMAL TREATMENT UNITS

These requirements are not applicable to the SHLWS T/S unit.

6.11 CLOSURE OF CHEMICAL, PHYSICAL, AND BIOLOGICAL TREATMENT UNITS [40 CFR 265.404]

6.11.1 Contents of Plan [40 CFR 265.112(b)]

This Plan addresses closure activities for the SHLWS treatment area at the SHLWS T/S unit.

6.11.1.1 Description of How Each Unit Will Be Closed [40 CFR 265.112(b)(1)]

The treatment area at the SHLWS T/S unit will be closed by removal of all dangerous/mixed wastes and dangerous/mixed waste residues. All equipment in the treatment area will be decontaminated to remove dangerous/mixed waste residuals or disposed of. All dangerous/mixed wastes resulting from decontamination activities will be removed from the unit.

All soils beneath the SHLWS treatment area having visual appearance of contamination by past waste leakage or spillage will be removed and disposed of as dangerous waste or mixed waste. Removal of all contaminated soils will be verified by sampling and analysis, as described in the SAP. If, during closure, it is determined that all dangerous/mixed waste residues cannot practicably be removed, the Closure Plan will be amended and additional procedures will be developed for meeting the closure performance standard given in Section 6.1.1.1.

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6.11.1.2 Description of How Final Closure Will Be Conducted [40 CFR 265.112(b)(2)]

Closure of the treatment area will be performed in concert with closure of the container storage areas. Closure activities will primarily involve decontamination of equipment. Decontamination activities at the treatment area will be conducted in the bermed temporary drum storage area as described in Section 6.11.2.1. Following completion of all decontamination activities, all decontamination wastes will be removed from the site and transported to an appropriate facility, depending on the regulatory designation of the wastes.

Removal and disposal of the liner under the treatment area was completed prior to closure and was handled in the same manner as described under Section. 6.3.1.2.

All visibly contaminated soils at the treatment area will be removed and the soils will be sampled, as described in Section 6.11.1.6, to meet the closure performance standards given in Section 6.1.1.1.

Following completion of all closure activities, closure will be certified as described in Section 6.1.4.

6.11.1.3 Identification of the Maximum Extent of Operation [40 CFR 265.112(b)(2)]

The SHLWS treatment area (see Figure 2-4) represents the maximum extent of the unit used for dangerous/mixed waste treatment. This area occupies approximately 4,100 square ft (380 square m). All SHLWS has been treated and the treatment area will not be used for additional waste treatment. The treatment area will be used during closure for decontamination of equipment used in closure of the storage areas. For this reason, closure of the

treatment area (i.e., removal of liners) will follow closure of the storage areas, as shown in Figure 6-1.

6.11.1.4 Estimate of the Maximum Inventory of Dangerous Wastes [40 CFR 265.112(b)(3)]

The SHLWS treatment area was used to treat 199 55-gal (208-L) drums of SHLWS whose characteristics are described in Section 3.0. These wastes constitute the only wastes treated at this area during its active life.

6.11.1.5 Detailed Description of Removal of Waste Inventory [40 CFR 265.112(b)(3), 265.404]

Most of the treated SHLWS was removed from the temporary storage area following solidification and transferred back to the SHLWS storage area. Some treated SHLWS was stored at the treatment area. The drums of treated waste will be removed from the unit and taken to a facility authorized for disposal of these wastes. This waste removal will occur prior to beginning closure and is not considered to be a closure activity (see Section 6.1.1.5).

During closure activities, drums of liquid decontamination wastes and other wastes (e.g., protective clothing) will be generated. Removal and management of these wastes is described in Section 6.11.2.2.

6.11.1.6 Detailed Description of Removal of Waste Residues [40 CFR 265.112(b)(4), 265.114, 265.404]

Equipment present at the SHLWS treatment area includes air-driven mixers and other equipment contaminated with treated SHLWS residuals. As described in Section 3.0, the treated SHLWS is a nondangerous waste. Equipment contaminated only with treated SHLWS, and which PNL does not intend to reuse, will not be decontaminated but will be disposed of as nondangerous solid waste. Other equipment will be disposed of as dasnerous or mixed waste,

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depending on the results of radiological survey, or will be decontaminated as described in Section 6.11.2.2.

Dangerous/mixed waste residues in the form of contaminated soil are not expected to be found at this area. The treatment area was designed to contain spills without contamination of soil. If, after removal of the liner, it becomes evident that spills have not been properly contained and that soil contamination has occurred, visibly contaminated soils will be removed. Soils at the treatment area will be sampled as described in Appendix A to verify removal of contamination.

6.11.1.7 Detailed Description Of Other Necessary Activities [40 CFR 265.112(b)(5)]

The closure of the SHLWS treatment area is based upon removal of all dangerous/mixed wastes and dangerous/mixed waste residues. Other activities such as groundwater monitoring, leachate collection, and run-on and run-off control are not expected to be necessary based on current knowledge. If, during implementation of the Closure Plan, it becomes evident that all dangerous/mixed waste residuals cannot be practicably removed, the Closure Plan will be amended and other closure activities will be identified.

6.11.1.8 Schedule for Closure of Each Unit [40 CFR 265.112(b)(6)]

A detailed schedule for closure is presented in Figure 6-1.

6.11.2 Decontamination Procedures [40 CFR 265.112(b)(4) 265.114, 265.404]

Decontamination efforts during closure of the SHLWS treatment area will involve decontamination of treatment equipment, spill pans, and large equipment contaminated during closure of the container storage areas.

Contaminated soil is not expected to be encountered at this area but will be removed if discovered.

6.11.2.1 Procedures for Cleaning Equipment and Removing Contaminated Soils [40 CFR 265.112(b)(4), 265.404]

Nondisposable equipment will be decontaminated using stainless steel drip pans to contain and collect decontamination wastes.

Prior to decontamination, all nondisposable equipment will be radiologically surveyed to determine if the equipment is radioactively contaminated. Liquid wastes from decontamination of radioactively-contaminated equipment will be kept separate from those from nonradioactively contaminated equipment.

The drums of liquid decontamination waste will be sampled as described in Appendix A.

Stainless steel spill containment pans will be decontaminated by scrubbing with a nonphosphate detergent solution until all visible contamination has been removed. The pans will then be rinsed with a mild acid solution (i.e., 0.1N HNO_3). The pans will then be rinsed thoroughly with clean tap water. All liquid wastes will be collected in polyethylene-lined drums and sampled and managed as described in Section 6.3.2.2.

If used, large equipment (e.g., the backhoe used to excavate contaminated soil) will be decontaminated by steam cleaning using a nonphosphate detergent solution. This equipment will be steam cleaned until all visible contamination is removed and then rinsed with clean tap water. This activity will be conducted over the stainless steel containment pans. If a larger containment area is required, a polyethylene-lined bermed containment area will be set up in the temporary drum storage area. The liner and berms will be used to collect liquid decontamination wastes. These

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wastes will be pumped into polyethylene-lined drums and sampled and managed as described above. Residual liquid which cannot be pumped from the bermed area will be absorbed using absorbent pillows or pads and the absorbent placed in polyethylene lined drums.

At the conclusion of all decontamination activities, the liner of the decontamination site will be allowed to air dry and then placed in a polyethylene-line drum. If the decontamination liquid collected from the liner is determined by sampling and analysis to be dangerous waste, the liner material will be disposed of as a dangerous waste. If the decontamination liquid is not hazardous, the polyethylene liner material will we disposed of as an unregulated waste. Visible soil contamination resulting from a leak in the liner will be disposed of per Section 6.3.2.1.

6.11.2.2 Management of Generated Wastes [40 CFR 265.114, 265.404]

Wastes that may be generated during closure of the SHLWS treatment area include personnel protective clothing, the liner from the temporary decontamination area, liquid decontamination wastes, and disposable equipment. These wastes will be managed in the same manner as the wastes from the container storage areas, as described in Section 6.3.2.2.

6.11.2.3 Methods for Sampling and Testing to Demonstrate Success of Decontamination [40 CFR 265.112(b)(4), 265.404]

Spill pans and other large equipment will be sampled with swipe samples to determine the effectiveness of decontamination. Swipe samples will be collected from the surface of the decontaminated equipment, as described in the SAP (Appendix A). These samples will be analyze3d to verify that all surface contamination has been removed. This equipment will be

radiologically surveyed following decontamination to verify that all radioactive contamination has been removed.

6.11.2.4 Criteria for Determining the Extent of Decontamination Necessary [40 CFR 265.112(b)(4)]

All equipment that comes into contact with dangerous/mixed wastes or dangerous/mixed waste residuals will be disposed of or decontaminated as described in Section 6.11.2.1.

APPENDIX A
SAMPLING AND ANALYSIS PLAN

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SHLWS T/S
Revision 5
June 25, 1990

SAMPLING AND ANALYSIS PLAN
SIMULATED HIGH-LEVEL WASTE SLURRY TREATMENT AND STORAGE (SHLWS T/S) UNIT CLOSURE

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SAMPLING AND ANALYSIS PLAN
SIMULATED HIGH LEVEL WASTE SLURRY TREATMENT AND STORAGE (SHLWS T/S) UNIT CLOSURE

1.0 OBJECTIVES

This plan describes activities for sampling and analysis of soils and wastes at the Simulated High-Level Waste Slurry Treatment and Storage (SHLWS T/S) unit. The objective of soil sampling is to determine if soils at the SHLWS T/S unit are contaminated with dangerous waste residuals above regulatory limits. The absence of dangerous waste residuals above regulatory limits will constitute verification that the closure performance standard has been met. If dangerous waste residuals are present above regulatory limits, the sampling will be used to determine the regulatory requirements for disposal of the soils. The objective of waste sampling is to collect sufficient data to designate decontamination wastes under WAC 173-303-070.

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2.0 DATA REQUIREMENTS

Soils at the SHLWS T/S unit may have been contaminated by past spills or leaks of the wastes formerly stored at the unit. The requirements of WAC 173-303-610(2)(b) require that residuals in soil do not exceed

> (i) background environmental levels, for any dangerous waste, managed at the facility that either is listed under WAC 173-303-081 or 173-303-082 or is designated by the characteristics of WAC 173-303-090; and
>
> (ii) at least the designation limits of WAC 173-303-084, or 173-303-101 through 173-303-103 for, any dangerous waste managed at the facility that is not listed under WAC 173-303-081 or 173-303-082 and is not designated by the characteristics of WAC 173-303-090.

In addition, Ecology has developed soil cleanup levels which are applicable to the SHLWS T/S unit closure (Washington Department of Ecology, Final Cleanup Policy - Technical, also referred to as the "How Clean Is Clean" guidance document). These levels are based, in decreasing order of preference, on drinking water standards, water quality standards, water quality background, or soil background. For example, if a contaminant has a drinking water standard, that standard is used to set the cleanup level. Otherwise, the water quality standard is used, followed by water quality background, and so on.

Based on the closure performance requirements under WAC 173-303-610(2)(b) and the "How Clean Is Clean" guidance, the following cleanup standards are applicable to the SHLWS T/S unit:

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1) For constituents listed in WAC 173-303-081 and WAC 173-303-082, and characteristic constituents under WAC 173-303-090, the cleanup level is soil background.

2) For constituents having drinking water standards or water quality standards, the cleanup level is that specified in the "How Clean Is Clean" guidance (i.e., 10 times the standard). If the cleanup level based on drinking water standards or water quality standards is determined to be less than background, a cleanup level of background will be used.

3) For constituents not addressed in 1) or 2) above, the cleanup level will be the designation limits specified in WAC 173-303-084 and WAC 173-303-101 through WAC 173-303-103.

Cleanup levels for specific constituents are defined in the following sections. These cleanup levels are identified in order to determine the analytical detection limits which will be required in order to ensure that cleanup standards have been met. These detection limits are needed in order to select appropriate analytical methods. The cleanup levels developed address those constituents known or reasonably likely to have been stored at the SHLWS T/S unit. If other constituents are identified during the sampling and analysis, the cleanup standards above will be applied to develop specific cleanup levels.

2.1 LISTED AND CHARACTERISTIC CONSTITUENTS

With respect to requirements under WAC 173-303-610(2)(b)(i), some of the SHLWS (PW-0) was designated as EHW under WAC 173-303-090 because of the concentration of barium, cadmium, chromium, and silver. In addition, other extraction procedure (EP) toxic metals could have been present in wastes

stored at the less-than-90-day storage area. To satisfy WAC 173-303-610(2)(b)(i), therefore, these metals should not be present in soils above background levels. Because no pesticides were known to have been stored at the SHLWS T/S unit, EP toxic pesticides will not be considered for establishing cleanup levels. All of the SHLWS was designated under WAC 173-303-090 as a corrosive waste. Soils should, therefore, be cleaned to background pH.

The SHLWS T/S storage area was not used to store wastes which are listed under WAC 173-303-081 or -082. The less-than-90-day storage area may, however, have been used to store listed wastes (information on the wastes stored at this area is incomplete). While information is lacking on the exact nature of listed wastes potentially stored at this area, it is likely that these wastes contained toxic organic constituents. To satisfy WAC 173-303-610(b)(i), organic listed waste constituents should be at background levels. Since exact constituents are not known, soils will be analyzed for a broad range of volatile and semivolatile organics using gas chromatography/mass spectrometry (GC/MS). Soil samples will be analyzed for organic compounds identified in EPA's target compound list for Methods 8240 and 8270.

2.2 "HOW CLEAN IS CLEAN" GUIDANCE

With respect to the Ecology soil cleanup levels, drinking water standards have been developed under 40 CFR 141 for a number of inorganic and organic hazardous substances. Of the inorganics, several of the metals are known to have been present in the SHLWS and the others could potentially have been present in wastes stored in the less-than-90-day storage area. All of the metals with drinking water standards will be considered, therefore, in developing cleanup levels.

The organics for which drinking water standards exist include several volatiles and pesticides. The volatiles could have been present in wastes stored at the less-than-90-day area and will be considered in developing cleanup levels. Wastes containing pesticides were not stored at the SHLWS T/S unit. Pesticides, therefore, will not be included in establishing cleanup levels.

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Water quality standards are given in WAC 173-201-047. Standards are given for a number of inorganic and organic contaminants. These contaminants do not include any known constituents of the SHLWS for which drinking water standards do not also exist, other than nickel. Therefore, cleanup levels will be established using drinking water standards for all constituents except nickel. The water quality standard given for nickel depends on the hardness of the water. A hardness value of 100 ppm was assumed, which yields a water quality standard of 0.16 ppm (based on chronic freshwater toxicity).

Cleanup levels based on "How Clean Is Clean" guidance are summarized in Table 1.

2.3 WASTE DESIGNATION LEVELS

With respect to requirements under WAC 173-303-610(2)(b)(ii), the SHLWS is designated as a toxic waste mixture under WAC 173-303-084. Under WAC 173-303-084, wastes are designated as dangerous if the equivalent concentration of toxic constituents exceeds 0.001 percent. Individual constituents are assigned to one of five toxicity categories depending on toxicity. These categories are identified as X, A, B, C, and D, with X being the most toxic and D the least. The equivalent concentration is determined as the sum of the percentage of Category X constituents plus one-tenth the percentage of Category A plus one-hundredth the percentage of Category B plus one-thousandth the percentage of Category C plus one-ten thousandth the percentage of

Table 1. Summary of "How Clean Is Clean" Soil Cleanup Levels

Contaminant	Drinking Water Standard[1]	Soil Cleanup Level[2]
Arsenic	0.05	0.5
Barium	1.0	10
Cadmium	0.01	0.1
Chromium	0.05	0.5
Lead	0.05	0.5
Mercury	0.002	0.02
Nickel	0.16[3]	1.6
Nitrate (as N)	10	100
Selenium	0.01	0.1
Silver	0.05	0.5
Total trihalomethanes	0.1	1.0
Benzene	0.005	0.05
Vinyl Chloride	0.002	0.02
Carbon Tetrachloride	0.005	0.05
1,2-Dichloroethane	0.005	0.05
Trichloroethylene	0.005	0.05
1,1-Dichloroethylene	0.007	0.07
1,1,1-Trichloroethane	0.20	2.0
para-Dichlorobenzene	0.075	0.75

Notes:
1 Concentrations in mg/L (ppm).
2 Concentrations in mg/kg (ppm).
3 Standard is water quality standard rather than drinking water standard.

Table 2. Results of Toxic Mixture Designation for PW-0 Waste

Constituent	Tox. Cat.	Conc. (ppm)	Equivalent Conc. (%)
$AgNO_3$	X	1,800	0.180
$Ba(NO_3)_2$	C	37,280	0.00373
$Cd(NO_3)_2 \cdot 4H_2O$	C	3,260	0.000326
$Co(NO_3)_2 \cdot 6H_2O$	C	15,380	0.00154
$Cr(NO_3)_3 \cdot 9H_2O$	D	25,370	0.000253
$Fe(NO_3)_3 \cdot 9H_2O$	C	232,660	0.0233
KNO_3	D	34,180	0.000341
$Ni(NO_3)_2 \cdot 6H_2O$	D	56,850	0.000568
$Sr(NO_3)_2$	D	30,190	0.000302
$ZrO(NO_3)_2 \cdot 2H_2O$	D	149,680	0.00150
MoO_3	C	88,950	0.00890
HNO_3	C	39,000	0.00390
TOTAL			0.224

Table 3. Results of Toxic Mixture Designation for PW-7A Waste

Constituent	Tox. Cat.	Conc. (ppm)	Equivalent Conc. (%)
$Fe(NO_3)_3 \cdot 9H_2O$	C	106,720	0.0107
$NaNO_3$	D	263,150	0.00263
HNO_3	C	120,000	0.0120
TOTAL			0.0253

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Table 4. Results of Toxic Mixture Designation for PW-0/PW-7A Mixture

Constituent	Tox. Cat.	Conc. (ppm)	Equivalent Conc. (%)
$AgNO_3$	X	900	0.0900
$Ba(NO_3)_2$	C	18,640	0.00186
$Cd(NO_3)_2 \cdot 4H_2O$	C	1,630	0.000163
$Co(NO_3)_2 \cdot 6H_2O$	C	7,690	0.000769
$Cr(NO_3)_3 \cdot 9H_2O$	D	12,690	0.000126
$Fe(NO_3)_3 \cdot 9H_2O$	C	169,690	0.0170
KNO_3	D	17,090	0.000170
$NaNO_3$	D	131,580	0.00132
$Ni(NO_3)_2 \cdot 6H_2O$	D	28,430	0.000284
$Sr(NO_3)_2$	D	15,100	0.000151
$ZrO(NO_3)_2 \cdot 2H_2O$	D	74,840	0.000748
MoO_3	C	44,480	0.00445
HNO_3	C	77,000	0.00770
TOTAL			0.126

Category D. The results of waste designation of the three types of SHLWS stored and treated at the unit, PW-0, PW-7A, and a mixture of PW-0 and PW-7A are given in Tables 2 through 4, respectively. As shown in these tables, the following compounds are present in the waste and provide the basis for designation (toxicity categories are also identified for each compound):

$AgNO_3$ -- Category X
$BaNO_3$ -- Category C
$Cd(NO_3)_2 \cdot 4H_2O$ -- Category C
$Co(NO_3)_2 \cdot 6H_2O$ -- Category C
$Cr(NO_3)_3 \cdot 9H_2O$ -- Category D

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$Fe(NO_3)_3 \cdot 9H_2O$ -- Category C
KNO_3 -- Category D
$NaNO_3$ -- Category D
$Ni(NO_3)_2 \cdot 6H_2O$ -- Category D
$Sr(NO_3)_2$ -- Category D
$ZrO(NO_3)_2 \cdot 2H_2O$ -- Category D
MoO_3 -- Category C
HNO_3 -- Category C

The designation limit for waste constituents is not strictly defined. Under the WAC 173-303-084 and WAC 173-303-101 procedures for waste designation, concentrations must be adjusted for toxicity to determine equivalent concentration. For wastes having a single constituent, the maximum concentration of the constituent that would cause the waste to be designated as dangerous would be the minimum equivalent concentration of 0.001% multiplied by the toxicity weighting factor. The toxicity weighting factor is 1 for Category X; 10 for Category A; 100 for Category B; 1,000 for Category C; and 10,000 for Category D. Because multiple constituents may be present in the soils at the SHLWS T/S unit, the designation limit for defining compliance with WAC 173-303-610(2)(b)(ii) will be taken as 10% of the limit for a single constituent waste. These limits, for each constituent toxicity category, are as follows:

Category X -- 1 ppm
Category A -- 10 ppm
Category B -- 100 ppm
Category C -- 1,000 ppm
Category D -- 10,000 ppm

Wastes may also be designated as dangerous if they contain persistent constituents which are defined as halogenated hydrocarbons (HH) or polynuclear

aromatic hydrocarbons (PAH). Under the procedures of WAC 173-303-084 and WAC 173-303-102, wastes are designated as dangerous if the total concentration of HH is greater than 0.01% (100 ppm) or the total concentration of PAH is greater than 1.0% (10,000 ppm). Because multiple HH or PAH constituents may be present in the soils at the SHLWS T/S unit, the designation limit for defining compliance with WAC 173-303-610(2)(b)(ii) for these compounds will be taken as 10% of the limit for a single constituent waste. Thus, the limit for HH species is 10 ppm and the limit for PAH species is 1,000 ppm.

Wastes may also be designated as dangerous if they contain carcinogenic constituents which are defined as International Agency for Research on Cancer (IARC) positive or suspect (human or animal) carcinogens. Under the procedures of WAC 173-303-084 and WAC 173-303-103, wastes are designated as dangerous if the concentration of any one IARC positive (human or animal) carcinogen is present at greater than 0.01% (100 ppm) or the total concentration of positive and suspect (human or animal) carcinogens exceeds 1% (10,000 ppm). The designation limit for defining compliance with WAC 173-303-610(2)(b)(ii) for IARC positive (human or animal) carcinogens is then 100 ppm. The designation limit for any IARC suspect (human or animal) carcinogens is taken as 10% of the total designation limit, or 0.1% (1000 ppm).

Cleanup levels based on designation limits will only be used for those constituents for which other levels do not exist. Many of the constituents in the SHLWS are characteristic waste constituents or have "How Clean Is Clean" levels based on drinking water standards. The constituents which do not, and for which designation limits will be used, are cobalt, iron, potassium, strontium, zirconium, and molybdenum.

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2.4 DESIGNATION OF DECONTAMINATION WASTES

Decontamination wastes generated during closure activities may contain the waste constituents described above. In order to properly manage and dispose of these wastes, it will be necessary to perform waste designation as described under WAC 173-303-070. To designate these wastes, it will be necessary to determine whether they contain toxic, persistent, or carcinogenic constituents above the designation limits in WAC 173-303-084 and WAC 173-303-101 through WAC 173-303-103 and whether they display the characteristics of toxicity and corrosivity under WAC 173-303-090 and 40 CFR 261.24.

For designation of decontamination wastes under WAC 173-303-084 and WAC 173-303-101 through WAC 173-303-103, the designation limits previously identified for soils will be used.

With respect to designation of decontamination wastes under WAC 173-303-090, the SHLWS had the characteristic of EP toxicity because of the presence of heavy metals. The waste did not contain any of the pesticides and herbicides included in the EP. To designate decontamination wastes under -090, therefore, it will only be necessary to analyze these wastes for toxic heavy metals and not for pesticides and herbicides. The designation limits for these metals in liquid wastes and extracts of solid wastes will be those given in WAC 173-303-090(8):

Arsenic -- 5 mg/L
Barium -- 100 mg/L
Cadmium -- 1 mg/L
Chromium -- 5 mg/L
Lead -- 5 mg/L
Mercury -- 0.2 mg/L
Selenium -- 1 mg/L

Silver -- 5 mg/L

The EP has recently been replaced by the toxicity characteristic leaching procedure (TCLP). The TCLP contains the same metals, pesticides, and herbicides as the EP, but adds 26 volatile and semivolatile organics. Decontamination wastes will be analyzed for volatile and semivolatile organics to determine if TCLP constituents are present above regulatory limits. The designation limits for these organics will be the regulatory limits given in 40 CFR 261.24:

Benzene -- 0.5 mg/L
Carbon tetrachloride -- 0.5 mg/L
Chlordane -- 0.03 mg/L
Chlorobenzene -- 100 mg/L
Chloroform -- 6 mg/L
o-Cresol -- 200 mg/L
m-Cresol -- 200 mg/L
p-Cresol -- 200 mg/L
Cresol -- 200 mg/L
1,4-Dichlorobenzene -- 7.5 mg/L
1,2-Dichloroethane -- 0.5 mg/L
1,1-Dichloroethylene -- 0.7 mg/L
2,4-Dinitrotoluene -- 0.13 mg/L
Heptachlor -- 0.008 mg/L
Hexachlorobenzene -- 0.13 mg/L
Hexachlorobutadiene -- 0.5 mg/L
Hexachloroethane -- 3.0 mg/L
Methyl ethyl ketone -- 200 mg/L
Nitrobenzene -- 2.0 mg/L
Pentachlorophenol -- 100 mg/L
Pyridine -- 5.0 mg/L

Tetrachloroethylene -- 0.7 mg/L

Trichloroethylene -- 0.5 mg/L

2,4,5-Trichlorophenol -- 400 mg/L

2,4,6-Trichlorophenol -- 2.0 mg/L

Vinyl chloride -- 0.2 mg/L

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3.0 ANALYTICAL PARAMETERS AND METHODS

The data needs described in Section 2.0 identify specific chemical parameters which must be determined to meet sampling and analysis objectives. The discussion in Section 2.0 also identifies, to the extent possible, the minimum levels at which contamination must be quantified in order to meet specific objectives (i.e., cleanup levels). These cleanup levels, and their rationale, are identified in Table 5.

Minimum detection limits (MDLs) have been established for analytical methods to be used to determine whether cleanup levels have been met. The required MDL is the soil cleanup level. The recommended MDL is set at 10% of the soil cleanup level. The methods selected and typical MDLs and cleanup levels are summarized in Table 6. Selection of methods to meet specific objectives is discussed in the following sections.

3.1 DETERMINATION OF LEVELS ABOVE BACKGROUND IN SOILS

Background concentrations of contaminants identified in Table 5 as having background cleanup levels will be established prior to initiating final closure activities. To determine background cleanup levels, soil samples will be collected from locations outside the SHLWS T/S unit as described in Section 4.0. Results from analysis of these samples will be used to calculate the background cleanup levels for specific contaminants. The approach used will be consistent with the approach being taken with closure of other facilities at Hanford requiring clean closure (e.g., 300 Area Solvent Evaporator).

The technical basis for background soil sampling requirements and also the methods by which contamination thresholds (e.g., significant deviation from background) are established, are being developed by Westinghouse Hanford Company (WHC) and the DOE-RL for the Hanford Site. The selection of the

number of background samples has been based on professional judgement. Eight background samples will be collected. Written notification will be provided to Ecology in the event that PNL and the DOE-RL recommend that this number be changed.

The data collected for determination of background cleanup levels will be interpreted by qualified scientists and statisticians. The technical basis for establishing the background cleanup levels, the methods by which significant deviation from background will be determined, and the appropriate sample sizes (i.e., numbers of samples), are being developed by WHC and the DOE-RL for the Hanford Site. Methods such as those identified for the assessment of groundwater data, e.g., the tolerance interval approach to the analysis of variance (EPA 1989), are being evaluated for application to soil and other media. The background cleanup levels, for example, can be based on information such as proportions of the population, mean concentrations, and standard deviations for each constituent of interest. Specific approaches, and the criteria and assumptions implicit in establishing concentration levels that constitute significant deviation from background or other control levels, as well as numbers of samples, etc. will be related to Ecology when these issues have been resolved by WHC and DOE-RL staff. Data evaluation will be based on statistical criteria and professional judgement, where appropriate.

No required method detection limit could be identified with respect to background levels of metals in soils since background values have not yet been established. (National average values have been established for many metals, but because of great regional variability these values are not useful for establishing cleanup levels.) For these samples, therefore, the following approach will be used. Soil samples will be analyzed by X-Ray Fluorescence (XRF). If XRF analysis shows the background level for a contaminant to be less than the detection limit of the XRF method, the soil will be digested according to SW-846 methods and analysis will be by more conventional SW-846

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methods [inductively coupled plasma spectroscopy (ICP), graphite furnace atomic absorption (GFAA), cold vapor atomic absorption (CVAA)] to determine the concentration in the soil.

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Table 5. Summary of Soil Cleanup Levels

Contaminant	Soil Cleanup Level	Basis for Cleanup Level
Arsenic	Background	Characteristic dangerous waste
Barium	Background	Characteristic dangerous waste
Cadmium	Background	Characteristic dangerous waste
Chromium	Background	Characteristic dangerous waste
Cobalt	320 ppm	1,000 ppm for $CO(NO_3)_2$; Toxic-C
Iron	230 ppm	1,000 ppm for $Fe(NO_3)_3$; Toxic-C designation limit
Lead	Background	Characteristic dangerous waste
Mercury	Background	Characteristic dangerous waste
Nickel	1.6 ppm*	"How Clean is Clean" guidance, water quality standard
Molybdenum	670 ppm	1,000 ppm for MoO_3; Toxic-C designation limit
Nitrate	100 ppm	"How Clean is Clean" guidance, drinking water standard
Potassium	3,860 ppm	10,000 ppm for KNO_3; Toxic-D designation limit
Sodium	2,700 ppm	10,000 ppm for $NaNO_3$; Toxic-D designation limit
Strontium	4,140 ppm	10,000 ppm for $Sr(NO_3)_2$; Toxic-D designation limit
Selenium	Background	Characteristic dangerous waste
Silver	Background	Characteristic dangerous waste
Zirconium	3,940 ppm	10,000 ppm for $ZrO(NO_3)_2$; Toxic-D designation limit
pH	Background	Characteristic dangerous waste
Volatile Organics	Background	Listed dangerous waste
Total Trihalomethanes	1.0 ppm	"How Clean is Clean" guidance, drinking water standard

Table 5. (Continued)

Contaminant	Soil Cleanup Level	Basis for Cleanup Level
Benzene	0.05 ppm	"How Clean is Clean" guidance, drinking water standard
Vinyl chloride	0.02 ppm	"How Clean is Clean" guidance, drinking water standard
Carbon tetrachloride	0.05 ppm	"How Clean is Clean" guidance, drinking water standard
1,2-Dichloroethane	0.05 ppm	"How Clean is Clean" guidance, drinking water standard
Trichloroethylene	0.05 ppm	"How Clean is Clean" guidance, drinking water standard
1,1-Dichloroethylene	0.07 ppm	"How Clean is Clean" guidance, drinking water standard
1,1,1-Trichloroethane	2.0 ppm	"How Clean is Clean" guidance, drinking water standard
para-Dichlorobenzene	0.75 ppm	"How Clean is Clean" guidance, drinking water standard
Semivolatile organics	Background	Listed dangerous waste
Toxic-X Constituents	1 ppm	Designation limit
Toxic-A Constituents	10 ppm	Designation limit
Toxic-B Constituents	100 ppm	Designation limit
Toxic-C Constituents	1,000 ppm	Designation limit
Toxic-D Constituents	10,000 ppm	Designation limit
Halogenated hydrocarbons	10 ppm	Designation limit
Polynuclear aromatic hydrocarbons	1,000 ppm	Designation limit

Table 5. (Continued)

Contaminant	Soil Cleanup Level	Basis for Cleanup Level
IARC positive (human or animal) carcinogens	100 ppm	Designation limit
IARC suspect (human or animal) carcinogens	1,000 ppm	Designation limit

*If background level is determined to be greater than "How Clean is Clean" cleanup level, background will be used as cleanup level.

Table 6. Summary of Analytical Methods and Typical Detection Limits

Constituent	Soil Cleanup Level	Method[1]	Minimum Detection Limit[2]
Arsenic	Background	XRF	2
		7060	0.1
		6010	5.3
Barium	Background	XRF	7
		7081	0.2
		6010	0.2
Cadmium	Background	XRF	5
		7131	0.01
		6010	0.4
Chromium	Background	XRF	40
		7191	0.1
		6010	0.7
Cobalt	320 ppm	XRF	12
		6010	0.7
Iron	230 ppm	XRF	20
		6010	0.7
Lead	Background	XRF	5
		7421	0.1
		6010	4.2
Mercury	Background	7470	0.02
Molybdenum	670 ppm	XRF	2
		6010	0.8
Nickel	1.6 ppm	XRF	6
		6010	1.5
Nitrate	100 ppm	300	0.67[3]
Potassium	3,860 ppm	XRF	60
		6010	Varies[4]
Selenium	Background	XRF	2
		7740	0.2
Silver	Background	XRF	4
		7761	0.002
		6010	0.07
Sodium	2,700 ppm	6010	0.29

Table 6. (Continued)

Constituent	Soil Cleanup Level	Method[1]	Minimum Detection Limit[2]
Strontium	4,140 ppm	XRF 6010	3 0.003
Zirconium	3,940 ppm	XRF	2
Volatile Organics	Background	502.2 8240	Varies 0.0005
Semivolatile Organics	Background	8270	Varies[5]

Notes:

1 Analytical methods numbers are EPA Method numbers per SW-846. XRF is x-ray fluorescence.

2 Detection limits are in mg/kg (ppm). For AA (7000 series) and ICP (6010) methods, detection limits for liquid extracts (mg/L) were converted to detection limits for soils (mg/kg) by multiplying by 100, assuming a 100:1 dilution during extraction.

3 Detection limit based on 1 mg/L detection limit for liquid extract and extraction procedure using 15 g soil and 10 mL water.

4 Detection limit for potassium varies, depending on operating conditions.

5 Detection limits vary depending on constituents but are generally in the low ppm range.

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Because of the large number of inorganics present in the SHLWS, maximizing the number of analytes by using a method such as XRF maximizes the opportunity for detecting contamination. The presence of any of the constituents known to be present in the SHLWS above background will be used as an indication of contamination. Soil samples determined to be above background cleanup levels using XRF will also be analyzed using ICP or AA. In addition, to verify XRF results, duplicates from 20% of the samples will be digested according to SW-846 methods and analyzed by ICP using EPA Method 6010.

Similarly, background levels of volatile and semivolatile organics are not known. As described in Section 4.0, soil gas sampling will be used to determine the presence of volatile organics. Methods 502.2 and Modified 502.2 will be used to analyze soil gas samples. These GC methods are more sensitive than GC/MS methods. Volatile organics having background cleanup levels would be those present in listed waste solvents and those having drinking water standards. The target compounds for Method 502.2 includes all of these listed solvent waste constituents. Because of the greater opportunity for volatiles to be present in samples from the less-than-90-day storage area, these samples will be analyzed for volatiles using Method 8240. This method will detect all volatiles having cleanup levels. For semivolatile organics, Method 8270 will be used. This GC/MS method was selected because of its large number of target compounds.

Soil pH will be determined using the method in Attachment 3 to Appendix B of WDOE 83-13.

3.2 EVALUATION OF "HOW CLEAN IS CLEAN" CLEANUP LEVELS

"How Clean is Clean" cleanup levels exist for nickel, several volatile organics, and nitrate. The XRF method to be used for analysis for background determinations will not meet the 1.6 ppm cleanup level for nickel. It is

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possible, however, that background levels of nickel are greater than the 1.6 ppm cleanup level. If XRF analysis indicates that background levels of nickel are greater than 1.6 ppm, background will be used as the cleanup level. If background levels are less than 1.6 ppm, soils will be analyzed using ICP. The soil gas method to be used for detecting volatile organics above background will also detect the volatile organics for which there are cleanup levels. No method is available in SW-846 for analysis of nitrate in soils. Therefore, a procedure using 15 grams of soil and 10 grams of water to extract the soil will be used. Analysis using EPA Method 300.0 (Anions by Ion Chromatography) will be used to analyze the extract for nitrate. This procedure will detect the 100 ppm cleanup level.

3.3 DESIGNATION OF TOXIC, PERSISTENT, AND CARCINOGENIC WASTE MIXTURES

The detection limits required for designation of soils or wastes under WAC 173-303-084 and WAC 173-303-101 through WAC 173-303-103 are generally much higher than those required for comparison to background levels. XRF detection limits are low enough to satisfy requirements for designation limits for metals. To verify XRF results, duplicates from 20% of the samples will be digested according to SW-846 methods and analyzed by ICP using EPA Method 6010. Nitrate in liquid wastes will be determined using Method 300.

The soil gas and semivolatile methods will provide an indication whether persistent waste constituents are present (i.e., HH or PAH). If these results suggest the presence of HH or PAH constituents for which other cleanup levels do not exist, soil samples will be analyzed for persistent waste constituents using the procedures in WDOE 83-13.

3.4 DESIGNATION OF CHARACTERISTIC WASTES

Concentrations of EP/TCLP toxic metals must be determined through use of the methods referenced in WDOE 83-13, Appendix D, Table 1.A. This determination may also be made by Method 6010 (ICP) according to the applicability information stated within this Method for certain metals. Method 6010 provides an efficient technique that exceeds the required detection limits quite easily for the majority of the EP/TCLP toxic metals. For EP/TCLP Toxic metals not appropriate for ICP analysis, direct aspiration flame AA methods, graphite furnace AA methods, or cold vapor AA methods will be used as appropriate. When more than one AA method was available for use, the most sensitive method was selected unless it was subject to interference with constituents known to be present in the wastes.

The pH of aqueous wastes resulting from equipment decontamination activities will be determined using the Method in Attachment 1 to Appendix B of WDOE 83-13.

Organic TCLP constituents must be analyzed using GC or GC/MS methods given in EPA SW-846.

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4.0 SAMPLING RATIONALE AND DESIGN

As described above, soil sampling activities are directed toward determining whether soils at the SHLWS T/S unit contain contaminants above cleanup levels. Soil sampling activities will initially be conducted in two phases. The first phase of sampling will be conducted before initiating final closure and will be performed to establish background cleanup levels. Random samples will be collected from areas outside of the SHLWS T/S unit and analyzed to establish background cleanup levels. As described in Section 3.1, background cleanup levels will be established using the methods which are currently being developed for the Hanford Site by WHC and the DOE-RL.

The second phase of soil sampling will take place during final closure after all soils known or suspected to be contaminated has been removed. Soil samples will be collected from random locations within the SHLWS T/S unit. The soils samples will be analyzed and the results used to determine whether any constituents are present above the cleanup levels specified in Table 5. If a sample indicates that presence of contaminants at greater than cleanup levels, the soil surrounding the sample location will be removed. The area will then be resampled to determine whether the cleanup level has been achieved.

Sampling in the SHLWS storage and treatment areas will initially be limited to surface soils. Samples will be collected from the zone 3 to 9 inches in depth. Samples will be collected in appropriate containers and preserved, as described in Section 5.0 of the Quality Assurance Project Plan (QAPjP, Appendix B). All samples will be analyzed for XRF metals (includes all EP/TCLP toxic metals except mercury), semivolatile organics, nitrate, and pH. If surface samples are found to be uncontaminated, samples from greater depths will not be collected. If surface contamination is found, additional samples will be collected from the initial sample locations at successive 12

inch increments to determine the extent of any vertical downward contaminant migration.

A similar approach will be used for the samples from the less-than-90-day storage area except that samples will initially be collected from 3 to 9 inches in depth and from 18 to 24 inches in depth.

Contamination of soils with volatile organics will be determined through the use of soil gas sampling. Soil gas probes will be used to collect soil gas samples from the top 4 ft of the soil profile. If contamination is detected, subsequent samples will be collected from additional locations to locate the source of the contamination or, if necessary, from greater depths to define the vertical extent of contamination. Soil samples from the less-than-90-day storage area will also be analyzed for volatiles using Method 8240.

Methods for determining the numbers of samples required are currently being developed for the Hanford Site by WHC and the DOE-RL. At present, sample numbers have been identified using best professional judgement. The number of samples has been selected as 8 from the background area and 14 from the waste management areas. Analytical data will be evaluated to determine whether this number of samples is adequate. If this evaluation indicates that additional samples are needed, they will be collected.

Sample locations for Phase 1 and Phase 2 will be selected randomly from uniform grids within the background area and waste management unit, respectively. The background area is defined as a 45-ft wide strip along and south and west borders of the SHLWS T/S unit and a 45-ft strip north of Stone Street immediately north of the SHLWS T/S unit, as shown in Figure 1. The old concrete building foundations to the south of the SHLWS T/S unit will not be included in the areas to be sampled. The area to the east of the SHLWS T/S

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unit is paved and will not be sampled. The waste management area is defined as the SHLWS T/S storage area, SHLWS T/S treatment area, and less-than-90-day storage area (see Figure 1). The area to be gridded for sampling encompasses these areas and an additional 5 ft buffer around each area.

The background area was selected because it is close to the waste management area, is comprised of similar soils, surrounds the waste management area to the extent possible, and is outside the predominant wind direction from the SHLWS T/S unit (see Figure 2-6 of the Closure Plan for wind roses). It is noted that the background area may not be reflective of true environmental background because the surface material is not all native soil (i.e., much is imported gravel) and the area is located within an industrial area. It is recognized that other activities within the 3000 Area may have resulted in background levels above native environmental background.

The sampling is intended to determine whether waste management activities have resulted in contamination of soils in the waste management area above the background levels in adjacent surface materials. In addition, the results of the sampling will be reviewed to determine whether any hazardous constituents, particularly synthetic organics, are present in the local background at levels greater than would be expected for natural background. The background analyses for the SHLWS T/S unit will be compared to analyses performed at the nearby 1100-EM-1 operable unit to determine whether they are approximately the same. If it appears that local background for man-made hazardous constituents at the SHLWS T/S unit is much greater than for other areas of the Hanford Site, it may be necessary to amend the closure plan. In addition, if the eight background samples have more than a 20% relative standard deviation in more than two constituents, additional background samples will be taken for the purpose of establishing background cleanup levels.

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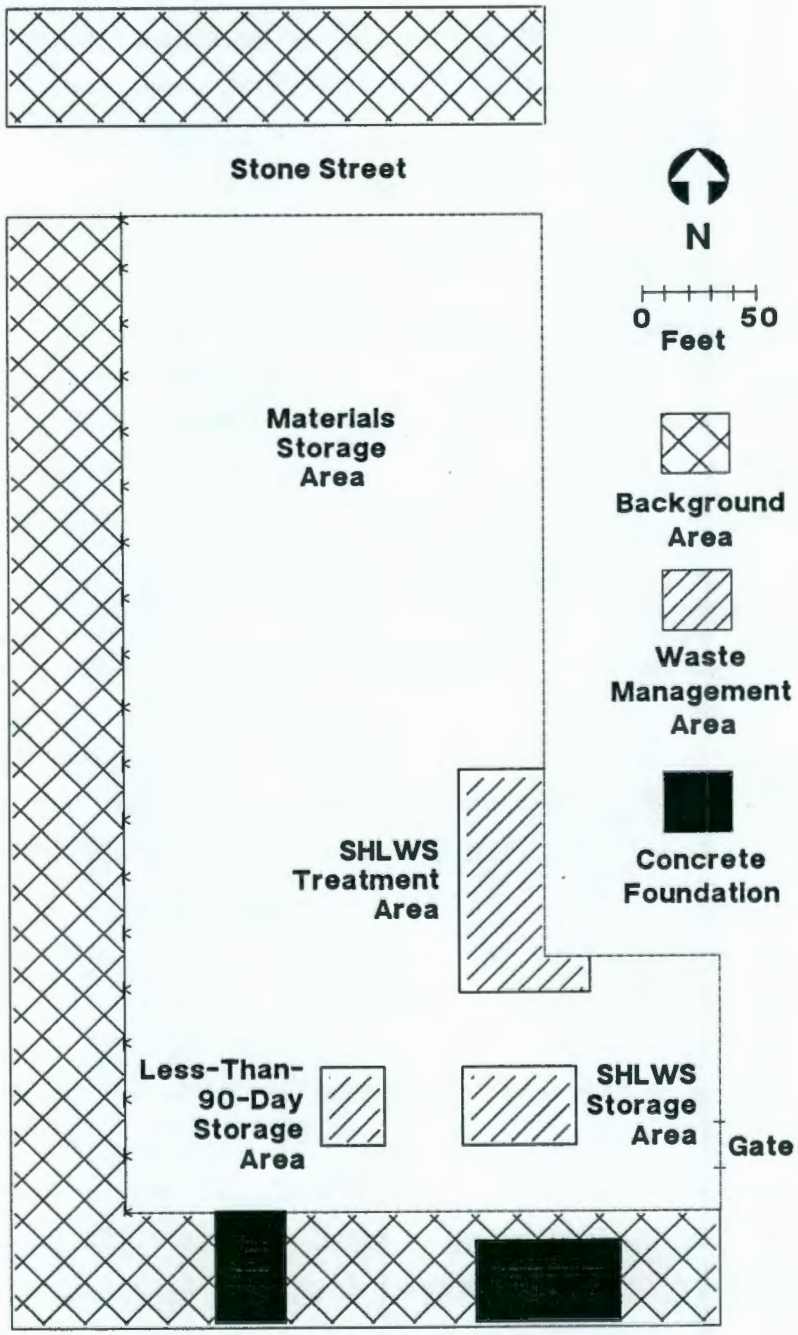

Figure 1. Location of Background Area and Waste Management Areas

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Sample locations will be determined by gridding the background area and waste management area into uniform grids having approximately 20 times the number of required samples (i.e., 140 for the background area and 280 for the waste management area). Each grid will be numbered and a random number table will be used to select 8 background area grids for sampling and 14 waste management area grids for sampling. Each grid for the background area will be approximately 15 ft (4.6 m) by 20 ft (6.1 m) and each grid for the waste management area will be 5 ft (1.5 m) by 5 ft. Grab samples will be collected from the center of each grid selected for sampling. The gridding system for the background and waste management areas is illustrated in Figures 2 and 3, respectively.

Soil sampling will also be required for soil removal activities. As described in the Closure Plan, all areas of soil which appear to be visibly contaminated will be excavated and placed in drums or roll-off boxes. Records will be kept in the field notebook or geologist's log indicating the source of the soil in each drum. A sample of the soil removed from each potentially contaminated area will be collected and analyzed for XRF metals, EP/TCLP toxic metals, volatile organics, and semivolatile organics. If the results indicate that contaminants are present above the cleanup level, a sample will be taken from the location where the soil was removed to verify that all contaminated soil above cleanup levels has been removed. If these samples indicate that residuals are still present above cleanup levels, additional soil will be removed and the location resampled.

The results of the analysis of the soils placed in the drum or roll-off box will also be used to perform a dangerous waste designation of the soil in the containers. This designation will be used to determine whether the soils must be disposed of as dangerous wastes.

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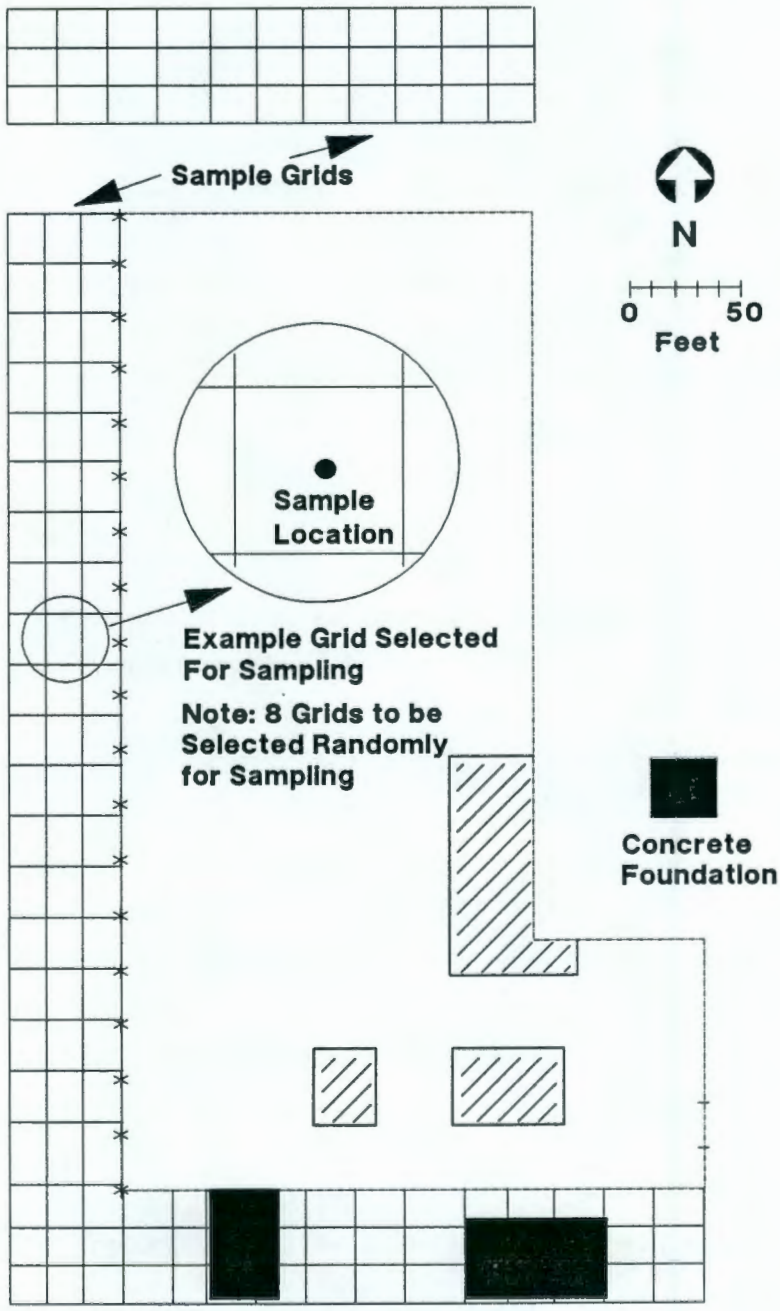

Figure 2. Sample Grids for the Waste Management Areas

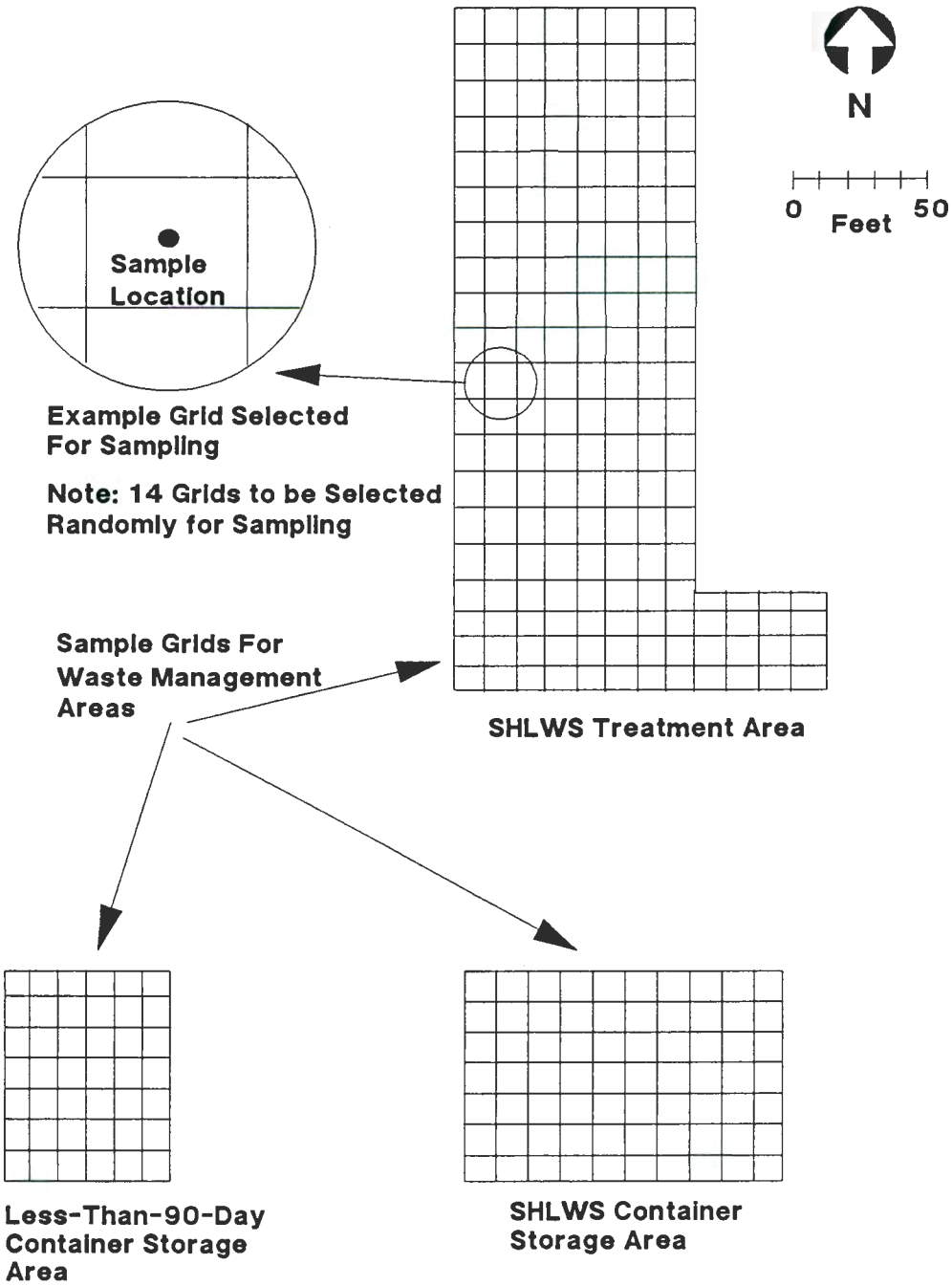

Figure 3. Sample Grids for the Waste Management Areas

For the purpose of designating liquid wastes generated from equipment decontamination activities, composite samples will be collected from each batch (i.e., each drum) using a composite liquid waste sampler (COLIWASA).

The only solid wastes currently expected to require designation are waste pallets used to store drums of SHLWS. There are 76 of these pallets at the SHLWS T/S unit. These pallets have the potential to have been contaminated due to leakage from drums. Once all containers of treated waste have been removed from the SHLWS T/S unit, the pallets will be inspected to determine whether they should be disposed of or saved for reuse. If a large number of the pallets appear to be contaminated, the decision may be made to dispose of the pallets as dangerous waste without sampling. In such a case, the pallets will be dismantled and placed in a roll-off box. If the pallets are to be reused, or disposed of as nondangerous waste, sampling will be performed to verify that they are nondangerous. A random number of these pallets will be sampled to determine whether they must be designated as dangerous waste. Initially, ten of the pallets will be selected at random and sampled. Each pallet will be numbered and a random number table used to select ten for sampling. Analytical results will be used to determine the mean and variance of contaminant concentrations. The mean and variance will then be used to determine if additional pallets must be sampled.

Samples will be collected from 10 pallets chosen at random (i.e., pallets will be numbered and a random number table used to select ten for sampling). Subsamples will be collected by removing approximately 10 grams of wood from each of six locations on each pallet. The locations will primarily include the working surfaces of the pallets (upper surface and lower surface of the skids) which are most likely to be contaminated. In addition, areas that appear to be contaminated as indicated by discoloration or other surface irregularities will be sampled. These subsamples will be composited to form a sample for each pallet. The samples will be analyzed by XRF for EP/TCLP toxic

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metals (except mercury). Samples with EP/TCLP toxic metals present at levels greater than 20 times the limit for TCLP toxic leachate will be analyzed using the TCLP toxicity procedure. Based on these results, the mean and variance of the concentrations of toxic metals will be calculated and used to determine if the pallets are dangerous waste. The mean and variance data will also be evaluated using the procedures given in SW-846 (i.e., Section 9.1.1.3.1) to determine if additional random samples must be collected for statistical purposes. If this analysis indicates that additional samples are required, they will be obtained in the same manner as the original samples. The pallet samples will not be analyzed for organics because the SHLWS stored on the pallets does not contain organics.

Swipe samples will be collected from decontaminated equipment from equipment surfaces which have come into contact with wastes. Samples will be collected randomly from 5% of the potentially contaminated surface area. Swipes will be collected using 45 cm analytical-grade filter papers. At each sample location a swipe will be collected from a one-foot square area using a filter paper saturated with 0.1 N nitric acid.

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5.0 SAMPLING METHODS

5.1 GENERAL DESCRIPTION OF SAMPLING ACTIVITIES

Soil samples will be collected according to the provisions outlined in this section. Soil samples will be consist of a homogenized sample from the zone from 3 to 9 inches at each designated sampling location. In addition, samples from 18 to 24 inches in depth will be collected at the less-than-90-day storage area. If contamination is found at these locations above cleanup levels, these same locations will be resampled at successive 12-inch increments to determine the extent of any vertical downward contaminant migration.

Samples of liquid wastes from equipment decontamination activities will be collected from each drum of waste. Composite samples will be collected using a COLIWASA sampler as described in Test Methods for Evaluating Solid Wastes, EPA SW-846.

Samples of wooden pallets will be collected by removing approximately 10 grams of shavings from six locations on the pallets. Shavings will be collected using a stainless steel knife or chisel.

Swipe samples will be collected from all nondisposable equipment which has been decontaminated for reuse. Swipe samples will be collected using analytical-grade filter papers which have been saturated with 0.1 N nitric acid. Wipes will be collected from one-food square areas which will be defined using a cardboard template. The area to be sampled will be swiped with filters saturated with 0.1 N nitric acid. Samples will be collected from locations totally 5% of the surface area which may have been contaminated.

Table 7. Summary of Sample Containers Required

Sample Type	Analysis	Required Container	Number of Containers per Sample
Soils	Metals (XRF, ICP, AA), nitrate, pH	16-oz. Glass w/ Teflon cap seal	2
	TCLP toxicity leaching	16-oz. Glass w/ Teflon seal	2
	Volatile organics	8-oz. Glass w/ Teflon-lined septum	2
	Semi-volatile organics	16-oz. Glass w/ Teflon cap seal	2
Liquid waste	Metals	16-oz. Polyethylene	2
	Anion	16-oz. Polyethylene	2
	Volatile organics	40-mL Glass/w Teflon-lined septum	2
	Semi-volatile organics	32-oz. Glass w/ Teflon cap seal	2
Pallet chips	Metals (XRF)	16-oz. Glass w/ Teflon cap seal	2
	TCLP toxicity (if required)	16-oz. Glass w/ Teflon cap seal	1
Filter Paper Swipes	Metals (ICP)	8 oz. Glass w/ Teflon cap seal	2

5.2 SAMPLE CONTAINERS

The number and types of sample containers required are summarized in Table 7. All sample containers will be precleaned and prelabeled before they are transported to the field.

5.3 SAMPLING EQUIPMENT

Primary sampling equipment anticipated to be used will include precleaned shovels, hand augers, trowels, buckets, coolers (with ice), filter papers for swipes, precleaned and prelabeled sample containers, various screens or sieves, a hammer, wooden stakes, and a stainless steel knife or chisel. All sampling equipment will be constructed of non-reactive material.

5.4 EQUIPMENT DECONTAMINATION

All nondisposable sampling equipment which comes into contact with samples will be decontaminated between samples to prevent cross contamination and will also be decontaminated at the end of each working day. Equipment will be decontaminated in the following manner:

1) Equipment will be given a radiological survey by a radiation protection technologist (RPT) to determine whether it is radioactively contaminated. Radiological surveys will be performed using procedures specified in PNL-MA-507, Procedures for Radiation Protection Technologists. Separate decontamination lines will be used for radioactively contaminated equipment and nonradioactively contaminated equipment, and decontamination wastes from these two lines will be segregated. The two lines will use identical decontamination procedures.

2) Equipment will be thoroughly scrubbed using Alconox or a similar laboratory detergent. All visible signs of contamination will be removed.

3) Equipment will be thoroughly rinsed with clean tap water, being certain that no detergent is left on the equipment.

4) Equipment to be used for collection of samples for organic analysis will be thoroughly rinsed with pesticide-grade hexane and allowed to air dry.

5) Equipment will be given a final rinse with deionized water. Samples of rinse water will be periodically collected for equipment blanks to verify decontamination, as specified in Section 5.9.

6) If the equipment is not to be used immediately, it will be allowed to air dry and will be wrapped with aluminum foil, with the dull side of the foil toward the equipment.

7) All equipment will be surveyed by an RPT to confirm radiologic decontamination.

All decontamination wastes will be collected in polyethylene-lined drums or polyethylene carboys. All waste streams will be segregated; i.e., a separate container will be used for detergent, rinse water, and hexane wastes. Prior to decontamination, equipment will be radiologically surveyed to determine if radioactive contamination is present. Decontamination wastes from radioactively contaminated equipment will be kept separate from wastes from nonradioactively contaminated equipment.

5.5 SAMPLING AND SAMPLING LOCATIONS

One set of samples will be obtained from each sample location.

The field notebook or geologist's log will be used to document sample collection activities and observations including the identification of the specific sample collected and the corresponding sample numbers.

A grid system discussed earlier will be established prior to sampling and will be used to identify and reference the random locations to be sampled. Wooden stakes identified with the sample number will be located at each sampling location and this location will be noted in the field notebook or geologist's log.

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5.6 SAMPLE COLLECTION

The number and amounts of samples to be collected is summarized in Table 8. Each sample container for aqueous and soil samples will be filled with sample material to minimize head space in the container. Large stones or cobbles will be removed from the sample by sieving or screening if necessary. If sieving or screening is necessary, soil will be transferred directly to the sieve or screen and will be shaken into a collection bucket until enough material has been collected for the sample. The material will then be transferred directly into the sample container. If sampling for volatile organics is required, EPA Method 5030 will be used (10 mL methanol per 4 g soil). Each sample container will be sealed tightly, the sample label information completed, the lid of the sample sealed with tape, and the sample placed into the ice chest. Sample container lids will not be interchanged. Samples will be delivered to the laboratory at the conclusion of each work day. In the case an off-site analytical laboratory is to be utilized, each day's samples will be prepared for delivery or shipment to the analytical laboratory and will be transported the following work day. Regardless of the laboratory to be utilized, all samples will be packed in suitable containers to provide the required environmental conditions outlined in Table 9.

Table 8. Number and Amounts of Samples to be Collected

Sample Type	Number of Samples[1]	Sample Size
Soil background		
Metals[2], nitrate, pH	8	2 - 16-oz. Glass Jar
TCLP toxicity[3]	8	2 - 16-oz. Glass Jar
Semivolatile organics	8	2 - 16-oz. Glass Jar
Soil gas	8	Syringe
Soil at waste management areas		
Metals[2], nitrate, pH	20[4]	2 - 16-oz. Glass Jar
TCLP toxicity[3]	20[4]	2 - 16-oz. Glass Jar
Volatile organics[5]	20[4]	2 - 8-oz. Glass Jar
Semivolatile organics	20[4]	2 - 16-oz. Glass Jar
Soil removed during closure		
Metals[2], nitrate, pH	TBD[6]	2 - 16-oz. Glass Jar
TCLP toxicity[3]	TBD[6]	2 - 16-oz. Glass Jar
Volatile organics[5]	TBD[6]	2 - 8-oz. Glass Jar
Semivolatile organics	TBD[6]	2 - 16-oz. Glass Jar
Wood from pallets		
Metals/TCLP toxicity	10	1 - 16-oz. Glass Jar
Filter paper swipes	TBD[7]	

Table 8. (Continued)

Sample Type	Number of Samples[1]	Sample Size
Liquid waste		
Metals	TBD[6]	2 - 16-oz. polyethylene bottle
Nitrate	TBD[6]	2 - 16-oz. polyethylene bottle
Volatile organics	TBD[6]	2 - 40-mL Glass vials
Semivolatile organics	TBD[6]	2 - 32-oz. Glass bottles

Notes:

1 Initial number of samples to be collected. Additional samples could be required based on analysis of mean and variance data. Numbers in table do not include quality control (QC) samples described in Section 5.9.

2 All metals samples will be initially be analyzed by XRF. If XRF results indicate background levels below detection, samples will be digested and analyzed using appropriate ICP or AA methods.

3 TCLP toxicity testing will be performed on soils and solid wastes only if XRF analysis indicates the presence of EP/TCLP toxic metals at greater than 20 times the TCLP toxic limits.

4 14 locations will be sampled with shallow (3-9 in.) samples collected at all locations and deep (18-24 in.) samples collected at locations in the less-than-90-day storage area. It is assumed that 6 locations will be in the less-than-90-day area.

5 Only soil samples collected from less-than-90-day area will be analyzed for volatile organics.

6 To be determined based on the amount of soil removed and volume of decontamination waste generated. One sample will be collected from each potentially contaminated area.

7 To be determined based on the amount and size of equipment

Table 9. Sample Preservation and Holding Time

Soils

- Metals, Nitrate, pH: Preserve by cooling to $4^{o}C$; holding time 6 months for metals, 48 hr for nitrate, immediate analysis for pH
- Volatile Organics: Preserve by cooling to $4^{o}C$; holding time 14 days
- Semivolatile Organics: Preserve by cooling to $4^{o}C$; holding time 7 days until extraction

Liquid Wastes

- Metals: Preserve by acidifying with nitric acid to pH<2 and cooling to $4^{o}C$; holding time 6 months
- Nitrate: Preserve by cooling to $4^{o}C$; holding time 48 hrs
- Volatile Organics: Preserve by cooling to $4^{o}C$; holding time 14 days
- Semivolatile Organics: Preserve by cooling to $4^{o}C$; holding time 7 days until extraction

Solid Wastes and Swipes

- Metals: Preserve by cooling to $4^{o}C$; holding time 6 months
- TCLP Toxicity: Preserve by cooling to $4^{o}C$; holding time 6 months

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5.7 DOCUMENTATION

As samples are collected during the day, the appropriate documents such as chain of custody forms, request for analysis forms, and the field notebook or the geologist's log will be completed. Information to be noted for sampling activities includes the following:

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- Personnel present during field operations;
- Procedures used for sampling (including any deviations from the SAP and reasons for deviations);
- Time of sample collection;
- Description of sample locations;
- Number and types of sample containers filled at each sample location; and
- Conditions during sampling (e.g., weather), especially conditions which could impact analytical results;

All original data recorded in field notes, chain-of-custody records, and other forms are written with permanent, waterproof ink; erasures of data will not be made. If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and dating and initialling the correction. Any subsequent error discovered on a document is corrected in the same manner (i.e., crossed through, initialed, and dated).

In all cases involving the use of a PNL analytical laboratory or other laboratory on the Hanford Site, samples will be maintained in restricted access areas and in the possession of field or analytical staff. If the samples are sent to an off-site analytical laboratory, tamper indicating seals will be used.

Sample possession will be recorded on a chain-of-custody (COC) form. The form to be used is shown in Figure 4. Each time possession of the sample or sample container is transferred between individuals, both the sender and receiver sign and date the COC form.

A photograph will be taken of each sampling location showing the sample identification number.

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Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington 99352

CHAIN OF CUSTODY

Company Contact: _____ Telephone: _____

Samples Collected by: _____ Date: _____ Time: _____

Sample Location: _____

Ice Chest No.: _____ Field Logbook Page No.: _____

Remarks: _____

Method of Shipment: _____

Sample Identification

CHAIN OF POSSESSION

Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time

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Figure 4. Chain-of-Custody Form

5.8 SAMPLE IDENTIFICATION

Each sample will be assigned a unique sample identification number. These numbers will be assigned in advance of the field effort and will be used to prepare sample labels for each container to be used. The sample label will contain the following information:

- Sample identification number (entered in advance);
- Date and time of sample collection (entered in field);
- Sample location (entered in field);
- Sample type (e.g., grab or composite) and sample media (entered in advance);
- Required analysis and preservatives (entered in advance); and
- Name of sampler (entered in field).

Labels will be attached to each container before entering the field. Field information will be entered on the labels using waterproof ink. After the label is completed, it will be wrapped with waterproof, transparent tape. Similar information, including the sample number, sample location and description, number of containers, and analyses to be performed will be documented on the request for analysis form. This form will be provided by the analytical laboratory and will be completed using the procedures described in Section 5.7.

5.9 INTERNAL FIELD QC

Internal QC checks for field activities will be as follows:

- At least one duplicate sample of each sample parameter will be collected each day. The total number of duplicates will equal 10 percent of the total number of samples collected with a minimum of three.

- At least one equipment blank consisting of the last water rinse from equipment decontamination will be collected for each type of sampling device used each day.
- One travel blank (i.e., deionized/organic free water) will be prepared per day for volatile organic analysis.
- One container blank (i.e., deionized/organic free water in one of the precleaned but unused sample containers) will be submitted for each lot of sample containers used.

Duplicate samples will be used to establish precision of the data. The total number of field duplicate samples submitted will be three samples or 10 percent of the total number of samples, whichever is greater. The number of duplicate samples submitted each day will be one sample or 10 percent of the samples collected each day, whichever is greater. Duplicate samples will be obtained by collecting a single sample, ensuring it is homogeneous, and splitting it into two identical sample containers.

Blank samples will consist of equipment and travel blanks which will be used to determine if contamination is introduced during sampling procedures. Since the use of soil materials for blanks is unproven and impractical, deionized/organic-free water will be used for travel blanks. A sample of the last water rinse from tool decontamination will be collected and analyzed to confirm the absence of sample cross-contamination. One equipment blank will be collected for each ten decontamination cycles, but not less than once per day.

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6.0 REFERENCES

Mendenhall, W. 1975. Introduction to Probability and Statistics. Duxbury Press, North Scltuate, Massachusetts.

Watson, E. C., et al. 1983. Draft Environmental Characterization: Two Potential Locations on Hanford Site for a New Production Reactor. Prepared by the Pacific Northwest Laboratory for the U.S. Department of Energy, Richland, Washington.

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APPENDIX B
QUALITY ASSURANCE PROJECT PLAN (QAPjP)

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1.0 TITLE PAGE

QUALITY ASSURANCE PROJECT PLAN (QAPjP)

SIMULATED HIGH LEVEL WASTE SLURRY TREATMENT AND STORAGE (SHLWS T/S) UNIT CLOSURE

2.0 TABLE OF CONTENTS

2.1 INTRODUCTION

This document is the Quality Assurance Project Plan (QAPjP) for closure of the Simulated High Level Waste Slurry Treatment and Storage (SHLWS T/S) unit. Described in this plan are quality assurance procedures for field activities associated with closure of the SHLWS T/S unit. These field activities are described in the Sampling and Analysis Plan (SAP) for the SHLWS T/S Unit Closure.

This QAPjP has been prepared in accordance with Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans, OER-QAMS-005/80. The analytical laboratory to perform the analysis of samples collected during closure will have a QAPjP in place to satisfy the requirements of this QAPjP and QAMS-005/80.

2.2 CONTENTS

This plan contains the sixteen QAPjP components specified in the above guidance. The plan is organized as follows:

Section	Contents
1.0	Title Page
2.0	Table of Contents
3.0	Project Description
4.0	Project Organization and Responsibility
5.0	QA Objectives for Measurement Data in Terms of Precision, Accuracy, Completeness, Representativeness, and Comparability
6.0	Sampling and Sample Preparation Procedures
7.0	Sample Custody, Preservation, and Storage

8.0 Calibration Procedures and Frequency
9.0 Analytical Procedures
10.0 Data Reduction, Validation, and Reporting
11.0 Internal Quality Control Checks
12.0 Performance and System Audits
13.0 Preventive Maintenance
14.0 Specific Routine Procedures Used to Assess Data Precision, Accuracy, and Completeness
15.0 Corrective Action
16.0 Quality Assurance Reports to Management
Attachment

2.3 DISTRIBUTION

PNL

DE Knowlton
BJ Bjorklund
HW Slater
JW Smith
BL Thomas

3.0 PROJECT DESCRIPTION

Pacific Northwest Laboratory (PNL) is responsible for operating the Simulated High-Level Waste Slurry Treatment and Storage (SHLWS T/S) unit. This unit is located at the 3000 Area of the U.S. Department of Energy (DOE) Hanford Site. The unit was used for the storage and treatment of simulated high level waste slurry (a dangerous waste) and for the accumulation of containers of dangerous waste. The unit has been operated under interim status as a storage and treatment unit and will undergo closure under interim status. Closure activities are described in the closure plan for this unit ("Closure Plan, Simulated High Level Waste Slurry Treatment and Storage (SHLWS T/S) Unit, Rev. 5).

The SHLWS T/S unit is being closed according to the requirements of WAC 173-303-610 and 40 CFR 265 Subpart G. These requirements call for the removal of all dangerous wastes and dangerous waste residuals at the time of closure. In order to verify that all dangerous wastes and residuals have been removed, sampling and analysis will be required. Specific sampling objectives related to regulatory requirements are described in the Sampling and Analysis Plan (SAP), which is Appendix A to the closure plan.

Soil samples will be taken, as described in the SAP, to determine that all soil contaminated by operation of the unit has been removed. The soil underlying areas used for dangerous waste storage and treatment and dangerous waste accumulation will be sampled to verify that contaminants are present below regulatory limits. Using grids, surface samples will be taken at random locations within waste management areas and at background areas outside the unit. Soils which appear to have been contaminated by past spills or leaks will be removed for disposal. Sampling and analysis will be required to determine the regulatory status of these soils and to ensure proper disposal.

Some of the waste management equipment at the SHLWS T/S unit will be decontaminated. Liquid decontamination solutions will be used to decontaminate this equipment. The liquid wastes resulting from decontamination will be sampled to determine if they are dangerous wastes.

Samples will be collected by PNL staff using procedures described in the SAP. As samples are collected they will be immediately identified with a unique sample number and the chain of custody will be initiated. Samples will be transported to the analytical laboratory at the conclusion of each day's sampling activities for sample preparation and analysis. Laboratory analyses will be conducted according to the Laboratory QAPjP. The laboratory QAPjP will approved by PNL prior to submission of samples to the laboratory.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Sampling activities associated with closure will be performed by the PNL Waste Technology Center (WTC). Mr. Wayne Slater of WTC Facility Operations will serve as Project Manager. A PNL Quality Engineer will serve as Quality Assurance Officer and will be responsible for monitoring activities to ensure the requirements of this QAPjP and the analytical laboratory's QAPjP are being adhered to. Appropriate PNL staff will be selected to oversee and conduct the field activities and will programmatically report to Mr. Slater. Field activities will be under the supervision of the field team leader. An analytical laboratory will be selected from several available, depending on availability at the time of sampling. Analyses may be conducted by PNL analytical laboratories, the Hanford Environmental Health Foundation, or a subcontract laboratory. The laboratory performing the analyses will have in place a QAPjP meeting the requirements of this QAPjP and OER-QAMS-005/80. The laboratory QAPjP will be approved by PNL prior to submission of samples to the laboratory.

5.0 QA OBJECTIVES FOR MEASUREMENT DATA IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS, AND COMPARABILITY

Data Quality Objectives (DQOs) are based on the specific objectives of the project. DQOs are selected so that the data collected during the project are of adequate quality to ensure that project objectives are met. Additional considerations for DQOs are proven performance of analytical methods and procedures and indirect requirements, such as regulatory mandates.

This project involves collection and analysis of samples to determine whether closure performance standards have been met at the SHLWS T/S unit and to determine the regulatory status of wastes generated during closure activities. Specific data (i.e., analyses and detection limits) which are needed to satisfy regulatory requirements are identified in the SAP.

Specific QA objectives for this project are as follows:

1. Establish sampling techniques in such a manner that the analytical data are representative of the soils and wastes being sampled.
2. Collect and analyze a sufficient number of duplicate field samples to establish sampling precision. Field duplicates will be used to establish precision among replicate samples collected from the same sample location. Laboratory duplicates of the same sample will provide a measure of precision within that sample (i.e., sample homogeneity).
3. Analyze a sufficient number of analytical duplicate samples (as specified in the analytical method) to assess the performance of the analytical laboratory.
4. Collect and analyze a sufficient number of travel blank and equipment blank samples to evaluate the potential for contamination from sampling equipment and techniques and/or transportation.

5. Analyze a sufficient number of blank, standard, duplicate, spike, and check samples in the laboratory (as specified in the analytical method) to evaluate results against numerical QA goals for accuracy and precision.

Laboratory QA procedures to ensure that analytical data meet DQOs are discussed in detail in the laboratory QAPjP. The following sections discuss activities to be performed during field sampling to support QA objectives.

5.1 ACCURACY

Accuracy refers to the difference between the reported test results and the true value of the parameter being measured. Accuracy of chemical analyses will be evaluated in the laboratory using such techniques as Percent Recovery for evaluation of spikes or known additions to sample matrices, and Percent Relative Error for evaluation of analysis of standards or other reagents of known concentration. The only potential field activities related to determination of accuracy are collection and preparation of field matrix spike samples. Use of field matrix spikes is not planned for the SHLWS T/S closure.

5.2 PRECISION

Precision refers to the reproducibility of measurements under a given set of conditions and is generally expressed as the variability of a set of measurements against their average value. Precision of chemical analyses will be assessed through analysis of duplicate aliquots of samples and evaluated using such techniques as Percent Relative Difference. Field activities related to determining precision of analytical results are collection of blind duplicate samples for analysis by the laboratory.

Precision in analyses will be assessed through analysis of duplicate aliquots of samples. When dealing with solid wastes and soils or other geologic materials, the precision attainable in the laboratory is a function of the relative homogeneity of the sample material. As the sample material becomes more homogeneous, the ability to select similar aliquots of sample increases, and the relative precision of the duplicate analyses improves (i.e., the range of analytical values decreases). Any factors that could affect the precision of duplicate analyses should be noted in the laboratory report. These factors may include obvious stratification of material, degree of sorting of particle sizes, the presence of multi-phase materials, color variations in the sample material, and any other factor that indicates the degree of heterogeneity of the sample.

Precision will be evaluated using Percent Relative Difference. Percent Relative Difference is computed by the following equation:

$RD = 100\ (X_{diff} / X_{avg})$

Where:

RD = Percent Relative Difference

X_{diff} = The absolute value of the difference between the duplicate measurements

X_{avg} = The arithmetic mean (average) of the duplicate measurements

After an adequate number of duplicate data sets are accumulated (minimum of 20 sets), a table of RD values for the range of concentrations encountered will be developed. Until performance-based RD values are obtained, interim objectives of 25% RD will be applied for water samples and 50% RD for soil and waste samples and surface swipe samples. If measured RD values exceed interim limits, the data will be reviewed for the presence of sample characteristics that could result in lower precision. If large RD values cannot be related to obvious sample characteristics, the method will be evaluated to determine

whether the difference results from sample preparation and handling. Expected RD limits will be established for each sample type analyzed.

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5.3 REPRESENTATIVENESS

Representativeness refers to how closely the results measured in the laboratory reflect the actual conditions in the medium sampled. The objective for representativeness is addressed through use of appropriate sampling methods and sample handling procedures. Sampling rationale and methods are described in the SAP.

Representativeness is also evaluated through the use of equipment blanks and travel blanks. These samples will be analyzed to determine if contamination is introduced to the samples through handling in the field.

5.4 COMPLETENESS

Completeness refers to the percentage of measurements planned which are judged to be valid measurements. The initial objective for completeness of samples is 95 percent. This objective means that at least 95 percent of the samples taken in the field will be received by the laboratory in good condition and acceptable for analysis. This objective will be met through the use of proper sample containers, proper sample packaging procedures to prevent breakage during shipment, proper sample preservation, and proper labeling and chain-of-custody procedures.

The initial objective for completeness of chemical analyses in the laboratory is 90 percent. This objective means that usable analytical data will be produced for a minimum of 90 percent of the analyses requested on all samples submitted to the laboratory. This objective will be reviewed after actual performance data are available for each sample type analyzed. The objective may be revised upward or downward based on actual performance, but will not be revised downward without making and documenting a reasonable effort to identify and rectify the limiting factor(s). Based on actual

laboratory performance in analysis of samples, individual completeness objectives for individual analytical methods may be developed.

Loss of analytical data will initiate a corrective action to identify the cause of the loss and prevent recurrence.

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5.5 COMPARABILITY

Comparability refers to the ability to compare the results of various measurements. The objective for comparability is to obtain measurements that are directly comparable. This objective will be met through the use of methods specified by USEPA in SW-846 (Test Methods for Evaluating Solid Waste -- Physical/Chemical Methods) and the State of Washington in WDOE 83-13 (Chemical Testing Methods for Complying with the State of Washington Dangerous Waste Regulation). The x-ray fluorescence (XRF) method specified for use in the SAP is not included in either SW-846 or WDOE 83-13. To support the comparability of XRF to conventional techniques, numerous tests were conducted on various standard materials obtained either from National Bureau of Standards (now known as the National Institute for Standards and Technology or NIST) or the United States Geological Services (USGS). Included in PNL-SP-19 (a Pacific Northwest Laboratory procedure for XRF analysis) is a comparison of XRF analytical results with NIST-certified values for various oils and steel standard samples. In the Attachment, a comparison is provided showing the XRF analytical results and USGS-certified values for three USGS rock samples: BCR-1, G-2, and AGV-1. To demonstrate the performance of XRF on this project, duplicates of 20% of the XRF samples will also be analyzed by SW-846 methods.

6.0 SAMPLING AND SAMPLE PREPARATION PROCEDURES

Samples will be collected and preserved to help ensure that QA objectives are met. The following sections discuss sampling procedures, sample containers, and sample preservation and holding time.

6.1 SAMPLING PROCEDURES

Sampling procedures for soils and wastes are presented in the SAP. These procedures are designed so that samples are collected in a manner that will ensure that project objectives are met.

Quality assurance objectives for sample collection will be met through use of duplicate samples, blank samples, chain-of-custody, and laboratory QA procedures. These items are discussed below.

Duplicate samples will be used to establish precision of the data. The number of field duplicates submitted will be 10 percent of the total of each sample parameter and/or one duplicate for each sample parameter per day, whichever is more frequent. Duplicate samples will be obtained by collecting a single sample, mixing it thoroughly, and splitting it into two identical sample containers.

Blank samples will consist of equipment and travel blanks which will be used to determine if contamination is introduced during sampling procedures. Since the use of soil materials for blanks is unproven and impractical, deionized/organic-free water will be used for travel blanks. A sample of the last water rinse from tool decontamination will be collected and analyzed to confirm the absence of sample cross-contamination. One equipment blank will be collected for each 10 decontamination cycles, but not less than once per day.

Chain-of-custody procedures are described in Section 7.0.

Laboratory QA procedures are described in the laboratory QAPjP. These procedures include the use of method blanks, spiked samples, duplicate samples, and check standard samples.

6.2 SAMPLE CONTAINERS

Sample containers to be used for soil and waste samples are described in the SAP. Precleaned analytical containers which are certified clean by the manufacturer will be used.

6.3 SAMPLE PRESERVATION AND HOLDING TIME

Preservation methods and holding times for the samples to be collected during SHLWS T/S unit closure are as follows:

- Soils
  - Metals: Preserve by cooling to $4^{o}C$; holding time 6 months
  - Volatile Organics: Preserve by cooling to $4^{o}C$; holding time 14 days
  - Semivolatile Organics: Preserve by cooling to $4^{o}C$; holding time 7 days until extraction
- Liquid Wastes
  - Metals: Preserve by acidifying with nitric acid to pH<2 and cooling to $4^{o}C$; holding time 6 months
- Solid Wastes and swipes
  - Metals: Preserve by cooling to $4^{o}C$; holding time 6 months
  - TCLP Toxicity: Preserve by cooling to $4^{o}C$; holding time 6 months.

Samples will be delivered or shipped to the laboratory daily to ensure that holding time limits are not exceeded.

7.0 SAMPLE CUSTODY, PRESERVATION, AND STORAGE

Samples will be handled, preserved, and stored using procedures that help ensure that quality objectives are met. The following sections describe field activities related to sample chain-of-custody, documentation, and corrections to documentation.

7.1 FIELD CHAIN-OF-CUSTODY PROCEDURES

Sample chain-of-custody refers to the process of tracking the possession of a sample from the time it is collected in the field until laboratory analysis is completed. In order for a sample to be considered under a person's custody, one of the following requirements must be met:

- The sample must be in the physical possession of the person.
- The sample must be in view of the person after he has taken possession.
- The sample must be secured by the person in possession so that no one can tamper with it.
- The sample must be secured by the person in possession in an area which is restricted to authorized personnel. In all cases involving the use of a PNL laboratory or other analytical laboratory on the Hanford Site, samples will be maintained in restricted access areas and in the possession of field or analytical staff. If the samples are sent to an off-site analytical laboratory, tamper-indicating seals will be used.

Sample possession will be recorded on a chain-of-custody (COC) form. The form to be used is shown in Figure 7-1. This form also provides a record of the analyses requested for each sample. Each time possession of the sample or sample container is transferred between individuals, both the sender and receiver sign and date the COC form. Similar information will be recorded on the analytical request forms to be provided by the laboratory.

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Battelle
Pacific Northwest Laboratories
P.O. Box 999
Richland, Washington 99352

CHAIN OF CUSTODY

Company Contact: _____ Telephone: _____

Samples Collected by: _____ Date: _____ Time: _____

Sample Location: _____

Ice Chest No.: _____ Field Logbook Page No.: _____

Remarks: _____

Method of Shipment: _____

Sample Identification

CHAIN OF POSSESSION

Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time:
Relinquished by:	Received by:	Date/Time

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Figure 7-1. Chain of Custody Form

7.2 FIELD SAMPLING OPERATIONS

Field sampling operations important to QA include documentation of field activities and documentation of sample information (i.e., sample location). All field activities will be documented in the field notebook or in a geologist's log by the field team leader. This documentation will include the following:

- personnel present during field operations
- procedures used for sampling (including any deviations from the SAP and reasons for deviations)
- time of sample collection
- description of sample locations
- number and types of sample containers filled at each sample location
- conditions or other observations during sampling (e.g., weather), especially conditions which could impact analytical results;

Each page of the field notebook or geologist's log will be dated and signed by the field team leader.

Documentation of sample location is very important. The location of each soil sample will be established according to grids, which are discussed in the SAP. This information will be recorded in the field notebook or geologist's log. Wooden stakes marked with the sample number will be driven into the ground at each sample location. A photograph will be taken of each sample location and will include the sample identification number.

Each sample will be assigned a unique sample identification number. These numbers will be assigned in advance of the field effort and will be used to prepare sample labels for each container to be used. The sample label will contain the following information:

- sample identification number (entered in advance)
- date and time of sample collection (entered in field)
- sample location (entered in field)
- sample type (e.g., grab or composite) and sample media (entered in advance)
- required analysis and preservatives (entered in advance)
- name of sampler (entered in field).

Labels will be attached to each container before entering the field. Field information will be entered on the labels using waterproof ink. After the label is completed, it will be wrapped with waterproof, transparent tape.

7.3 CORRECTIONS TO DOCUMENTATION

All original data recorded in field notes, chain-of-custody records, and other forms are written with permanent, waterproof ink; erasures of data will not be made. If an error is made on a document, the individual making the entry will correct the document by crossing a line through the error, entering the correct information, and dating and initialing the correction. Any subsequent error discovered on a document is corrected in the same manner (i.e., crossed through, initialed, and dated).

8.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments and equipment used during sampling will be operated, calibrated, and maintained according to manufacturer's guidelines and recommendations. Operation, calibration, and maintenance will be performed by personnel who have been properly trained in these procedures.

The only direct measurements expected to be taken in the field are distance measurements for sample location, air temperature during sampling, and pH of liquid wastes. Distance measurements necessary to establish the sample grid will be made with a steel tape. Temperature measurements will be made with a mercury or electronic thermometer which will be calibrated before sampling begins. The pH measurements will be made with a portable pH meter. This meter will be calibrated with standard buffer solutions prior to each measurement.

Procedures and schedules for calibration of laboratory instruments are contained in the laboratory QAPjP.

9.0 ANALYTICAL PROCEDURES

The only field analytical procedure to be conducted is field measurement of the pH of aqueous wastes. These measurements will be conducted using the procedure in Attachment 1 to Appendix B of Chemical Testing Methods for Complying With the State of Washington Dangerous Waste Regulations, WDOE 83-13.

Laboratory analytical methods are identified in the SAP.

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10.0 DATA REDUCTION, VALIDATION, AND REPORTING

Analytical data giving concentrations of metals and organics in soils will be used to determine if the closure performance standard given in WAC 173-303-610(2)(b)(i) has been met. Data from analyses for barium, cadmium, chromium, silver, volatile organics, and semivolatile organics will be used to calculate mean concentrations of these constituents for the background area and waste management areas, as described in the SAP. The mean concentrations for these two areas will be compared using a Student's t test to determine if there is a significant difference at a 95% confidence level. Standard statistical procedures for the test of a hypothesis concerning the difference between two means will be used.

Analytical data giving the concentrations of toxic metals in soils will be used to determine if the closure performance standard given in WAC 173-303-610(2)(b)(ii) has been met. Data from analyses for metals will be used to determine if SHLWS residuals in soils are present above designation limits. The dangerous waste designation procedures given in WAC 173-303-084(5) will be used.

Analytical data giving the concentrations of toxic metals in wastes and the results of TCLP toxicity testing of wastes will be used to determine if wastes are designated as dangerous wastes. Data from analyses for metals and nitrate will be used to determine if SHLWS residuals in wastes are present above designation limits defined in the SAP. The procedures given in WAC 173-303-084(5) will be used. The results of EP toxicity tests will be used to determine if the wastes are characteristic dangerous wastes. The procedures in WAC 173-303-090(8) will be used to determine if the wastes are EP toxic.

All analytical data used in calculations will first be validated by the cognizant analytical supervisor. Procedures for validation of data are

included in the laboratory QAPjP. The laboratory will submit backup data in the data package, as requested, for use in verifying data validation. These backup data will be used to confirm that the data quality objectives have been met. The results of this validation will be documented in a QA/QC report for each analytical data package received from the laboratory. This report will be maintained in the project files.

All calculations will be performed on standard calculation sheets that will include the date and the name of the person performing the calculations. All calculations will be checked by a second person. This person's name and the date that the calculations were checked will be entered on each calculation sheet. All calculation sheets will be retained in the project file.

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11.0 INTERNAL QUALITY CONTROL CHECKS

Quality control of data will involve the collection of field sample duplicates and blanks (described in Section 5.0), laboratory analysis of the samples, and evaluation of the data. Internal quality control checks that will be implemented to ensure that all data generated are of a known quality are as follows:

- Field Activities
  - At least one duplicate sample of each sample parameter will be collected each day.
  - The total number of duplicates collected for each sample parameter will be 10 percent of the total number of samples collected, or a minimum of three.
  - At least one equipment blank will be collected for each type of sampling device used per day.
  - One travel blank will be prepared per day for volatile organic analysis.
  - One container blank will be submitted for each lot of sample containers used.
- Laboratory Activities
  - A multipoint calibration curve will be generated for each parameter to be measured. As appropriate for each parameter, a new calibration curve will be generated daily or with each batch of samples analyzed, or a midrange calibration-curve check sample will be analyzed daily with each batch of samples analyzed.
  - One method blank will be analyzed daily for each method at a 5% frequency or one per batch of samples, whichever is more frequent.
  - At least one sample will be analyzed in duplicate with each batch of 20 or less samples.

- At least one spiked sample will be analyzed with each batch of 20 or fewer samples.
- An EPA QC-certified sample will be analyzed.
- Surrogate spikes will be added to and analyzed with each volatile organics and semivolatile organics sample analyzed.

12.0 PERFORMANCE AND SYSTEM AUDITS

The requirement for systems audits for the field activities associated with closure of the SHLWS T/S unit will be satisfied by approval of this QAPjP and the SAP by the quality assurance representative of Pacific Northwest Laboratory. The QAPjP, SAP, and all procedures referenced therein must be approved prior to conducting any field activities. In addition, field and laboratory activities will be monitored by the project QA officer to ensure compliance with the requirements of this QAPjP and the SAP. An independent system audit will also be performed by a representative of PNL's Quality Verification Department to evaluate whether project activities were conducted in accordance with the QAPjP and SAP.

The requirements for performance audits will be satisfied by taking measures to ensure measurement accuracies are being achieved and maintained. These measures primarily include the provisions identified in Section 11 of this QAPjP including the analysis of blanks, spikes, EPA-certified samples, and duplicate samples. The performance of these activities will be witnessed, as appropriate, by the project QA officer.

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13.0 PREVENTIVE MAINTENANCE

Field activities do not require the use of equipment other than field analytical instruments (e.g., pH meter) and common hand tools. All equipment to be used in the field will be maintained according to the manufacturers recommendations. Because of the limited amount and simplicity of the field equipment, failure of any field instrumentation or equipment would not significantly impact data quality or project schedule. Additional instrumentation or equipment can be readily obtained within an hour should failure occur.

The preventive maintenance program for laboratory equipment is described in the laboratory QAPjP.

14.0 ROUTINE PROCEDURES TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Procedures to assess precision, accuracy, and completeness of laboratory data are described in the laboratory QAPjP. The only field analytical techniques to be employed are field measurement of the pH of aqueous wastes. The accuracy and precision of these data will be controlled by performing measurements in accordance with the procedures contained in the analytical method (Attachment 1 to Appendix B of Chemical Testing Methods for Complying with the State of Washington Dangerous Waste Regulations, WDOE 83-13).

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15.0 CORRECTIVE ACTION

Events or conditions which produce, or may produce, adverse effects on quality of data will be addressed through documented corrective action. The vehicles for identifying such events or conditions are the performance or system audits described in Section 12.0. If, during the course of an audit, the QA Officer or analytical or field staff discovers such events or conditions, corrective actions will immediately be initiated. The QA Officer may, at his discretion, order the stoppage of work until corrective actions have been identified and implemented. The QA Officer and the responsible analytical supervisor or field team leader will be responsible for the following:

- identifying the cause of the event or condition
- identifying actions required to prevent reoccurrence of event or condition
- identifying any required changes to the QAPjP, SAP, or referenced procedures
- determining the impact of the event or condition on the quality of data
- determining if these impacts will cause the data to be unacceptable for meeting the objectives of the project
- identifying unacceptable data which must be replaced through re-sampling or re-analysis.

16.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The QA Officer will prepare periodic reports summarizing the QA/QC status of the project and any adverse events or conditions. These reports will be submitted to the Project Manager and cognizant PNL management. Items which may be addressed in these reports include the following

- results of performance or system audits
- significant QA problems and recommended solutions
- corrective actions taken for any problems previously identified.

Such reports will be prepared after each system audit and following discovery of any event or condition requiring corrective action.

The field team leader will prepare a report to the Project Manager and cognizant PNL management at the conclusion of sampling activities and upon discovery of any adverse event or off-normal condition. Items which may be addressed include

- status of field activities
- significant QA problems and recommended solutions
- corrective actions taken for any problems previously identified.

The responsible analytical supervisor will prepare a report to the Project Manager and cognizant PNL management at the conclusion of analytical activities and upon discovery of any adverse event or off-normal condition. Items which may be addressed in these reports include

- results of performance or system audits
- significant QA problems and recommended solutions
- corrective actions taken for any problems previously identified.

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ATTACHMENT TO APPENDIX B

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X-RAY FLUORESCENCE ANALYSIS

SPONSOR: JANET SCHRAMKE / KHRIS OLSEN
DATE OF WORK: 4-7-90
WORK ORDER NUMBER: M 46721
TYPE OF MATERIAL: SEDIMENTS

SERIES NAMES ASSOCIATED WITH THIS SAMPLE SET:
TZJS42
ZJS042
AJS042
GJS042

9004071509

DESCRIPTION OF XRFA TECHNIQUES USED

NORMAL PROCEDURE FOR 500 MG WAFERS.
PROCESSED ACCORDING TO PNL-SP-19.

ANALYST: R.W. SANDERS / L. BAKER
PHONE: 6-3877

ELEMENT		BCR-1490		USGS BCR-1	G-2490		USGS G-2	AGV-1490		USGS AGV-1
Ti TARGET		<	+-		<	+-		<	+-	
Al	%	7.6	0.46	7.2	8.04	0.47	8.15	8.94	0.51	9.13
Si	%	25.9	1.3	25.5	32.6	1.6	32.3	27	1.4	27.6
P	%	0.176	0.039	0.16	0.137	0.032	0.07	0.235	0.036	0.23
S	%	0.029	0.012	0.039	.018		0.002	.02		0.001
Cl	%	.010		0.005	.010		0.005	.01		0.011
K	%	1.55	0.078	1.41	3.7	0.19	3.74	2.33	0.12	2.4
Ca	%	5.14	0.26	4.95	1.362	0.069	1.38	3.35	0.17	3.5
Zr TARGET										
Si	%	26	1.4	25.5	32.6	1.7	32.3	28.2	1.5	27.6
K	%	1.56	0.083	1.41	3.76	0.19	3.74	2.46	0.13	2.4
Ca	%	5.12	0.26	4.95	1.43	0.074	1.38	3.49	0.18	3.5
Ti	%	1.36	0.069	1.32	0.301	0.016	0.3	0.62	0.032	0.62
V	PPM	404	45	399	47		35	96	29	125
Cr	PPM	37		17.6	20		7	27		12.2
Mn	PPM	1443	76	1406	248	16	260	764	41	763
Fe	%	9.56	0.48	9.35	1.833	0.092	1.85	4.73	0.24	4.72
Co	PPM	70		38	28			46		
Ni	PPM	16.2	3.1	15.8	5.2	1.5	5.1	20.7	2.4	18.5
Cu	PPM	21.1	2.3	18.4	11.8	1.4	11.2	60.1	3.7	59.7
Zn	PPM	125	6.8	120	83.3	4.5	85	84.6	4.7	84
Ga	PPM	20.9	1.4	20	20.5	1.4	22.9	20.3	1.4	20.5
Se	PPM	1.1		0.1	.8		0.7	.88		0.14
Pb	PPM	15.1	1.9	17.6	31.1	2.2	31.2	35.7	2.5	35.1
As	PPM	2		0.7	1.6		0.25	1.9		0.8
Br	PPM	1.1		0.15	.79		0.3	.97		0.5
Rb	PPM	46.8	2.5	46.6	165.8	8.4	168	69	3.5	67
Ag TARGET										
Rb	PPM	47	3.4	46.6	168	12	168	66.6	4.8	67
U	PPM	3.1		1.7	5.3	2.2	2	4	1.7	1.9
Sr	PPM	323	23	330	478	34	479	656	46	657
Y	PPM	36.8	2.7	37.1	11.9	1.1	12	20.3	1.6	21.3
Zr	PPM	181	13	190	317	22	300	225	16	225
Nb	PPM	12.5	1.1	13.5	10.73	0.95	13.5	14.8	1.2	15
Mo	PPM	1.42	0.34	1.1	1.53	0.38	0.36	2.36	0.39	2.3
Th	PPM	6.4	2.4	6	25	3.3	24.2	5.1	2.5	6.4
Gd TARGET										
Ru	PPM	5.3		1	5.3			5.7		
Rh	PPM	5.9		0.2	5.5			5.7		
Pd	PPM	6.7			6			6.1		
Ag	PPM	7.1		0.04	6.7		0.11	6.7		0.05
Cd	PPM	7.4		0.12	7.1		0.04	7.4		0.09
In	PPM	8.2		0.095	7.8		0.034	7.5		0.02
Sn	PPM	8.4		2.6	8.4	3.9	3.5	8.3		4.2
Sb	PPM	9.0		0.7	9.3		0.1	9.4		0.3
Te	PPM	12			10			11		
I	PPM	13			13			14		
Cs	PPM	15		0.95	14		1.4	16		1.4
Ba	PPM	672	14	675	1889	17	1870	1208	16	1208
La	PPM	25		26	81	12	96	39	13	35
Ce	PPM	71	13	54	136	14	150	64	14	63

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TABLE 106.—*Estimates of components normally determined in a rock analysis, in percent*

[Data are listed as recommended, averages, or magnitudes]

	W-1	G-1	G-2	GSP-1	AGV-1	PCC-1	DTS-1	BCR-1
SiO_2	52.64	72.64	69.11	67.38	59.00	41.90	40.50	54.50
Al_2O_3	15.00	14.04	15.40	15.25	17.25	.74	.24	13.61
Fe_2O_3	1.40	.87	1.08	1.77	4.51	2.85	1.21	3.69
FeO	8.72	.96	1.45	2.31	2.05	6.24	7.23	8.80
MgO	6.62	.38	.76	.96	1.53	43.18	49.80	3.46
CaO	10.96	1.39	1.94	2.02	4.90	.51	.15	6.92
Na_2O	2.15	3.32	4.07	2.80	4.26	.006	.007	3.27
K_2O	.64	5.48	4.51	5.53	2.89	.004	.0012	1.70
H_2O^+	.53	.34	.55	.57	.81	4.70	.46	.77
H_2O^-	.16	.06	.11	.12	1.03	.50	.06	.80
TiO_2	1.07	.26	.50	.66	1.04	.015	.013	2.20
P_2O_5	.14	.09	.14	.28	.49	.002	.002	.36
MnO	.17	.03	.034	.042	.097	.12	.11	.18
CO_2	.06	.07	.08	.15	.05	.12	.08	.03
Total	100.26	99.93	99.73	99.84	99.91	99.89	99.86	100.28
Total Fe as Fe_2O_3	11.09	1.94	2.65	4.33	6.76	8.35	8.64	13.40
O	44.77	---	48.34	47.78	47.24	----	----	45.48

TABLE 107.—*Estimates for trace elements in USGS samples*

[Data are listed as recommended, averages, or magnitudes; in all parts per million, except for Au, Hg, Ir, Os, Pd, Pt, Re, Rh, and Ru, in parts per billion and for Ha in μμg/g]

Element	W-1	G-1	G-2	GSP-1	AGV-1	PCC-1	DTS-1	BCR-1
Ag	0.081	0.05	0.049	0.10	0.11	0.005	0.008	0.036
As	1.9	.5	.25	.09	.8	.05	.03	.70
Au	3.7	4.0	1.0	1.6	.6	1.6	.8	.95
B	15	1.7	2.0	<3	5	6	<5	5
Ba	160	1,200	1,870	1,300	1,208	1.2	2.4	675
Be	.8	3	2.6	1.5	3	--------	---------	1.7
Bi	.046	.065	.043	.037	.057	.013	.010	.050
Br	.4	.4	.3	--------	.5	.6	.2	.15
C	------	--------	--------	--------	--------	--------	---------	65
Cd	.15	.03	.039	.06	.09	.1	.12	.12
Ce	23	170	150	394	63	.09	.06	53.9
Cl	200	70	60	300	110	60	11	50
Co	47	2.4	5.5	6.4	14.1	112	133	38
Cr	114	20	7	12.6	12.2	2,730	4,000	17.6
Cs	.9	1.5	1.4	1.0	1.4	.006	.006	.95
Cu	110	13	11.7	33.3	59.7	11.3	7.0	18.4
Dy	4	2.4	2.6	5.4	3.5	--------	.003	6.3
Er	2.4	1.15	1.3	3.0	1.2	--------	<.003	3.59
Eu	1.11	1.3	1.5	2.4	1.7	.002	.0009	1.94
F	250	690	1,290	3,200	435	15	15	470
Ga	16	19.6	22.9	22	20.5	.4	.2	20
Gd	4	5	5	16	6.5	--------	<.01	6.6
Ge	1.4	1.1	1.15	1.3	1.1	.93	.00	1.54
Hf	2.67	5.2	7.35	16.9	5.2	.06	.01	4.7
Hg	225	97	39	16.5	16	7.2	8.7	10.7
Ho	.69	.35	.4	<.5	.8	--------	.003	1.2
I	<.03	<.03	--------	--------	--------	--------	---------	<1
In	.065	.02	.034	.05	.04	.003	.0025	.095
Ir	.28	.008	.002	.012	.011	5.2	1.0	.004
La	9.8	101	96	191	35	.15	.04	26
Li	14.5	22	34.8	32.1	12	2	2	12.8
Lu	.35	.19	.11	.23	.28	.006	.002	.55
Mn	1,278	195	260	331	763	959	969	1,406
Mo	.57	6.5	.36	.90	2.3	2	2	0.1
N	52	59	56	48	43	43	27	80
Nb	9.5	23.5	13.5	29	15	<2	<3	13.5
Nd	15	56	60	188	39	--------	<.02	29

TABLE 107.—*Estimates for trace elements in USGS samples*—Continued

Element	W-1	G-1	G-2	GSP-1	AGV-1	PCC-1	DTS-1	BCR-1
Ni	76	1	5.1	12.5	18.6	2,339	2,269	16.8
Os	.25	.07	--------	<32	<34	11	1	1
Pb	7.8	48	31.2	61.3	35.1	13.3	14.2	17.6
Pd	25	2	<.5	<.5	<.5	13	1	12
Pr	3.4	19	19	50	7	--------	.006	7
Pt	12	19	<.5	<.5	1	8	3	2
Ra	--------	--------	.71	.66	.69	.0018	.0013	.56
Rb	21	220	168	254	67	.063	.053	46.6
Re	<2	<2	<7	<2	<5	.07	<.4	.8
Rh	<1	--------	--------	--------	--------	1.0	.9	.2
Ru	------	--------	--------	--------	--------	9.5	2.5	1
S	123	58	24	162	<10	<10	<10	392
Sb	1.0	.31	1	3.1	4.5	1.4	.46	.69
Sc	35.1	2.9	3.7	7.1	13.4	6.9	3.6	33
Se	.13	.007	<.7	<.04	<.14	<.18	<.3	.10
Sm	3.6	8.3	7.3	27.1	6.9	.008	.004	6.6
Sn	3.2	3.5	1.5	6.3	4.2	1	1	2.6
Sr	190	250	479	233	657	.41	.35	330
Ta	.50	1.5	.91	1.0	.9	<.1	<.1	.91
Tb	.65	.54	.54	1.3	.70	.001	.0003	1.0
Te	<1	<1	<1	<1	<1	<1	<1	<1
Th	2.42	50	24.2	104	6.41	.01	.01	6.0
Ti	--------	--------	2,780	3,990	6,190	70	71	12,750
Tl	.11	1.24	1.0	1.3	1	.0008	.0005	.30
Tm	.30	.15	.3	--------	.4	--------	.001	.6
U	.58	3.4	2.0	1.96	1.88	.005	.004	1.74
V	264	17	35.4	52.9	125	30	10.3	399
W	.5	.4	.1	.1	.55	.08	.04	.40
Y	25	13	12	30.4	21.3	<5	.05	37.1
Yb	2.1	1.06	.88	1.8	1.7	.02	.01	3.36
Zn	86	45	85	98	84	36	45	120
Zr	105	210	300	500	225	7	3	190

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