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Title of Document: SAFETY ASSESSMENT FOR THE 118-B-1 BURIAL GROUND EXCAVATION TREATABILITY TESTS

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ACRONYMS

ALARA	as low as reasonably achievable
ARF	airborne release factor
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DOE	U.S. Department of Energy
EII	Environmental Investigation Instruction
ERDF	Environmental Restoration Disposal Facility
GM	Geiger-Mueller
HMS	Hanford Meteorological Station
HWOP	Hazardous Waste Operating Plan
JSA	job safety analysis
LTP	low-range totem pole (radiation dose rate detector)
msl	mean sea level
PCB	polychlorinated biphenyl
PWAC	preliminary waste acceptance criteria
OSHA	Occupational Safety and Health Administration
OSL	operational safety limit
OU	operable unit
RQ	reportable quantity
RWP	radiation work permit
SD	supporting document
USQ	unresolved safety question
VOC	volatile organic compound
WAC	Washington Administration Code

DEFINITIONS OF TERMS

Cask--Special container for handling or shipping high-dose-rate materials.

Cladding--A "skin" or covering around reactor fuel pieces, poison, P-10 pieces, and all special test pieces.

Crossheader--Pipe that connects to main coolant supply to provide coolant of designated process tubes (always sections of two rows).

Gunbarrel--Steel tube used to support the process tubes and provide a gas seal at the penetrations to the reactor block.

Horizontal control rod--Used to control the nuclear reaction in the reactor.

Lead-cadmium element--Rod-shaped, 6-in.-long piece with aluminum cover used to absorb neutrons in the process tubes.

Nozzle--Capped opening to the process tubes for fuel loading and unloading.

Pigtail--Small, pigtail-like pipe connection for cooling flow to the process tubes.

Poison--Any nonfissionable element in a reactor with appreciable neutron absorption cross sections (high probability of capturing the neutron).

Process tubes--Aluminum or zirconium tubes through the reactor core that carry the fuel column and coolant.

Silica gel--Desiccant used to dry gases that circulated through the reactor.

Spacers--Cylindrical pieces used to center the fuel in the process tube and prevent fuel elements from flushing to the rear during reactor operation.

Splines--Flat strips of aluminum and boron used to shape the active section of the reactor, or to flatten (distribute evenly) or control the neutron flux in the reactor.

Thimble (rod channel thimble, rod thimble)--Sealed aluminum tubes that ran through the graphite to maintain the gas seal in the vertical safety rod and horizontal control rod channels. Vertical thimbles were designed to contain liquid boron if a 3X system was used.

1.0 INTRODUCTION

This document provides the safety assessment for a treatability study designed to test excavation, screening, and sorting of material in a low-level waste burial ground. This safety assessment follows the guidelines of WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual* and WHC-CM-6-32, *Safety Analysis and Engineering Work Procedures*.

From 1943 to 1990, the primary mission of the Hanford Site was to produce nuclear material. Waste disposal activities associated with this mission resulted in the creation of more than 1,000 past-practice waste sites. The remediation of these sites forms the Richland Environmental Restoration Project, a major system acquisition funded by the U.S. Department of Energy (DOE). Remediation of these sites, which have been grouped into operable units (OU), is governed by the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA). The waste sites are contaminated with radioactive constituents, chemical constituents, or combinations of both. Contamination from some of these sites has migrated into the groundwater.

Remediation alternatives have been developed and screened in the *100 Area Feasibility Study Phases I and II* (Roeck 1992). Currently, treatability data are needed to support Phase III, Detailed Analyses. The *Treatability Study Program Plan, Draft A* (Field 1992) outlines treatability studies to support remediation work in the 100 Area. This plan discusses the near-term need to test excavation and sorting systems to support waste excavation and disposal.

The 118-B-1 Burial Ground treatability study has been required by milestone change request #M-15-93-04, dated September 1993. The change request requires that a treatability test be conducted at the 100-B Area to obtain additional information for remedial design of burial grounds receiving waste from 100 Area removal actions.

1.1 ASSESSMENT SUMMARY

This document provides a safety assessment of the hazards and operational controls to ensure safe operation of the work associated with excavating, sampling, sorting, and replacing of waste buried in the 118-B-1 Burial Ground. Details of the effort are described in the test plan for this operation (Frain 1994).

The 118-B-1 Burial Ground was found to be a low-hazard (per WHC-CM-4-46), nonnuclear facility (less hazardous than Hazard Category 3 per DOE 1992a) and radiological (per DOE 5481.1B [DOE 1986]) operation. Using the worst-case radioactivity scenario, the hazards and consequences associated with this operation were determined to be acceptable risks. An operational safety limit (OSL) has been established that bounds the safety envelope of this assessment by restricting operations to one trench open at any given time (a trench is closed when 1.22 m [4 ft] of clean overburden is reestablished). Except for trenches P-1 and P-2, no restrictions limit where a trench is excavated within the 118-B-1 Burial Ground;

however, excavated volume is limited to 2,000 yd^3. Trenches P-1 and P-2 may contain tritium; hazards associated with this element were not assessed. Based on historical data, personal interviews, engineering drawings, and ground-penetrating radar contour charts, there is a high probability that the location of these trenches can be firmly established and encroachment into these trenches can be avoided.

Only spillage, erosion, and fire-offered scenarios that, when combined with wind, could potentially constitute a hazard to onsite workers, the public, and the environment. Wastes in the 118-B-1 Burial Ground are (1) irradiated solid, monolithic metals from the 105-B Reactor Building; and (2) low-level combustible trash, the largest volume of waste. Because of the low moisture content, the radiation from these materials has not migrated to the soil to any appreciable degree. The total amount of radiation available from the spillage of the 3 yd^3 bucket of a track-mounted backhoe (trackhoe) is 6.5×10^2 μCi. The source term for erosion of the soil from one sample site (1,000 yd^3) is 0.2 Ci. Further, the source term contributed by burning all the trash within the 118-B-1 Burial Ground is 17 Ci. The airborne release factor reduces this amount by a factor of 5×10^{-4}. Therefore, the radiological hazards are negligible.

Chemical hazards also were assessed. Because organic liquid wastes were sent to other burial grounds (cribs), heavy metals (e.g., cadmium, lead, and mercury) make up the primary source of wastes that are chemically hazardous. Realistic pathways could not be identified that could place this metal in a position that would adversely impact the onsite workers or the public. The facility worker could be impacted through the inhalation of oxides and dust particles of these heavy metals and toxic materials, and precautions such as training in identifying and handling these materials and air samplers are recommended as prudent actions.

In addition to radiological and toxic hazards, other health and safety issues are addressed: voids in soil, pit collapse, dust control, fire lanes, air monitoring, and ingress and egress paths.

1.2 SUMMARY OF PRUDENT ACTIONS

In addition to the OSLs, several prudent actions are provided (see Section 4.2). These actions should be implemented to be in consonance with as low as reasonably achievable (ALARA) principles. These prudent actions are to be implemented through management commitments and through incorporation into work procedures and practices, such as radiation work permits (RWP), hazardous work operations plans (HWOP), job safety analyses (JSA) and other administrative controls.

2.0 RELEVANT BACKGROUND DATA

2.1 LOCATION AND DESCRIPTION OF SITE

A total of 28 burial grounds were used in the 100 Area for direct burial of solid low-level radioactive waste associated with reactor operations. Seven of these burial grounds specifically supported reactor operations and are considered primary burial grounds. Burial ground 118-B-1 supported 105-B Reactor from 1944 to 1973. It was the primary burial ground for 105-B Reactor wastes but also received waste from the 100-N Reactor and the Tritium Separation Program (P-10 Project). The 118-B-1 Burial Ground has also been referred to as the 105-B Burial Ground, the 105-B Solid Waste Burial Ground, and the Operation Solid Waste Burial Ground. A sketch of the trenches is shown in Figure 1.

The 118-B-1 Burial Ground is located in the 100 B/C Area of the Hanford Site, about 914 m (3,000 ft) due west of the 105-C Reactor Building. The burial ground dimensions are approximately 304 m (1,000 ft) running north and south, by 97 m (320 ft) running east and west. Historical records indicate that the trenches were typically 91 m (300 ft) long, 6 m (20 ft) wide, and 6 m (20 ft) deep, and were separated by 6-m (20-ft) spaces. Reconstruction shows that the burial ground contains 21 trenches running east and west and 3 trenches running north and south. Waste materials were typically covered with 1.2 m (4 ft) of clean overburden. This clean soil has been stabilized with gravel to inhibit wind erosion. In addition, the burial grounds are routinely treated with herbicides to prevent translocation of radioactivity by deep-rooted weeds. Any subsidence caused by settling of material is filled as required.

All radioactive solid waste burial grounds are routinely surveyed to ensure that contamination is not spreading to the environment. Bimonthly surveillances of the burial grounds are conducted from May 1 through November 1 to detect tumbleweeds and any other unusual conditions that potentially arise from soil erosion, wind, rodents, burrowing animals, etc. These actions are required by WHC-CM-7-5, *Environmental Compliance*, Section 6.0, "Restoration and Remediation."

2.2 ACTIVITY DESCRIPTION AND PURPOSE

2.2.1 Objectives

As part of the remediation and restoration of the Hanford Site burial grounds, portions of the 118-B-1 Burial Ground are being excavated to determine treatability of this and similar areas. The objectives of the treatability test are summarized in Table 1. These objectives are grouped according to the three operations being investigated as part of the treatability test: excavation, screening, and handling (Frain 1994).

Figure 1. 105-B Reactor Solid Waste Burial Ground 1944-1965.

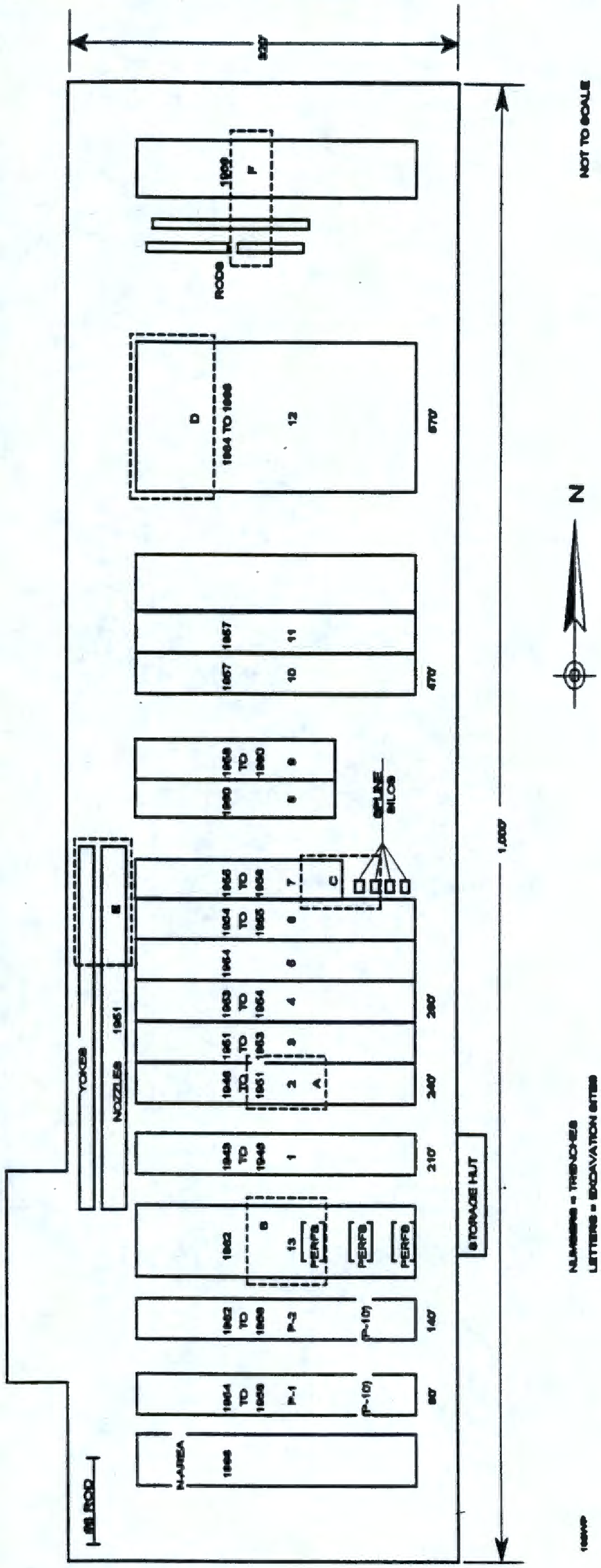


Table 1. Treatability Test Objectives.

Operation	Test objective
Excavation	Compare effectiveness of the top-down and side approaches.
	Identify waste forms requiring special excavation equipment and their frequency of occurrence.
Screening	Determine implementability of screening for currently established preliminary waste acceptance criteria (PWAC) for an environmental restoration disposal facility (ERDF) during bulk removal using field instruments and visual observations.
	Determine whether contents of containers meet ERDF PWAC using field instruments and visual observations.
Handling	Determine feasibility of segregating waste forms into categories during excavation using a backhoe with thumb.
	Determine feasibility of sorting waste forms into categories using a grizzly screen, disc screen, manual raking, and hand picking.

2.2.2 Excavation Site Description

The excavation effort will remove approximately 1,000 yd^3 from five sampling areas within the 118-B-1 Burial Grounds. These sampling areas have been chosen to provide a cross section of the wastes that are expected to be encountered. An alternative excavation site has also been selected. These excavation sampling sites have been superimposed over the 118-B-1 Burial Ground plot in Figure 1. These sampling plots have been selected for the following reasons:

- Location A is in the center of Trench 2, which was used from 1946 to 1951, and is believed to contain radioactive metals, soft waste, and miscellaneous waste. The center area was chosen because trash was apparently disposed on the east end and metal wastes were deposited on the west end; thus, this position should provide access to both waste types. Although the trench is marked, the actual location could correspond to Trench 1 or Trench 3 and either trench would be acceptable because they cover the same approximate utilization period.

- Location B is in Trench 13, which was used in 1962. Drawings show that segregation may have been attempted by using railroad ties (note "PERF" in Figure 1); however, confirmation that these crib-like structures were actually built is unavailable. Trench 13 is expected to be wider and deeper (9 by 10 m [30 by 32 ft]) than the other trenches.

- Location C is in Trench 7, which was filled in the mid-1950's, will also include the reactor spline silos. In addition to the splines, this excavation site is expected to contain radioactive metal, as well as soft and miscellaneous wastes (see paragraph 2.5.5 for definition of these waste categories).

- Location D is in Trench 12, which was filled from 1964 to 1966. The trench is expected to be wider and deeper than earlier trenches and is presumed to contain a variety of wastes. The western end of the trench will be investigated.

- At location E, the north-south trenches will be investigated. These trenches are expected to contain lead and steel spacers, nozzles, and yokes. This location could also contain water-sampling pumps, piping, duct work, scrap metal, and gunbarrels. The excavation will proceed south if waste is not found at the planned location.

- Location F is an alternate excavation site and is positioned over the northernmost trench, which was filled in 1966. This alternate excavation site will include two smaller trenches, located to the south of this trench, and are expected to contain horizontal control rods and vertical safety rods.

2.2.3 Overburden Removal and Stockpiling

A front-end loader is the most effective machine to remove the clean, uncontaminated overburden. The overburden is defined as the soil between the surface and 0.3 to 0.6 m (1 to 2 ft) above the trench top and is estimated to be from 1.5 to 3 m (5 to 10 ft) deep. Although the original overburden was approximately 1.2 m (4 ft) deep, an extra 1.2 to 1.5 m (4 to 5 ft) of soil has been added to further stabilize the area and prevent wind erosion of the covered material. This removed overburden will be monitored for contaminants and stockpiled in a designated area upwind from the excavation site. The stockpile of overburden will be covered or dampened to control fugitive dust.

Overburden is removed to cut a slope at a horizontal to vertical ratio of 1.5:1 (i.e., $\sim 34°$ gradient). The location of the stockpile of overburden soil will depend on the logistics of removal and of minimizing interference with other operations. The overburden should also be located upwind of the excavation area to mitigate contamination potential.

Trench depth and location are two uncertainties that will need to be managed during the implementation of overburden removal and stockpiling. Either of these uncertainties could impact the area required for overburden removal. The test plan (Frain 1994) has a decision matrix that addresses these issues. These decisions should not impact safety issues because this analysis is made independent of the excavation area within a given trench. The depth of the trench is also not a safety issue for the same reason. Maintaining the gradient and determining the placement of the overburden are ALARA issues; however, WHC-CM-4-3, *Industrial Safety Manual* requires that a registered professional engineer design the protection system if it is determined that the excavation has the potential to exceed 6 m (20 ft) even if the 1.5:1 sloping ratio is maintained. Pit egress and ingress pathways should conform to the standards provided in Washington Administrative Code (WAC) 296-155.

2.2.4 Excavation

For this test, excavation is defined as (1) material removed from the trench, or (2) material that is segregated within the trench. An estimated 5,000 to 10,000 yd^3 (i.e., 1,000 to 2,000 yd^3 per trench) of waste material will be excavated. All excavation will be performed with a Caterpillar[1] 245 (Cat)[1] trackhoe equipped with a thumb. This vehicle is essentially a track-mounted backhoe with a mechanism to cover the load in the bucket while the bucket is maneuvering to place the extracted material in a designated area or retainer.

Initially, the trackhoe will work from the side of the trench, establishing the gradient and removing bulk material until sufficient space has been generated to allow the trackhoe to enter the trench and begin bulk removal and segregation. The test plan (Frain 1994) estimates the following composition of the work effort:

- Bulk removal out of and within the trench (70 to 75 percent of the total excavated volume)

- Segregation within the trench (20 to 25 percent)

- Bulk removal and sorting out of the trench (1 to 10 percent).

Initially, the trackhoe will use a top-down approach to remove bulk that will be field screened for radionuclides, organics, and free liquids. Data concerning cross-contamination, spillage volume, and waste-form removal are to be collected per guidance provided in the test plan (Frain 1994). Excavation will continue until at least one side slope and the bottom of the original trench are uncovered, at which point the slope stability will assessed.

When approximately 10 percent of the total planned volume has been excavated, the excavation technique may be changed to the side approach, for which the trackhoe is positioned within the trench and excavates side to side.

[1]Caterpillar and Cat are trade names of Caterpillar, Inc.

2.2.5 Field Screening

The test plan categorizes waste forms into four groups: containers, soil, hard waste, and soft waste. These categories have been established to facilitate initial screening in the field and to identify the sorting process to which each category will be subjected.

- **Soil.** Naturally occurring inorganic materials. This classification includes cross-contaminated soil from the trench bottom and sidewalls, and cross-contaminated overburden.

- **Containers.** Any enclosed receptacle that may contain materials that require additional segregation into free and organic liquids, soil, hard waste, and soft waste. Different data are needed to evaluate the feasibility of segregation when containers are and are not visible in the waste materials. For this test, cardboard boxes are not considered sealed containers that contain free liquids. A sample number of cardboard boxes will be opened and examined.

- **Hard Waste.** Includes all metallic and reasonably noncompressible solids. Examples of hard wastes are aluminum tubing, spacers and dummies, lead shielding and bricks, miscellaneous metal parts, and glass. Rock is defined as soil and not hard waste.

- **Soft Waste.** Includes all nonmetallic and compressible solid wastes. Examples of soft wastes are paper, cardboard boxes, plastics, personnel clothing such as gloves and booties, and office waste.

The objectives of field screening are defined in Frain (1994). Bulk removal will be visually screened and monitored for radionuclides and volatile organic compounds (VOC). Should Hazard Category 3 (per WHC 1993) material be detected, work shall be halted until the DOE, U.S. Environmental Protection Agency, and Washington State Department of Ecology have been informed of the situation. An unresolved safety question (USQ) determination should also be initiated to determine whether activity levels are within the envelope established by this supporting document. Materials with more than twice the expected beta/gamma rates or that exhibit neutron activity will be set aside for secondary screening.

Organic vapor screening is performed on the bulk removal by using a photo-ionization detector or flame-ionization detector. If readings are above the established background level, an effort will be made to locate and isolate the source, and a sample will be collected for additional analysis.

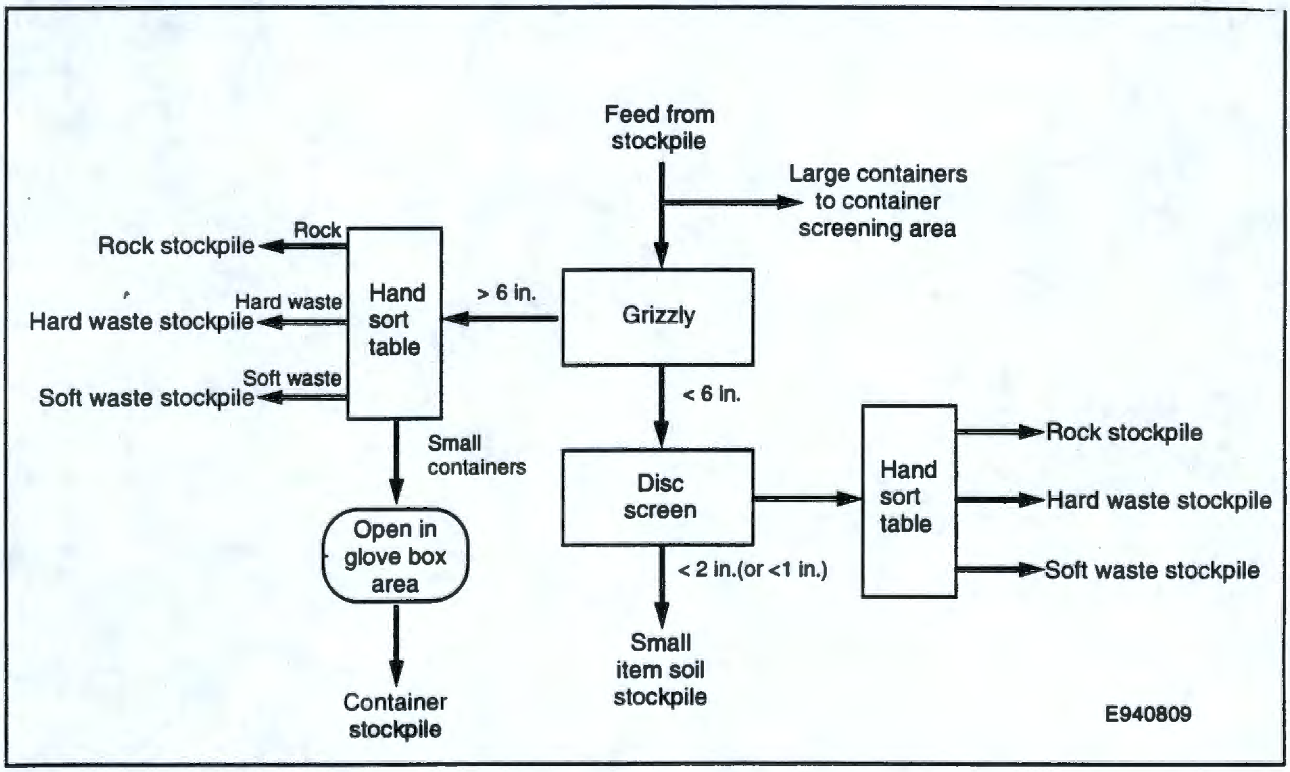
Container screening is the same as bulk screening except that some containers will be opened manually to determine if free liquids are present. Initially, all containers will be opened until a trend can be established and, once established, the frequency of sampling will be reduced to 10 percent.

2.2.6 Handling, Segregation and Sorting

Segregation will be performed in the trench when room to conduct such an operation is established. All material, except free liquids, will eventually be put back into the trench. Waste will be classified into the four categories (soil, hard, soft, and miscellaneous) and the location of the waste in the trench recorded. The ability to effectively carry out segregation is to be evaluated.

Sorting will involve approximately 1 to 10 percent (i.e., 5 yd^3) of the excavated volume and will be accomplished outside the trench. This effort is a pilot test because the ability of the sorting equipment must also be evaluated. A static, inclined screen, called a grizzly screen, will be used in this evaluation. The grizzly screen has been selected using an abbreviated best-available-technology methodology (Frain 1994). The material will be dumped onto the screen from a front-end load. The conceptual flow chart for sorting this material is shown in Figure 2.

Figure 2. Sorting Flow Chart.



2.2.7 Closure

All material, except for free liquids, will be returned to the excavated trench. A 1.2-m (4-ft) overburden will be reestablished before the excavation on the next trench can begin. Free liquids should be processed in accordance with WHC-CM-7-5, Environmental Investigation Instruction (EII) 4.2.

2.3 WASTE DESCRIPTION

Although records of what went into the trenches are sparse, the sources of the waste are well known: (1) 105-B Reactor Building, (2) tubing from N Reactor, and (3) the Tritium Separation Program. Miller and Wahlen (1987) reconstructed the waste inventory of the 118-B-1 Burial Ground based on logs and records, process knowledge, operating practices, reactor power levels, and interviews with knowledgeable individuals involved in the disposal of wastes generated during the years of reactor operations.

In 1976, 14 core samples were taken in the 118-B-1 Burial Grounds (Dorian and Richards 1978). The results showed that little or no vertical migration of the contaminants had occurred and that the prime radionuclide contributor is ^{60}Co. All material in the trenches appeared to be solid, low-level waste.

2.3.1 Radionuclides

The data provided in Miller and Wahlen (1987) have been updated and the radionuclides decayed to June 1, 1994. These data are shown in Table 2. The total quantity of any radionuclide does not exceed that of the Hazard Category 3 threshold quantity (TQ) as specified in DOE 1992a, nor does the sum of the radionuclide ratios (inventory divided by TQ) exceed one. Therefore, the excavation is defined as a non-nuclear activity per DOE 1992a and not subject to the requirements of DOE 1992a. Table 2 also contains the reportable quantity (RQ) per 10 CFR 302.4 for each nuclide. Because three of the nuclides exceed the RQ value, the activity is designated as a radiological facility.

Dorian and Richards (1978) reported traces of plutonium in the southernmost trench in which N Reactor tubing had been buried. Also, plutonium traces were detected in the northernmost trench, which received waste in 1966. Because these traces of ^{239}Pu could not be attributed to any particular waste form or justified through process knowledge (i.e., plutonium was not consistently nor routinely disposed of in the 118-B-1 pits), the plutonium is assumed to be isolated to these two pits. Defining each pit as a segmented facility as defined in DOE 1992a, each pit may be assessed separately. The maximum plutonium concentration level detected by Dorian and Richards (1978) is 1 pCi/g. The volume of the typical pit is 1.2×10^5 ft^3 (3.4×10^3 m^3). Therefore, conservatively, the maximum plutonium in a typical pit is 3.4×10^{-3} Ci. This activity level is below the Category 3 TQ of 5.2×10^{-1} Ci and is below the 10 CFR 302.4 reportable quantity of 0.01 Ci. The plutonium content is not considered further and therefore not listed in Table 2.

Table 2. Radionuclide Summary.

Nuclide	Inventory[a] (Ci)	Inventory[b] (Ci)	TQ[c] (Ci)	Ratio (Inventory /TQ)	RQ[4d] (Ci)	Sample[e] (pCi/g)
^{3}H	1.6	1.1	1,000	0.00	100	-
^{14}C	0.34	0.34	420	0.00	10	-
^{60}Co	323	129	280	0.46	10	16,000
^{63}Ni	262	249	5400	0.05	100	28
^{59}Ni	2	2	11,800	0.00	100	-
^{90}Sr	0.3	0.25	16	0.02	0.1	91
^{137}Cs	2.3	2	60	0.03	1	1,800
^{152}Eu	2.3	1.3	200	0.01	10	1,100
^{154}Eu	1.6	0.9	200	0.00	10	620
^{133}Ba	0.5	0.3	1,100	0.00	10	-
^{41}Ca	0.01	0.01	1,600	0.00	10	-
^{108m}Ag	9	8.7	200	0.05	10	-
Total		-	-	0.62	-	-

[a]Worst case from Tables 10 and B.1 in Miller and Wahlen (1987).
[b]Inventory decayed to June 1, 1994.
[c]Hazard Category 3 threshold quantities (TQ) from DOE 1992a.
[d]Reportable quantities from 10 CFR 302.4, Appendix B.
[e]G-22 soil sample from Trench 7; worst case sample taken by Dorian and Richards (1978) and decayed to June 1, 1994.

Dorian and Richards (1978) measured dose rates in addition to taking samples for laboratory analysis. The highest dose rates were associated with the N Reactor trench, in which readings of 300 mR/hr were recorded on a wide scale beta/gamma detector (see Table 2). Another hot spot where the Geiger-Mueller (GM) probe went off scale was in the northernmost trench, where low-range totem pole (LTP) readings were found to be as high as 60 mR/hr.

The in situ readings showed that the overburden for each of the trenches sampled was 2.4 to 3 m (8 to 10 ft); readings reached background level, indicating the trench bottom, after 6 m (20 ft). The N Reactor trench was the exception; this trench had 3.6 m (12 ft) of overburden and reached background levels at 6.7 m (22 ft). The northernmost trench had a 9 m (30 ft) bottom below grade.

Dorian and Richards (1978) found little (if any) migration of the contaminants to the soil; the in situ counts indicate that contaminated materials can be close to a test hole without any contamination being detected in samples taken from the test hole. The radionuclide content in Table 2 was determined from laboratory analysis of the G-22 sample, taken 6.7 m (22 ft) belowgrade (Dorian and Richards 1978). Because the radionuclide data given by Miller and Wahlen (1987) are primarily associated with metals (which are not highly mobile), the G-22 sample is more representative of the radionuclide content of the soil. Because the G-22 sample has the highest activity levels of any sample taken by Dorian and Richards (1978), it provides a very conservative estimate of the level of contaminants present in the soil .

The 3,800 Ci of tritium from Project P-10 is not included in this analysis because Trenches P-1 and P-2 in which this material is located (Trenches P-1 and P-2) are not part of the excavation effort.

2.3.2 Chemicals

Because of the lack of data on chemical constituents, little information exists on the chemical composition of the 118-B-1 Burial Ground. However, the following chemical contaminants are likely to be present:

- Mercury from manometers and the Tritium Separation Program (P-10 Project).
- Lead bricks and sheets from used shielding and shielded waste packages.
- Boron, lead, and cadmium from used splines and poisons.

Containerized liquids and gases are not expected in the burial grounds because standard practices did not involve disposal of containerized free liquids or gas cylinders. Liquid wastes were usually sent to cribs for disposal. Hydraulic oil, contained in drums, and mercury are the most probable forms of liquid wastes in 118-B-1 Burial Ground. Other wastes could include polychlorinated biphenyls (PCB) in discarded electrical transformers. Because the data show (Dorian and Richards 1978) that leeching and migration of the contamination has been minimal, the surrounding soil should not be overly contaminated with residues from adjacent waste.

Burial grounds are not expected to contain VOCs for the following reasons:

- Little (if any) volatile organic solvents were used in reactor operations.
- Liquids generally were not buried in 118-B-1 trenches but were sent to tanks in the 200 Area.

- No waste has been buried in 118-B-1 since 1973, and, if not in a sealed container, the liquids would have evaporated.

2.4 POTENTIAL ENERGIES OF CONCERN

The potential energies of concern were identified and evaluated to determine whether they would contribute to the dispersion of resuspendable contaminated dust. Wind stresses were identified as the energies that could contribute to a potential inhalation hazard of resuspendable dust. Stable air conditions provide the greatest impact of a potential inhalation hazard to the site worker. Dispersion of resuspendable dust due to high winds has a greater inhalation hazard impact on the onsite worker and the public.

The diesel fuel for the trackhoe is another possible energy source that could spill in an accident (e.g., trackhoe overturns) and ignite, causing a fire that will aerosolize combustible waste. Joyce (1993) analyzed this scenario using a much higher source term than anticipated in excavation operations and determined that the risk was still within acceptable limits. Although wind stress is considered the most credible natural phenomena, it presents an insufficient source term to generate an unacceptable risk. However, consideration should be given to curtailing excavation operations in winds greater than 24 km/h (15 mi/h) to limit fugitive dust concerns and to comply with ALARA principles regarding the potential to spread contaminants off site. Other natural phenomena events are considered in Section 4.0.

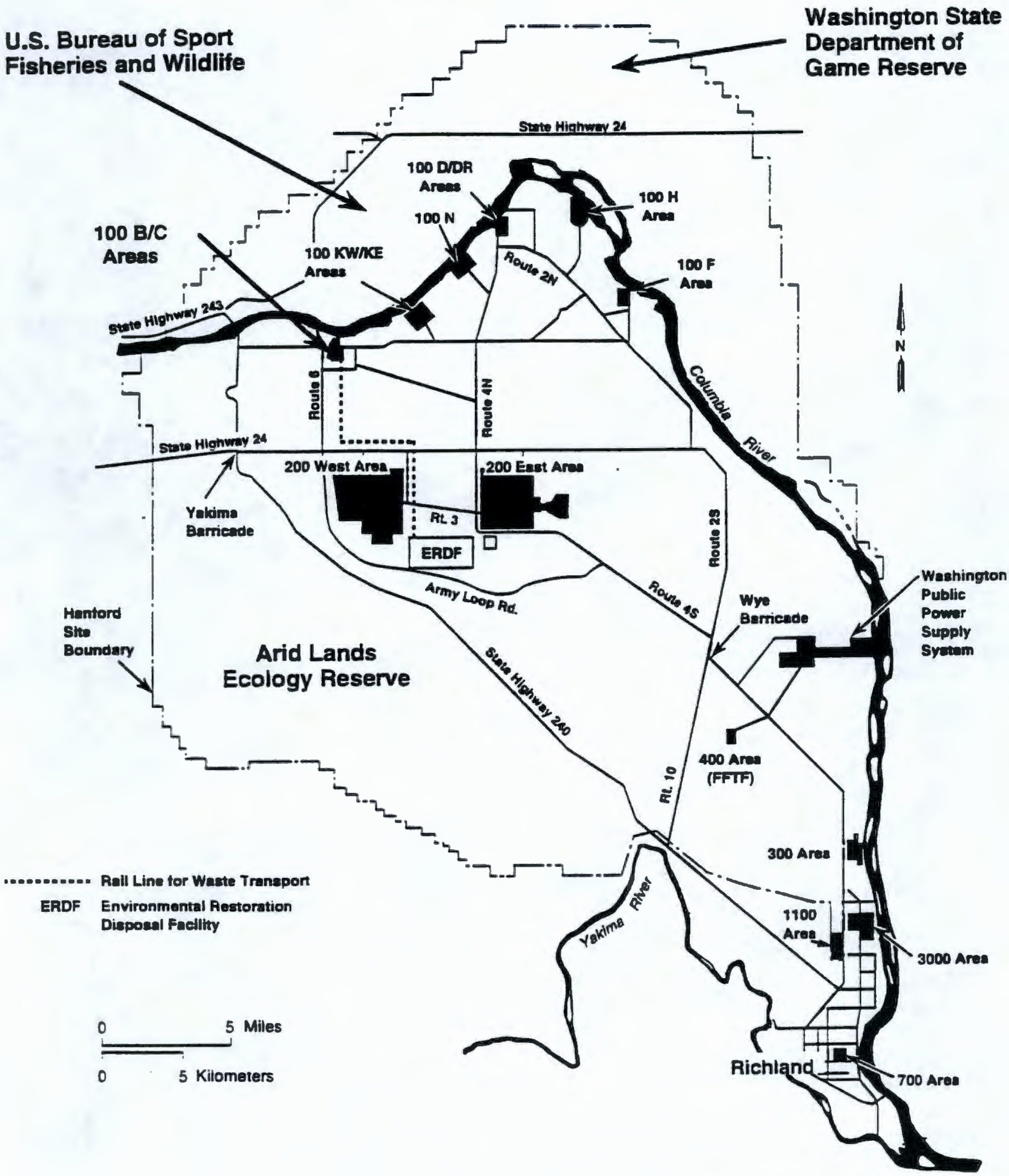
Dropping or spilling loads (3 yd^3) of excavated soil and waste has the highest postulated frequency of occurrence and allows the wind to create fugitive dust and expand the pathways to onsite personnel and the public. The resuspension of dust from exposed burial trenches is an additional source that needs to be examined.

2.5 SITE DESCRIPTION

2.5.1 Geography

The Hanford Site, shown in Figure 3, is situated 45 km (28 mi) northwest of the city of Richland in Benton County in the south-central portion of Washington State. The excavation and soil sample screening will take place within the 100 B/C Area, which is located in the north-central part of the Hanford Site along the southern bank of the Columbia River. This area covers approximately 3 km^2 (1.1 mi^2). The vicinity of 118-B-1 Burial Ground is characteristic of the Hanford Site and consists of a flat, semiarid bench. The burial ground is distinguished from its surroundings by 1.2 to 1.5 m (4 to 5 ft) of fill (sandy gravel with cobbles) above the natural ground level. The resulting mound contains no

Figure 3. Hanford Site.



vegetation. Concrete posts surround the perimeter of the mounded area and are presumed to indicate where the trenches are located.

Additional signs reading

CAUTION: UNDERGROUND RADIOACTIVE MATERIAL

are posted around the site. Blue and green survey stakes have been placed around the perimeter, on 3 m (10 ft) centers, to aid in orienting the ground-penetrating radar survey conducted in 1993.

2.5.2 Geology

The Hanford Site lies on a small subdivision of the geologic formation known as the Columbia Plateau Physiographic Province. This small subdivision is called the Pasco Basin and is composed of large quantities of basalt interspersed with layers of sedimentary material. Many of these sedimentary layers are water bearing and collectively constitute a vertically stratified series of confined aquifers beneath the Hanford Site. Above the uppermost layer of basalt lies the unconsolidated sand and gravel of the Ringold Formation, which ranges up to 304 m (1,000 ft) in depth. Above the Ringold Formation and extending to the surface is the Hanford Formation. The Hanford Formation consists of the Pasco Gravels and Touchet Beds of silts, sands, and gravel, and the formation is covered by a thin layer of windblown silt and sand. The Hanford Formation comprises materials that are moisture deficient and has a high capacity for cation exchange. The geological features of the Hanford Site should have no impact on the excavation effort.

2.5.3 Topography

The topography of the Hanford Site is relatively flat although elevations range from greater than 1,000 m (3,300 ft) above mean sea level (msl) at Rattlesnake Mountain to 122 m (400 ft) above msl along the Columbia River. The 118-B-1 Burial Ground is situated in the northern part of the Hanford Site adjacent to the Columbia River and has an elevation of 145 m (480 ft).

2.5.4 Meteorology

The climate of the Hanford Site is mid-latitude semiarid or mid-latitude desert. The summers are warm and dry with abundant sunshine and the winters are cool with occasional precipitation.

The mean surface air temperature at the Hanford Meteorology Station (HMS) [located about 0.4 km (0.3 mi) east of the 200 West Area] averages about 54°F (12°C). Temperatures average 75°F (24°C) in July and 30°F (-1° C) in January. Mean average precipitation at the HMS is 16 cm (6 in.). The average Hanford Site atmospheric pressure is 742 mm Hg (14.4 psi). The barometric pressure is higher in the winter than in the summer, although both the highest and lowest recorded pressures occurred during the winter.

Prevailing near-surface wind around the HMS is primarily from the west with an average wind speed of 4.8 km/h (3.0 mi/h). June has the highest average monthly wind speed of 5.8 km/h (3.6 mi/h), with the prevailing wind direction from the west-northwest. In November and December, average wind speeds fall to about 3.8 km/h (2.4 mi/h) and the prevailing wind direction is from the northwest. Figure 4 shows the wind roses for the Hanford Site. The strongest winds are generally from the southwest. A peak gust wind (straight) of 80 mi/h was measured on January 11, 1972, at the 15 m (50 ft) level of the HMS tower. On January 28, 1990, a windstorm with a maximum gust of 73 mi/h significantly damaged roofs and destroyed many trees in Richland, Pasco, and Kennewick (also known as the Tri-Cities). Using 35 yr of wind data, a 100-yr return period peak gust of 86 mi/h has recorded between 1916 and 1982 (DOE 1987). The return period on gusts of 70 mi/h is 10 yr.

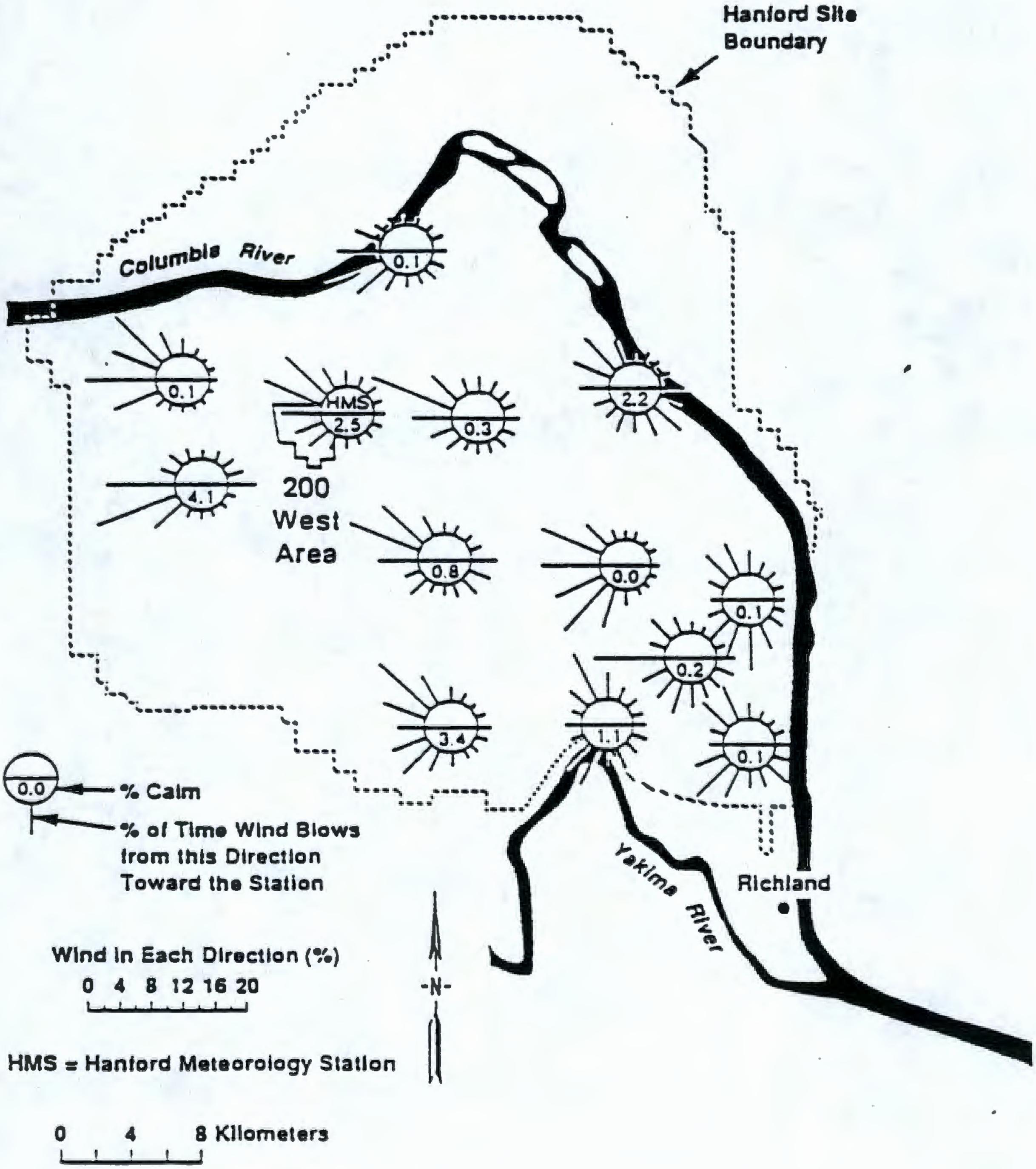
Washington State averages less than one tornado per year; the last tornado in the region occurred in 1983. None of the tornadoes have caused major damage to property or loss of life. Tornadoes are less severe than those that affect the midwest region of the nation. A survey of tornadoes in the Pacific Northwest showed that, within an 140 km (87 mi) radius of the Hanford Site, 24 tornadoes occurred 15 mi east of the Hanford Site in north Pasco. Although temperature and wind conditions could curtail the excavation efforts, the meteorological conditions of the Hanford Site should have no safety impact.

The Hanford Site is not a major thunderstorm area. On average, only about 10 thunderstorm days are recorded each year at the HMS, although this number has varied from a low of three to a high of 23 thunderstorm days each year. Thunderstorms can occur during any month of the year, although none have yet been observed in either November or January. They occur most frequently from April through September. Data on the number of monthly and annual thunderstorm days are presented in Stone (1983). The largest number of thunderstorms days recorded in a single month is eight, a number occurring in both June and August. Large differences in electric potential can occur during thunderstorms, which in turn can lead to lightning strikes. In general, about 20 percent of lightning strikes are cloud-to-ground discharges; the balance are intra-cloud discharges (Salnave and Lodochy 1987). Lightning strikes in the summer have occasionally ignited range fires in the Hanford Site region.

2.5.5 Surface Water Hydrology

The Columbia River and two of its tributaries, the Yakima River and the Snake River, are the principal rivers in the region. The average annual flow for the Columbia River is about 3,400 m^3/s. The only flood concern for the 100 Area would emanate from the Columbia River because the flood plains of the Snake and Yakima Rivers are too far south to

Figure 4. Wind Rose for the Hanford Site.



be a threat. The Columbia River is a flood-controlled river and the flood threat comes from failure of the Grand Coulee Dam, which is considered an unlikely event.

The typical moisture content of the soil is 2 to 7 percent. The water table is below 7.6 m (25 ft).

2.5.6 Seismic

Earthquakes occurring before 1969 are documented mainly from reports of tremors that were felt. Since 1969, when a network of seismographs was installed on the Columbia Plateau, earthquakes within the Columbia Plateau have been instrumentally located. These records indicate that the Columbia Plateau is an area of moderate seismicity. Although seismic activity above magnitude 3.0 modified Mercalli intensity has occurred in this region, activity above magnitude 3.5 is most commonly found around the northern and western portions of the Columbia Plateau. A few events occurred along the border between Washington and Oregon (DOE 1987).

Multiple, small, shallow earthquakes are the predominant seismic events of the Columbia Plateau. Earthquakes (as detected by the regional seismograph network) may contain from 4 to 100, or more, locatable earthquakes of magnitude 1.0 to 3.5 (DOE 1987). These swarms typically last a few days to several months and occur within areas typically 2 by 5 km (1.2 to 3 mi) horizontally and 3 to 5 km (1.86 to 3 mi) vertically (DOE 1987).

Seismic activity and related phenomena such as liquefaction, fault rupture, and subsidence are unlikely events and are not germane to this safety assessment.

2.5.7 Demography

Population in most of the area surrounding the Hanford Site is sparse and consists mainly of farming communities to the north, east and west. Land use is primarily for agriculture; however, urban and industrial sectors are also present in the surrounding area.

The 1980 census data estimated that the population within a 50-mi radius of the Hanford Site is 263,950, which is expected to increase by 12 percent by calendar year 2000. The major population concentration in the area are the Tri-Cities located to the south and southeast. Other population areas are Prosser and Grandview located to the west and southwest, respectively. The nearest public population is 3.25 mi (5.23 km) to the northwest on State Highway 24.

3.0 HAZARDS ASSESSMENT

3.1 SUMMARY OF POTENTIAL HAZARD

For radiological wastes, DOE (1992a), which meets DOE 5480.23 (DOE 1992b) requirements for a preliminary assessment and hazard categorization, is used to determine limits for the hazard categories. The final categorization is based on an "unmitigated release" of available hazardous material. For the purposes of hazard classification, the ratio of the radionuclides present to the maximum allowed for Hazard Category 3 were summed and totaled less than 0.5. Therefore, the operation is considered non-nuclear (DOE 5480.23 [DOE 1992b] does not apply). In addition, the potential to cause risk to the onsite worker (100 m from the work area) is negligible; therefore, the operation is low hazard per WHC-CM-4-46.

3.1.1 Radiological

The radiological hazard assessment showed that the amount of radionuclides available to develop a source term resulting from the trackhoe spillage of 3 yd^3 of soil was 6.5E+2 μCi. Assuming that the entire 1000 yd^3 of each excavation was aerosolized, the amount of material available is less than 1 Ci. Using the general rule of thumb that an exposure of 1.0 Ci of airborne radioactive material results in an ingestion of 2.8 μCi (Taylor et al. 1992), this results in an approximate dose to the individual of 6E-6 rem. The amount of radionuclides available for the entire 118-B-1 Burial Ground at any given time that can be aerosolized by fire is 17 Ci. This assumes that all trenches are exposed and all combustible material is consumed by fire. The airborne release factor (ARF) further reduces the material available for a source term by a factor 5E-4 (DOE 1993). Therefore, neither spillage, erosion or fire, regardless of frequency of occurrence, constitutes an unacceptable hazard to the onsite worker, the public or the environment.

During the excavation activities, radiation protection technologists must be alert for "hot spots" at which dose rates to the worker can be as high as 300 mrem/h (Dorian and Richards 1978). Complying with ALARA principles (per WHC-CM-4-11) and RWPs written in accordance with WHC-CM-1-6 will control personnel exposure. The entire excavation area should be treated as an airborne contaminated area with appropriate RWPs to control entry.

Every effort should be made to ensure that the worker can identify the vacuum bags filled with graphite dust. This material is highly aerosolizable and, if found, should be containerized in a more durable container. The total activity for all bags is estimated to be less than 0.5 Ci; however, good ALARA practices dictate that care should be taken to avoid dispersing this material.

This analysis does not address more than one excavation site open at a time; therefore, a USQ per WHC-CM-7-7, EII 1.16 will be required should the need arise to open two or more trenches simultaneously. A trench is considered closed when overburden of 4 ft or more of clean soil is re-established. Also, this analysis is limited to the removal of 1,000 yd^3 of material from any single excavation; however, this amount may be increased to 2,000 yd^3 without exceeding the safety envelope. This condition is allowed assuming that no material is found that would exceed by a factor of 10 the radiological composition of the soil used in this analysis and as shown in Table 2.

3.1.2 Chemical

The substances that have been identified as hazardous have no mechanism for release because they are solids and not readily transportable with the energy sources identified. Table 3 lists the hazardous materials and the reportable quantities (RQ) per 40 CFR 302. Reports are per WHC-CM-7-5, Section 5.

Table 3. Hazardous Substances and Reportable Quantities.

Hazardous substance	Reportable quantity (kg)
Cadmium*	4.54
Copper	2270
Lead*	4.54
Mercury	0.454
Nickel*	45.4
Sodium	4.54
Zinc*	454

*No reporting of this substance is required if the diameter of the pieces of solid metal releases is equal to or exceeds 100μm.

Mercury (Hg) may be present in all trenches; however, the largest concentration of Hg is expected to be in Trenches P-1 and P-2, the disposal site for the Tritium Separation Project. These trenches are not part of the excavation effort and are not covered in this assessment.

Large quantities of lead are present in several different forms: 25-lb bricks, lead sheets, lead-lined casks, and lead wool. Lead must be controlled per 29 CFR 1926.26, *Safety and Health Regulations for Construction*.

Asbestos has not been identified as being present in this burial ground; however, workers should be cautioned that asbestos could be found given the operating period of B Reactor. Asbestos was more than likely used within the reactor facility and could have been discarded to the burial grounds. If encountered, standard operating practices for asbestos need to be understood by all before work commences.

No VOCs are known to have been disposed at this burial site; but this process knowledge does not ensure the absence of these materials. Liquids and VOCs, if discovered, should be segregated and disposed of by using approved procedures. These procedures should be reviewed with the workers.

The presence of PCBs is also not confirmed, but cannot be excluded. Discarded electrical stepdown transformers could have been placed in this burial ground. PCBs should be handled per WHC-CM-4-40.

3.1.3 Environmental

The analysis showed that all releases to the environment should be within acceptable regulatory waste limits. However, fugitive dust is still an issue regardless of hazardous material content. Measures to control resuspension of soil particulates are necessary and required under Washington Administrative Codes. The use of dust-control agents on graded slopes, overburden soil piles, and other aerosolizable materials is mandatory. Loose waste (i.e., light weight cardboard boxes, combustible trash, etc.) should be covered with tarps. Consideration should also be given to enclosing the soil screening operation, which should be designated as an airborne radioactivity area.

Within the excavated trench, water should not be used as a dust-control mechanism unless it is on the trench bottom, where surveys show that radionuclides are at background levels. The application of water to contaminated waste could cause migration and leeching of radioactivity.

Wind conditions were not a factor in the safety analysis, but prudent measures dictate that mass transfer activities should be restricted to when sustained wind speeds are less than 15 mi/h. Insults to the environment could be exacerbated from spillage and exposed soils when winds exceed this limit.

3.1.4 Natural Phenomena

Because of the low source term, accidents due to such natural phenomena as seismic events, high winds, missiles, and floods were not formally evaluated. None of these events could exacerbate the radiological hazard to the public or onsite workers.

3.1.5 Events Considered Not Credible

Criticality is not considered credible because of the lack of fissile material in the site. Radon (^{222}Rn) levels are considered to be no higher than natural levels.

3.2 INDUSTRIAL SAFETY

3.2.1 Emergency Considerations

During excavation operations, reasonable precautions should be taken to protect the health and safety of the facility worker. The excavation area should remain open and should remain accessible to emergency vehicles at all times and evacuation routes should be clearly visible and should remain unobstructed. Remediation activities will conform to recognized safety codes and practices and Occupational Safety and Health Administration (OSHA) standards (per WHC-CM-4-3). Emergency excavation and procedures shall be controlled by WHC-CM-4-1.

3.2.2 Soil Voids and Instabilities

After removal of the overburden, soil collapse may occur because of voids in the substrate. Access control to the excavation area is mandatory and pathways should be clearly marked. Before allowing individuals to walk over burial grounds, testing should be conducted to ensure that the structure can support foot traffic. This load testing should take place at 0.3 m (1 ft) depth intervals. Access by any path other than the approved path should be controlled by a physical barrier. Pathways must be used at all times.

The slope of the excavation should have a vertical-to-horizontal ratio of 1:1.5. The operating route for the trackhoe should also be load tested to prevent the trackhoe from overturning and falling into the excavated trench. A registered professional engineer shall design all excavations with the potential to exceed 6 m (20 ft) in depth.

3.2.3 Physical Hazards

Workers need to be aware of the physical hazards associated with handling and sorting waste shapes and forms. Sharp objects, burrs, heavy objects and heavy equipment operations are examples of physical hazards that should be addressed in the HWOP.

3.2.4 Fire Protection

Because of the potential for fire in the excavation area, smoking should be prohibited at the excavation site. Sparks from the trackhoe bucket striking other metal objects or rocks have a potential for creating fires and igniting any VOCs that may be present. Portable chemical fire extinguishers should be readily available including on all heavy equipment. Water should be used only as a last resort and by qualified fire fighters.

4.0 SAFETY FUNCTIONS AND CONTROLS

Safety functions and controls for the 118-B-1 excavation treatability test are defined by one OSL, using prudent actions, and institutional and organizational controls. The prudent actions will ensure that consequences of intrinsic hazards are minimized. The institutional controls will ensure that the infrastructure is available to support the safe operations and to take corrective action should the safety basis established by this assessment be abrogated.

4.1 OPERATIONAL SAFETY LIMITS

Operational Safety Limit 1 - Open Trench Limit

1.0 TITLE: Limiting Number of Open Trenches.

1.1 APPLICABILITY: This OSL applies to the excavation of 118-B-1 Burial Grounds at all locations within the site except trench areas P-1 and P-2, which have not been assessed by this document.

1.2 OBJECTIVE: To ensure that the excavation effort remains within the safety envelope as defined by this document.

1.3 REQUIREMENTS:

1. Limit number of open trenches to one at any given time.
2. Trench is closed when 1.2 m (4 ft) of clear overburden is reestablished.
3. Trench volume limited to 2,000 yd^3.
4. Enroachment into P-1 and P-2 is prohibited.

1.4 SURVEILLANCE: Auditable records (field log) shall be kept per WHC-CM-7-7, EII 1.5, "Field Logbooks" that document the opening and closing of trenches, and the volume excavated.

1.5 RECOVERY: **Noncompliance with the requirement of the OSL**

Excavation operation shall cease and a recovery plan shall be developed and approved by line management with concurrence from Safety Assurance.

Noncompliance with the surveillance requirement

Failure to implement a surveillance requirement shall be documented as required by WHC-CM-1-3, *Management Requirements and Procedures* and a recovery plan shall be initiated.

1.6 AUDIT POINT: An auditable log or field activity report shall be maintained at the site documenting the results of the surveillance. This log shall be reviewed weekly by the operating organization to ensure compliance with the requirement and surveillance.

1.7 BASIS: The limits in the requirements are consistent with the test plan (Frain 1994) and the scope of this document.

4.2 PRUDENT ACTIONS

Prudent actions are management commitments that are important to safety. The commitments will be implemented through appropriate work procedures (e.g., work plan, RWPs, JSA, and HWOP) and will be managed compliant to the USQ procedure in WHC-CM-7-7.

- Establish perimeter barriers around the excavation site to control ingress and egress of personnel to defined pathways.
- Prohibit smoking in the exclusion zone.
- Employ mercury vapor and VOC detectors in the excavation area as required by the Site Safety Officer.
- Instruct all workers in the procedures for identifying and handling toxic materials.
- Provide for remote radiological monitoring of excavated materials.
- Provide method for ensuring personnel are not exposed to airborne contaminants or greater than the criteria established in WHC institutional or OSHA guidance for suspected contaminants.
- Implement dust control techniques to prevent migration of contamination.
- Avoid excessive use of water (whenever possible) in excavation pit.
- Establish wind direction indicators to aid in evacuation upwind of the trench.

- Establish and identify fire lanes and emergency evacuation routes.
- At sustained wind speeds greater than 15 mph, cease mass transfer activities of contaminated soil/material.
- Verify air quality before human entry into the trench.
- Ensure properly sized respirators are available to all test personnel required to work in the exclusion zone.
- Provide dry-chemical fire extinguishers in the excavation area.

4.3 INSTITUTIONAL AND ORGANIZATION CONTROLS

4.3.1 Institutional Controls

Table 4 shows the various institutional controls that contribute to safe operations at the excavation site or any other operation at the Hanford Site. The area of safety concern, the applicable control manual, and the application to the excavation effort are also shown in Table 4.

4.3.2 Organizational Controls

Organization controls that support safe operations include assigning each organization with specific responsibilities and the necessary resources for conducting oversight, review, approval, and audit activities. In general, the mission and responsibilities are defined in WHC-CM-1-2. For this excavation effort, the responsibilities and duties, lines of authority and communication, and channels of communication are developed in Frain 1994.

Table 4. Institutional Safety Controls. (2 sheets)

Area of control	WHC control manual	Application to excavation effort
Radiation Protection	WHC-CM-1-6	Establishes requirements and responsibility for developing radiation work permits, radiation exposure limits, monitoring, release to the environment, radioactive materials, dosimetry, and records.
ALARA	WHC-CM-4-11	Establishes the requirements and responsibility for maintaining scope of work procedures to ensure that ALARA principles are applied.
Emergency Planning	WHC-CM-4-1	Establishes the requirements and responsibility for developing emergency responses and for reporting emergency actions.
Occupational safety	WHC-CM-4-3 WHC-CM-7-7	Establishes the requirements and responsibility for ensuring that work is performed safely and that action is taken as necessary to correct safety deficiencies.
Fire protection	WHC-CM-4-41	Establishes the requirements and responsibility for ensuring that fire protection is considered in all evaluations.
Industrial hygiene	WHC-CM-4-40	Establishes the requirements and responsibility for ensuring that the health and safety of all workers by limiting exposure to harmful chemical, physical, and biological agents and by observing limits established by the DOE.
Training	WHC-CM-7-7 WHC-CM-4-40 WHC-C-4-3	Establishes the requirements and responsibility for ensuring that workers are properly indoctrinated, trained and qualified to perform the tasks they are assigned.
Waste management	WHC-CM-7-7	Establishes the requirements and responsibility for interim control of unknown, suspected hazardous and mixed, and radioactive waste
USQ	WHC-CM-1-3 WHC-CM-7-5	Establishes the requirements and responsibility for reviewing changes to documents, procedures, drawings, and work efforts to ensure that the safety basis is not changed and the scope falls under the safety analysis reports.
Occurrence reporting	WHC-CM-1-5 WHC-CM-7-5	Establishes the requirements and responsibility for reporting occurrences that exceed the safety basis, operating limits, or technical safety requirements.

Table 4. Institutional Safety Controls. (2 sheets)

Area of control	WHC control manual	Application to excavation effort
Safety classification	WHC-CM-1-3 WHC-CM-6-1	Establishes the requirements and responsibility for developing and assigning safety-related equipment to a safety class commensurate with its impact on environment, the public, and the worker.
Quality assurance	WHC-CM-4-2 WHC-CM-7-7	Establishes the requirements and responsibility for conducting oversight on all aspects of safety-related documents, drawings, procedures, and work plans.
Configuration management	WHC-CM-6-1 WHC-CM-6-8	Establishes the requirements and responsibility for establishing controls and reviews that facilitate maintaining correct representation of system, process, and facility operations.
Conduct of operations	WHC-EP-0208 WHC-CM-1-1	Establishes the requirements and responsibility for ensuring the management, controls, training, configurations, and procedures are in place, effective, and support safe operations.
Environmental protection	WHC-CM-7-5 WHC-CM-7-7	Establishes the requirements and responsibility for ensuring that remediation efforts are developed that will address environmental monitoring of the remediation sites and will include the performance of random audits of the sites and analytical labs by industrial health personnel. In addition, specific procedures are developed requiring that all procedures, revisions, or modifications having the potential to exceed permitted standards be reviewed by Environmental Assurance.
Work control	WHC-CM-8-8	Establishes the requirements and responsibility for ensuring that all work packages are reviewed for configuration management, job safety assessment, ALARA, RWPs, entry permits, and other safety-related preventive measures.

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WHC-CM-4-40, *Industrial Hygiene Manual*, Westinghouse Hanford Company, Richland, Washington.

WHC-CM-4-46, *Nonreactor Facility Safety Analysis Manual*, Westinghouse Hanford Company, Richland, Washington.

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WHC-CM-7-5, *Environmental Compliance Manual* Westinghouse Hanford Company, Richland, Washington.

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