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Hanford Facility Dangerous Waste Permit Application

Date Published
October 1991

United States
Department of Energy
P.O. Box 550
Richland, Washington 99352

Approved for Public Release

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STATE ENVIRONMENTAL POLICY ACT
ENVIRONMENTAL CHECKLIST

FOR

HANFORD FACILITY DANGEROUS WASTE PERMIT APPLICATION

REVISION 0

SEPTEMBER 18, 1991

WASHINGTON ADMINISTRATIVE CODE
ENVIRONMENTAL CHECKLIST FORMS
[WAC 197-11-960]

A. BACKGROUND

1. **Name of proposed project if applicable:**

Permitting of the Hanford Facility. This *State Environmental Policy Act* (SEPA) *of 1971* Checklist is being submitted concurrently with the *Hanford Facility Dangerous Waste Permit Application* (Hanford Facility Permit Application) for the treatment, storage, and/or disposal of dangerous waste and mixed waste on the Hanford Facility. Information contained in this checklist pertains only to treatment, storage, and/or disposal (TSD) units located on the Hanford Facility for which a final status permit has been, or will be, sought under the *Resource Conservation and Recovery Act* (RCRA) *of 1976*/Washington State Department of Ecology (Ecology) *Dangerous Waste Regulations*, Washington Administrative Code (WAC) 173-303. In the context of this document, 'facility' refers to the contiguous portion of the Hanford Site that contains these TSD units and, for the purposes of the RCRA and *Dangerous Waste Regulations*, is owned and operated by the U.S. Department of Energy (excluding lands north and east of the Columbia River, river islands, state owned or leased lands, lands owned by the Bonneville Power Administration, and lands leased to the Washington Public Power Supply System). 'Site' refers to the Hanford Site, the approximately 560 square mile (1,450 square kilometers) area in southeastern Washington State owned by the United States Government and commonly known as the Hanford Reservation.

The environmental checklist for the Hanford Facility will be supplemented by environmental checklists prepared to accompany the submittal of unit-specific Part B permit applications.

2. **Name of applicants:**

U.S. Department of Energy (DOE) Field Office, Richland (RL)

3. **Address and phone number of applicant and contact person:**

U.S. Department of Energy
Field Office, Richland
P.O. Box 550
Richland, Washington 99352

Contact Person:

E. A. Bracken, Director
Environmental Restoration Division
(509) 376-7277

4. **Date checklist prepared:**

September 18, 1991

5. Agency requesting the checklist:

Washington State
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

6. Proposed timing or schedule (including phasing, if applicable):

Pursuant to the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990), a single RCRA/dangerous waste permit will be issued to cover the entire Hanford Facility. The Tri-Party Agreement specifies that the U.S. Environmental Protection Agency (EPA) and Ecology will issue the Hanford Facility Dangerous Waste Permit (Hanford Facility Permit) for less than the entire Hanford Facility because all of the TSD units cannot be permitted simultaneously. Using a step-wise permitting process will ensure proper implementation of the Tri-Party Agreement. The permit eventually will grow into a single permit for the entire Hanford Facility. Any TSD units that are not included in the initial Hanford Facility Permit normally will be incorporated through a permit modification. Individual TSD units will be processed using the schedule outlined in the Tri-Party Agreement Action Plan, or amendments thereof.

7. Do you have any plans for future additions, expansion, or further activity related to or connected with this proposal? If yes, explain.

Yes. The permitting process for the Hanford Facility is outlined in Section 6.3 of the Tri-Party Agreement Action Plan. This process applies to existing TSD units operating under interim status, TSD units provided for under interim status expansion, and new TSD units (units that do not have interim status and must have a RCRA/dangerous waste permit before construction). A Notice of Intent (as specified in WAC-173-281) will be submitted for 'interim status expansion' or 'new' TSD units.

8. List any environmental information you know about that has been prepared, or will be prepared, directly related to this proposal.

- This environmental checklist is being submitted concurrently with the *Hanford Facility Dangerous Waste Permit Application*
- The *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988).

Environmental information on the Hanford Site, in general, can be found in the following references: (1) *Final Environmental Impact Statement - Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes*, DOE/EIS-0113 (U.S. Department of Energy, 1987, Richland, Washington); (2) *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratories,

1990, Richland, Washington); (3) *Draft Environmental Impact Statement - Decommissioning of Eight Surplus Production Reactors at the Hanford Site, Richland, Washington*, DOE/EIS-0119D (U.S. Department of Energy, 1989, Washington, D.C.); (4) *Final Environmental Impact Statement - Waste Management Operations*, ERDA-1538 (U.S. Energy Research and Development Administration, 1975, Richland, Washington); and (5) *Archaeological Survey of the 200 East and 200 West Areas, Hanford Site Washington*, PNL-7264 (Pacific Northwest Laboratory, 1990, Richland, Washington).

9. **Do you know whether applications are pending for government approvals of other proposals directly affecting property covered by your proposal? If yes, explain.**

Yes. The Hanford Site currently has three such permits: Clean Water Act - National Pollutant Discharge Elimination System (NPDES), EPA, WA-000374-3; Clean Air Act - Prevention of Significant Deterioration (PSD), EPA PSD-X80-14; Clean Air Act - Radioactive Source Registration, Washington State Department of Health, FF-01.

10. **List any government approvals or permits that will be needed for your proposal, if known.**

A RCRA/dangerous waste permit for the treatment, storage and/or disposal of dangerous waste and mixed waste on the Hanford Facility will be required. A permit application has been submitted concurrently with this environmental checklist and will serve as the basis for the initial Hanford Facility Permit. Once issued, the Hanford Facility Permit will be modified, as necessary, to incorporate permits for individual TSD units. This process briefly is described in the answer to Checklist Question 6.

For the most part, other approvals or permits needed by the Hanford Facility are required by the *Clean Air Act of 1977*, the *Clean Water Act of 1977*, and the *Toxic Substances and Control Act of 1976*.

11. **Give a brief, complete description of your proposal, including the proposed uses and the size of the project and site.**

The Hanford Site covers approximately 560 square miles (1,450 square kilometers) of semiarid land that is owned by the U.S. Government and managed by the DOE-RL. The Hanford Site is located northwest of the city of Richland, Washington. The city of Richland adjoins the southeastern most portion of the Hanford Site boundary and is the nearest population center. In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for reactor, chemical separation, and related activities for the production and purification of special nuclear materials and other nuclear activities. The mission of the Hanford Site recently has focused on environmental remediation and restoration.

The Hanford Facility, for purposes of the RCRA and the *Dangerous Waste Regulations*, is defined as the contiguous portion of the Hanford Site that includes approximately 25 TSD units for which a final status permit has been, or will be, sought. The Hanford Facility is assigned the single EPA/State Identification Number WA7890008987, and the RL is specified as the owner/operator. All waste management activities carried out under the assigned identification number are considered to be onsite.

The Hanford Facility does not include the Bonneville Power Administration Midway Site, the U.S. Department of Energy lands north and northeast of the Columbia River, nor lands owned or leased by the state of Washington. The Midway Site is owned by the Bonneville Power Administration, and the U.S. Department of Energy Field Office, Richland has no ownership or control over this site. The U.S. Department of Energy lands north and east of the Columbia River contain no TSD units and are not considered to be contiguous to the Hanford Facility because these lands are separated by the state-owned Columbia River bed.

In addition, the Washington Public Power Supply System will be applying for a RCRA permit for the U.S. Department of Energy lands leased to the Washington Public Power Supply System. These lands will be covered by a separate permit and, therefore, will not be included in the Hanford Facility Permit.

The Hanford Facility generates dangerous and mixed waste, and treats, stores, and/or disposes of dangerous and mixed waste that is generated onsite. Mixed waste that is generated offsite also is managed within certain TSD units on the Hanford Facility. The radioactive component of mixed waste is interpreted by the U.S. Department of Energy to be regulated under the *Atomic Energy Act of 1954*; the nonradioactive dangerous component of mixed waste is interpreted to be regulated under the RCRA and WAC 173-303.

The TSD units to be permitted on the Hanford Facility are centralized in four numerically designated areas, the 200, 300, 400, and 600 Areas. These TSD units include container storage units, surface impoundments, waste piles, tank systems, and miscellaneous units, unique units not fitting into an established category for a TSD unit. These units treat, store, and/or dispose of dangerous and/or mixed waste designated as: (1) characteristic dangerous waste; (2) toxic, carcinogenic, and persistent (by WAC 173-303 criteria); and (3) listed (because the waste contains small amounts of spent solvents and discarded pure chemical products). Specific dangerous waste codes, process design capacities, and estimated quantities of waste handled on an annual basis by specific TSD units are specified in the *Hanford Facility Dangerous Waste Part A Permit Application*.

12. **Give the location of the proposal. Give sufficient information for a person to understand the precise location of the proposed project, including a street address, if any, and section, township, and range, if known. If a proposal would occur over a range of area, provide the range or boundaries of the site(s). Provide a legal description, site plan, vicinity map, and topographic map, if reasonably available.**

The location of the Hanford Facility is described in the answer to Checklist Question 11. The location of individual TSD units on the Hanford Facility is provided in the *Hanford Facility Dangerous Waste Part A Permit Application.*

A map of the Hanford Facility and legal description is included in Section 2.2 of the *Hanford Facility Dangerous Waste Permit Application.* Legal descriptions for individual TSD units will be provided in the unit-specific Part B permit applications.

B. ENVIRONMENTAL ELEMENTS

1. **Earth**

a. General description of the site (indicate one): Flat, rolling, hilly, steep, mountainous, other.

The terrain of the central and eastern portions of the Hanford Facility is relatively flat. The northern and western parts of the Hanford Facility have moderate to steep topographic ridges composed of basalt and sediments. The TSD units are located on the relatively flat, central portion of the Hanford Facility. A more detailed description of the Hanford Facility can be found in *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratory, 1990, Richland, Washington). More detailed descriptions of individual TSD units can be found in unit-specific Part B permit applications.

b. What is the steepest slope on the site (approximate percent slope)?

The TSD units are located on the relatively flat, central portion of the Hanford Facility. The approximate slope of the land at each TSD unit is generally less than two percent. More detailed descriptions of individual TSD units can be found in unit-specific Part B permit applications.

c. What general types of soils are found on the site (for example, clay, sand, gravel, peat, muck)? If you know the classification of agricultural soils, specify them and note any prime farmland.

The soil at the Hanford Facility ranges from fine silty and sandy soil to sandy gravel with good drainage characteristics. No farming is permitted on the Hanford Facility or the Hanford Site.

d. Are there surface indications or history of unstable soils in the immediate vicinity? If so, describe.

No. There are no indications of unstable soils at the Hanford Facility.

e. Describe the purpose, type, and approximate quantities of any filling or grading proposed. Indicate the source of the fill.

Excavation will be required for the operation of some TSD units such as the Low-Level Burial Grounds and the Grout Treatment Facility. Excavation also will be required for the modification and construction of some TSD units. Excavated material will be stockpiled for use as backfill. Excavated material also will be used, as required, for finish grading to blend the materials into the existing topography and to provide drainage away from buildings and structures.

f. Could erosion occur as a result of clearing, construction, or use? If so, generally describe.

Erosion due to wind and/or precipitation could occur in areas on and directly surrounding TSD units at which excavation is used during operations. Erosion due to wind and/or precipitation also could occur in association with the modification and construction of TSD units. Topographical expression of erosional features is uncommon at the Hanford Site.

g. Approximately what percent of the site will be covered with impervious surfaces after project construction (for example, asphalt or buildings)?

Less than one percent of the Hanford Facility is affected by impervious surfaces. A more detailed description of impervious surfaces associated with individual TSD units can be found in unit-specific Part B permit applications.

h. Proposed measures to reduce or control erosion, or other impacts to the earth, if any?

To control the amount of dust generated by excavation, modification, or construction activities, water trucks might be used to periodically spray areas undergoing such activities. Paved access roadways and graveled parking areas will be provided to minimize erosion due to vehicular traffic. Natural vegetation covers much of the Hanford Site minimizing both wind and water erosion.

2. **Air**

a. What types of emissions to the air would result from the proposal (i.e., dust, automobile, odors, industrial wood smoke) during construction and when the project is completed? If any, generally describe and give approximate quantities if known.

Small amounts of air emissions (exhaust) might be generated by excavation and construction equipment and vehicles used by personnel to gain access to the Hanford Facility. Some dust will be generated during construction activities.

Air emissions which may result from operational activities associated with individual TSD units will be permitted as required under federal and state clean air regulations. Emissions of regulated air pollutants from existing Hanford Site operations are reported in the *Hanford Site Environmental Report*, which is updated annually by Pacific Northwest Laboratory.

b. Are there any off-site sources of emissions or odors that may affect your proposal? If so, generally describe.

None.

c. Proposed measures to reduce or control emissions or other impacts to the air, if any?

To control the amount of dust generated by excavation or construction activities, water trucks will be available onsite to periodically spray affected areas. For individual TSD units, plant ventilation systems will use airlocks, pressure and temperature differentials, continuous air monitoring and surveillance equipment, and air scrubbers and HEPA filters to ensure that air emissions remain within applicable regulatory limits and guidelines at all times. Individual sources of regulated air pollutants will be permitted under applicable Clean Air Act regulations.

3. **Water**

a. Surface:

1) Is there any surface water body on or in the immediate vicinity of the site (including year-round and seasonal streams, saltwater, lakes, ponds, wetlands)? If yes, describe type and provide names. If appropriate, state what stream or river it flows into.

Yes. The primary surface-water features associated with the Hanford Facility are the Columbia and Yakima Rivers. Several surface ponds and ditches are present, and are generally associated with fuel and waste processing activities. Some of

these ponds have been in place for as long as two decades, although many have been eliminated. Two intermittent streams transverse the Hanford Site. These are Cold Creek and Dry Creek. Water drains through these creeks during the wetter winter and spring months. No perennial streams originate within the Hanford Site. Small spring streams, Rattlesnake Springs and Snively Springs, flow for short distances in the western portion of the Hanford Site.

2) Will the project require any work over, in, or adjacent to [within 200 feet (61 meters) of] the described waters? If yes, please describe and attach available plans.

Yes. Individual TSD Units with such work will address impacts on the described waters through environmental checklists submitted with the unit-specific Part B permit applications.

3) Estimate the amount of fill and dredge material that would be placed in or removed from surface water or wetlands and indicate the area of the site that would be affected. Indicate the source of fill material.

None.

4) Will the proposal require surface water withdrawals or diversions? Give general description, purpose, and approximate quantities if known.

Yes. Nearly all the water used on the Hanford Facility is withdrawn from the Columbia River (approximately 1.3 million gallons per day). Individual TSD Units that use Columbia River water will address this use in environmental checklists submitted with unit-specific Part B permit applications.

5) Does the proposal lie within a 100-year floodplain? If so, note location on the site plan.

Yes. Portions of the 100 and 300 Areas are within the 100-year floodplain. However, none of the current TSD units within the Hanford Facility are within the 100-year floodplain.

6) Does the proposal involve any discharges of waste materials to surface waters? If so, describe the type of waste and anticipated volume of discharge.

Some of the TSD units might discharge nondangerous liquid effluent to ponds, cribs, or to the Columbia River. The specific details of these liquid effluent discharges will be documented in environmental checklists submitted with unit-specific Part B permit applications.

b. Ground:

1) Will ground water be withdrawn, or will water be discharged to ground water? Give general description, purpose, and approximate quantities, if known.

Yes. Several drinking water supply wells are located on the Hanford Facility. Water supply wells are the Yakima Barricade well about 3.2 miles (5.2 kilometers) west of the 200 West Area, two wells in the 400 Area (one supply and one back-up), and the Rattlesnake Springs well located 4 miles (6.4 kilometers) southwest of the 200 West Area. Relatively small volumes of water are withdrawn from these wells, as most drinking water and water used for other purposes is taken from the Columbia River. A small volume of water is withdrawn from wells distributed throughout the Hanford Facility for groundwater monitoring and sampling.

No water will be discharged directly to the groundwater.

2) Describe waste materials that will be discharged into the ground from septic waste tanks or other sources, if any (for example: domestic sewage; industrial, containing the following chemicals...; agricultural; etc.). Describe the general size of the system, the number of such systems, the number of houses to be served (if applicable), or the number of animals or humans the system(s) are expected to serve.

Septic tanks and drain fields exist and might be expanded to receive sanitary waste from restrooms, changerooms, showers, and lunchrooms of the various TSD units. Some of the TSD units might discharge nondangerous liquid effluent or purgewater to ponds or cribs that might be sources for groundwater recharge. The specific details of these liquid effluent discharges will be documented in environmental checklists submitted with unit-specific Part B permit applications.

c. Water run-off (including storm water):

1) Describe the source of run-off (including storm water) and method of collection and disposal, if any (include quantities, if known). Where will this water flow? Will this water flow into other waters? If so, describe.

Extremely small quantities of storm water run-off will be generated. Descriptions of collection and disposal methods for individual TSD units are detailed, where applicable, in the unit-specific Part B permit applications.

2) Could waste materials enter ground or surface waters? If so, generally describe.

Yes. Nonradioactive, nondangerous waste might be released to the ground via septic systems and various drains associated with TSD units within the Hanford Facility. Some of the TSD units might discharge nondangerous liquid effluent to ponds or cribs that might be sources for groundwater recharge. The specific details of these liquid effluent discharges will be documented in environmental checklists submitted with unit-specific Part B permit applications. Discharges to ground or surface waters will be permitted as appropriate under the Clean Water Act.

d. Proposed measures to reduce or control surface, ground, and run-off water impacts, if any:

Many TSD units use double containment piping and leak detection, grading and ground cover, and/or other measures to prevent degradation of groundwater quality. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific Part B permit applications

4. Plants

a. Check the types of vegetation found on the site:

_x_ deciduous tree: alder, maple, aspen, other
_x_ evergreen tree: fir, ceder, pine, other
_x_ shrubs
_x_ grass
___ pasture
___ crop or grain
_x_ wet soil plants: cattail, buttercup, bulrush, skunk cabbage, other
_x_ water plants: water lily, eelgrass, milfoil, other
_x_ other types of vegetation

The vegetation on the Hanford Facility consists of sagebrush, forbs, and other common central Washington desert plant species. A more detailed description of the Hanford Site vegetation can be found in *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratory, 1990, Richland, Washington).

b. What kind and amount of vegetation will be removed or altered?

Vegetation around many TSD units is removed routinely, so that there is a low potential for accidental open burning. Vegetation will also be removed from unit construction localities and areas to be paved.

Most of the Hanford Facility beyond the bounds of the 200, 300, 400, and 1100 Areas is maintained as a natural habitat.

c. List threatened or endangered species known to be on or near the site.

The Columbia milk-vetch, and yellowcress are threatened and endangered plants occurring on the Hanford Site. Additional information on species can be found in *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratory, 1990, Richland, Washington).

d. Proposed landscaping, use of native plants, or other measures to preserve or enhance vegetation on the site, if any:

Compaction of the soil is used to stabilize the soil during and after construction activities. Native vegetation often is planted to eliminate erosion potential of soils due to wind and water. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific Part B permit applications. Most of the Hanford Facility beyond the bounds of the 200, 300, 400, and 1100 Areas is maintained as a natural habitat.

5. **Animals**

a. Indicate (by underlining) any birds and animals which have been observed on or near the site or are known to be on or near the site:

birds: <u>hawk</u>, <u>heron</u>, <u>eagle</u>, <u>songbirds</u>, <u>other</u>
mammals: <u>deer</u>, bear, <u>elk</u>, <u>beaver</u>, <u>other</u>
fish: <u>bass</u>, <u>salmon</u>, <u>trout</u>, herring, shellfish, other

A variety of insects, birds, and mammals are common to the Hanford Site and Hanford Facility, including pigeons, passerine birds, rodents, and lagomorphs. Larger mammals commonly seen in the vicinity include deer and coyote. Additional information on birds and animals on the Hanford Site can be found in *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratory, 1990, Richland, Washington).

b. List any threatened or endangered species known to be on or near the site.

The Aleutian Canada goose, bald eagle, white pelican, sandhill crane, ferruginous hawk, and the peregrine falcon are sometimes seen on the Hanford Site.

The TSD unit locations are not known to be used by any threatened or endangered species. Additional information concerning endangered and threatened species on the Hanford Site can be found in *Hanford Site National Environmental Policy Act (NEPA) Characterization*, PNL-6415 (Revision 3, Pacific Northwest Laboratory, 1990, Richland, Washington).

c. Is the site part of a migration route? If so, explain.

Yes. The adjacent Columbia River is part of the broad Pacific Flyway for waterfowl migration and other birds also migrate along the river.

d. Proposed measures to preserve or enhance wildlife, if any:

Fences around TSD units exclude larger animals. Landfill waste is covered with soil to isolate this waste from local fauna.

6. **Energy and Natural Resources**

a. What kinds of energy (electric, natural gas, oil, wood stove, solar) will be used to meet the completed project's energy needs? Describe whether it will be used for heating, manufacturing, etc.

Diesel fuel, coal, gasoline, oil, and electrical power will be used to power equipment, to power building ventilation and lighting systems, and to provide process heating.

b. Would your project affect the potential use of solar energy by adjacent properties? If so, generally describe.

No.

c. What kinds of energy conservation features are included in the plans of this proposal? List other proposed measures to reduce or control energy impacts, if any:

Energy conservation guidelines outlined in the U.S. Department of Energy Order 6430.1A, "General Design Criteria", will be incorporated in the design of new structures. Under these guidelines, each area of a building will be subject to the air in-leakage depressurization test. The test will be done in accordance with American Society of Testing Materials E 779-87, "Standard Test Method for Determining Air Leakage Rate by Fan Pressurization". Only the depressurization test will need to be performed, and will demonstrate whether the building envelope meets the design specification for air tightness. A more detailed description of the energy conservation features of individual TSD units can be found in the environmental checklists accompanying unit-specific Part B permit applications.

7. **Environmental Health**

a. Are there any environmental health hazards, including exposure to toxic chemicals, risk of fire and explosion, spill, or hazardous waste, that could occur as a result of this proposal? If so, describe.

Yes. Radioactive materials and toxic and explosive chemicals are routinely handled at the Hanford Facility.

1) Describe special emergency services that might be required.

Hanford Site security, fire response, ambulance services, and an emergency communications and response system are on call 24 hours a day, 7 days a week, in the event of an onsite emergency.

2) Proposed measures to reduce or control environmental health hazards, if any:

The TSD units on the Hanford Facility will provide primary and secondary confinement barriers to prevent the release of potentially hazardous materials. Primary confinement will prevent direct physical contact between the hazardous materials and personnel and will be provided by process enclosures and ventilation systems. Secondary confinement will prevent releases of hazardous materials to the environment and will be provided by buildings housing the process enclosures and by building ventilation systems. Some of the buildings will be designed to withstand design-basis accidents required by the U.S. Department of Energy Order 6430.1A and criteria defined in Hanford Plant Standard Design Criteria (SDC) 4.1. Descriptions of measures to reduce or control environmental health hazards for individual TSD units are detailed, where applicable, in the unit- specific Part B permit applications and in environmental checklists accompanying these permit applications.

b. Noise

1) What types of noise exist in the area which may affect your project (for example: traffic, equipment, operation, other)?

None.

2) What types and levels of noise would be created by or associated with the project on a short-term or a long-term basis (for example: traffic, construction, operation, other)? Indicate what hours noise would come from the site.

The Hanford Facility is sufficiently removed from residential and offsite industrial areas to preclude excessive noise impacts. The

primary source of noise from the Hanford Facility will be from the operation of exhaust systems and from heavy equipment associated with excavation and construction activities.

3) Proposed measures to reduce or control noise impacts, if any:

Excavation, construction, and operational equipment will meet manufacturer's requirements for noise suppression.

8. **Land and Shoreline Use**

a. What is the current use of the site and adjacent properties?

The Hanford Site is dedicated to U.S. Department of Energy-controlled operations, with limited exceptions. Located within the boundaries of the Hanford Site and Hanford Facility are the Washington Public Power Supply System reactor and generating complex and the U.S. Ecology Company, Incorporated waste disposal facility located southwest of the 200 East Area. Seimens Nuclear Power is located just north of Richland, Washington, adjacent to the Hanford Site boundary. The eastern boundary of the nearest military installation, the Yakima Firing Center, is 25 miles (40 kilometers) west-northwest of the Hanford Site.

The portion of the Hanford Site south and west of the Columbia River is where reactor, fuel reprocessing, and TSD units are located. The portion of the Hanford Site that is located on the north and east sides of the Columbia River is designated as a buffer zone and currently is used for wildlife refuge or wildlife recreation land. The southwest portion of the Hanford Site is the Arid Lands Ecology Reserve.

Outside the Hanford Site are privately owned farms and the urban and suburban areas of Richland and West Richland.

b. Has the site been used for agriculture? If so, describe.

No portion of the Hanford Site, including the localities of the TSD units, have been used for agricultural purposes since 1943.

c. Describe any structures on the site.

The Hanford Site contains a number of structures, generally restricted to the 100, 200, 300, 400, 1100, and 3000 Areas. A map of these areas is contained in the Hanford Facility Permit Application. More detailed descriptions of the structures associated with individual TSD units can be found in the unit-specific Part B permit applications and in environmental checklists accompanying these permit applications.

d. Will any structures be demolished? If so, what?

Structures might be demolished in association with closure of TSD units on the Hanford Facility. Descriptions of these demolition activities will be included in the closure and postclosure plan portion of the unit-specific Part B permit applications.

e. What is the current zoning classification of the site?

The Hanford Site is zoned by Benton County as an Unclassified Use (U) district.

f. What is the current comprehensive plan designation of the site?

The 1985 Benton County Comprehensive Land Use Plan designates the Hanford Site as the "Hanford Reservation". Under this designation, land on the Hanford Site might be used for "activities nuclear in nature". Nonnuclear activities are authorized "if and when [U.S. Department of Energy] approval for such activities is obtained".

g. If applicable, what is the current shoreline master program designation of the site?

Does not apply.

h. Has any part of the site been classified as an "environmentally sensitive" area? If so, specify.

No. However, the Hanford Reach of the Columbia River borders the Hanford Facility. The *Hanford Reach Study Act* (Public Law 100-605) directs the Secretary of the Interior to prepare a study on the Hanford Reach of the Columbia River including consideration of its addition to the National Wild and Scenic Rivers System. During the eight-year study period, ending in 1996, activities undertaken within a quarter mile of the Columbia River mean high-level mark, from river miles 396 to 345, must be conducted in consultation and coordination with the National Park Service, acting for the Secretary of the Interior. Activities undertaken within the Hanford Reach are conducted in compliance with the *Hanford Reach Study Act*. Discussions of activities affecting the Hanford Reach are included in TSD unit-specific permit applications.

i. Approximately how many people would reside or work in the completed project?

Approximately 15,000 people work on the Hanford Site. Work localities for most personnel are in the 100, 200, 300, 400, 1100, and 3000 Areas. Hanford Facility TSD units are located in the 200, 300, 400, and 600 Areas.

j. Approximately how many people would the completed project displace?

None.

k. Proposed measures to avoid or reduce displacement impacts, if any:

Does not apply.

l. Proposed measures to ensure the proposal is compatible with existing and projected land uses and plans, if any:

Does not apply. (Refer to Checklist Question B.8.f.)

9. **Housing**

a. Approximately how many units would be provided, if any? Indicate whether high-, middle-, or low-income housing.

None.

b. Approximately how many units, if any, would be eliminated? Indicate whether high-, middle-, or low-income housing.

None.

c. Proposed measures to reduce or control housing impacts, if any:

Does not apply.

10. **Aesthetics**

a. What is the tallest height of any proposed structure(s), not including antennas; what is the principal exterior building material(s) proposed?

The height of structures on the Hanford Facility is generally less than 100 feet (33 meters) The height of various structures associated with TSD units can be found in the unit-specific Part B permit applications and environmental checklists accompanying these permit applications.

b. What views in the immediate vicinity would be altered or obstructed?

None.

c. Proposed measures to reduce or control aesthetic impacts, if any:

None.

11. Light and Glare

a. What type of light or glare will the proposal produce? What time of day would it mainly occur?

None.

b. Could light or glare from the finished project be a safety hazard or interfere with views?

No.

c. What existing off-site sources of light or glare may affect your proposal?

None.

d. Proposed measures to reduce or control light and glare impacts, if any:

Does not apply.

12. Recreation

a. What designated and informal recreational opportunities are in the immediate vicinity?

None.

b. Would the proposed project displace any existing recreational uses? If so, describe.

Does not apply.

c. Proposed measures to reduce or control impacts on recreation, including recreation opportunities to be provided by the project or applicant, if any?

Does not apply.

13. Historic and Cultural Preservation

a. Are there any places or objects listed on, or proposed for, national, state, or local preservation registers known to be on or next to the site? If so, generally describe.

No places or objects listed on, or proposed for, national, state, or local preservation registers are known to be on or next to any TSD units. Additional information on the Hanford Facility

environment can be found in the environmental documents referred to in the answer to Checklist Question A.8.

b. Generally describe any landmarks or evidence of historic, archaeological, scientific, or cultural importance known to be on or next to the site.

There are no known archaeological, historical, or native American religious localities at or next to any TSD units. Additional information on the Hanford Site environment can be found in the environmental documents referred to in the answer to Checklist Question A.8.

NOTE: Pacific Northwest Laboratory recently filed a Request For Determination of Eligibility for the White Bluffs Road with the State Historic Preservation Office. If the road is found eligible, it might be necessary to determine if any TSD units will have an effect on the historic property.

c. Proposed measures to reduce or control impacts, if any:

Where appropriate, a cultural resource review will provide the vehicle for necessary approvals required under the *National Historic Preservation Act of 1966*.

14. Transportation

a. Identify public streets and highways serving the site, and describe proposed access to the existing street system. Show on site plans, if any.

See maps in the accompanying Hanford Facility Permit Application.

b. Is site currently served by public transit? If not, what is the approximate distance to the nearest transit stop?

Portions of the Hanford Facility are served by public transportation. The 300 and 400 Areas of the Hanford Site are served by public transportation. Individual TSD units are not served by public transportation.

c. How many parking spaces would the completed project have? How many would the project eliminate?

A more detailed description of the parking needs for individual TSD units can be found in environmental checklists accompanying unit-specific Part B permit applications.

d. Will the proposal require any new roads or streets, or improvements to existing roads or streets, not including driveways? If so, generally describe (indicate whether public or private).

Paved roads for access to TSD units might be required. A more detailed description of transportation needs can be found in the environmental checklists accompanying unit-specific Part B permit applications. A portion of the roads will not be publicly accessible.

e. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation? If so, generally describe.

No.

f. How many vehicular trips per day would be generated by the completed project? If known, indicate when peak volumes would occur.

Peak traffic volumes will occur at the beginning and end of regular 8-hour working shifts. Many employees use the Hanford Site shuttle bus system for transportation from northern Richland to the operational areas of the Hanford Site, including TSD units of the Hanford Facility.

g. Proposed measures to reduce or control transportation impacts, if any:

Proper codes, standards, regulations and accepted safety practices will be followed to mitigate human exposure while transporting waste.

15. Public Services

a. Would the project result in an increased need for public services (for example: fire protection, police protection, health care, schools, other)? If so, generally describe.

No.

b. Proposed measures to reduce or control direct impacts on public services, if any:

Does not apply.

16. Utilities

a. List utilities currently available at the site (electricity, natural gas, water, refuse service, telephone, sanitary sewer, septic system, other):

The Hanford Site and Hanford Facility are supported by a variety of utilities including electrical, natural gas, water, refuse service, telephone, sanitary sewer, and septic system. Descriptions of utilities currently available for individual TSD units can be found in unit-specific Part B permit applications and environmental checklists accompanying these permit applications.

b. Describe the utilities that are proposed for the project, the utility providing the service, and the general construction activities on the site or in the immediate vicinity which might be needed.

The Hanford Site and Hanford Facility are supported by a variety of utilities including electrical, natural gas, water, refuse service, telephone, sanitary sewer, and septic system. Construction activities will, in general, 'tie-in' to existing utilities. Descriptions of utilities currently available for individual TSD units can be found in unit-specific Part B permit applications and environmental checklists accompanying these permit applications.

SIGNATURE

The above answers are true and complete to the best of my knowledge. I understand that the lead agency is relying on them to make its decision.

E A Bracken — 10-3-91

E. A. Bracken, Director — Date
Environmental Restoration Division
U.S. Department of Energy
Field Office, Richland

HANFORD FACILITY
DANGEROUS WASTE PERMIT APPLICATION

FOREWORD

The Hanford Site is owned by the U.S. Government and operated by the U.S. Department of Energy Field Office, Richland. The Hanford Site manages and produces dangerous waste and mixed waste (containing both radioactive and dangerous components). The dangerous waste is regulated in accordance with the *Resource Conservation and Recovery Act of 1976* and the *State of Washington Hazardous Waste Management Act of 1976* [as administered through the Washington State Department of Ecology *Dangerous Waste Regulations*, Washington Administrative Code 173-303]. The radioactive component of mixed waste is interpreted by the U.S. Department of Energy to be regulated under the *Atomic Energy Act of 1954*; the nonradioactive dangerous component of mixed waste is interpreted to be regulated under the *Resource Conservation and Recovery Act of 1976* and Washington Administrative Code 173-303.

For purposes of the *Resource Conservation and Recovery Act* and the Washington State Department of Ecology *Dangerous Waste Regulations*, the Hanford Site is considered to be a single facility. The single dangerous waste permit identification number issued to the Hanford Site by the U.S. Environmental Protection Agency and the Washington State Department of Ecology is U.S. Environmental Protection Agency/State Identification Number WA7890008967. This identification number encompasses over 60 treatment, storage, and/or disposal units within the Hanford Site, hereinafter referred to as the Hanford Facility when cited in the context of the *Resource Conservation and Recovery Act* and the Washington State Department of Ecology *Dangerous Waste Regulations*. All waste management activities carried out under the assigned identification number are considered to be 'onsite'.

Pursuant to the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990), a single Resource Conservation and Recovery Act/ Washington State Dangerous Waste Permit will be issued to cover the entire Hanford Facility. The consent order specifies that the U.S. Environmental Protection Agency and the Washington State Department of Ecology initially will issue the permit for less than the entire Hanford Facility because all of the treatment, storage, and/or disposal units cannot be permitted simultaneously.

The *Hanford Facility Dangerous Waste Permit Application* serves as the basis and application for the *Hanford Facility Permit* and currently consists of three sets of documents as follows:

- Set 1 -- *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b)

- Set 2 -- *Hanford Facility Dangerous Waste Part B Permit Application* (this volume)

- Set 3 -- Treatment, storage, and/or disposal unit-specific permitting documentation contained in the following chapters:

  - Chapter 1.0 -- *616 Nonradioactive Dangerous Waste Storage Facility Dangerous Waste Permit Application* (DOE-RL 1989a)

  - Chapter 2.0 -- *Hanford Waste Vitrification Plant Dangerous Waste Permit Application* (DOE-RL 1989c).

Set 1, the *Hanford Facility Dangerous Waste Part A Permit Application*, consists of two "Dangerous Waste Permit General Information, Form 1s" and over 60 "Dangerous Waste Permit Application, Form 3s." Two Form 1s have been submitted at the facility level. A Form 3 has been submitted for each of the over 60 treatment, storage, and/or disposal units located on the Hanford Facility.

Set 2, the *Hanford Facility Dangerous Waste Part B Permit Application*, consists of 15 chapters that address the content of the Part B checklists prepared by the Washington State Department of Ecology (Ecology 1987) and the U.S. Environmental Protection Agency (40 CFR 270), with additional information requirements mandated by the *Hazardous and Solid Waste Amendments of 1984* and revisions of WAC 173-303. For ease of reference, the Washington State Department of Ecology checklist section numbers, in brackets, follow the chapter headings and subheadings. This permit application contains 'umbrella-type' documentation with overall application to the Hanford Facility. This documentation is broad in nature and applies to all TSD units that have final status under the Hanford Facility Permit.

Set 3, unit-specific permit applications, contains two treatment, storage, and/or disposal unit-specific chapters (i.e., for the 616 Nonradioactive Dangerous Waste Storage Facility and the Hanford Waste Vitrification Plant).

Once the Hanford Facility permit is issued, the following process will be used. As documents are developed in accordance with the *Hanford Federal Facility Agreement and Consent Order* schedule, additional unit-specific permits will be incorporated as chapters into the *Hanford Facility Dangerous Waste Permit* through the permit modification process.

This *Hanford Facility Dangerous Waste Permit Application* submittal contains information current as of September 15, 1991.

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ACRONYMS AND ABBREVIATIONS

ACL	alternate concentration limit
ANOVA	analysis of variance
ARAR	applicable, relevant, and appropriate requirement
ASTM	American Society for Testing and Materials
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	Code of Federal Regulations
CMS	corrective measure study
DOE	U.S. Department of Energy
DOE-RL	U.S. Department of Energy Field Office, Richland
DST System	Double-Shell Tank System
DWS	Drinking Water Standards
°C	degree Celsius
°F	degree Fahrenheit
Ecology	Washington State Department of Ecology
EII	environmental investigation instructions
EPA	U.S. Environmental Protection Agency
FFTF	Fast Flux Test Facility
HDPE	high-density polyethylene
HEIS	Hanford Environmental Information System
HEPA	high-efficiency particulate air filter
M	milestones
MCL	maximum concentration limit
MEMO	monitoring efficiency model
PARCC (parameters)	precision, accuracy, representativeness, completeness and comparability
pH	negative logarithm of the hydrogen-ion concentration
PUREX	plutonium-uranium extraction (Plant)
RCRA	*Resource Conservation and Recovery Act of 1976*
REDOX	reduction oxidation
RFA	RCRA facility assessment
RFI	RCRA facility investigation
SWL	Solid Waste Landfill
SWMU	solid waste management units
TCE	trichloroethylene
TOC	total organic carbon
TOX	total organic halogen

ACRONYMS AND ABBREVIATIONS (cont)

Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRUSAF	Transuranic Waste Storage and Assay Facility
TSD	treatment, storage, and/or disposal
WAC	Washington Administrative Code
WIDS	Waste Information Data System
WIPP	Waste Isolation Pilot Plant
WPPSS	Washington Public Power Supply System
WRAP	Waste Receiving and Processing (Facility)

PART A

The Hanford Facility is one treatment, storage, and/or disposal facility consisting of over 60 treatment, storage, and/or disposal units. The single dangerous waste permit identification number issued to the Hanford Site by the U.S. Environmental Protection Agency and the Washington State Department of Ecology is U.S. Environmental Protection Agency/State Identification Number WA7890008967.

The current Hanford Facility Dangerous Waste Part A Permit Application consists of two "Dangerous Waste Permit General Information, Form 1s" and over 60 "Dangerous Waste Permit Application, Form 3s". Two Form 1s have been submitted at the facility level. A Form 3 has been submitted for each of the over 60 treatment, storage, and/or disposal units located on the Hanford Facility.

The Part A Permit Application for the Hanford Facility has been submitted to the Washington State Department of Ecology and the U.S. Environmental Protection Agency as the *Hanford Facility Dangerous Waste Part A Permit Application* (three volumes) (DOE-RL 1988b). This document consolidates the current revisions of all Hanford Facility Part A Permit Application Form 1s and Form 3s submitted to the U.S. Environmental Protection Agency and the Washington State Department of Ecology into a single controlled document. This document was designed to facilitate the insertion of revised material. The document will be revised in the future as needed to ensure compliance with applicable regulations. All revisions to Part A permit applications for treatment, storage, and/or disposal units operating under interim status will be carried out in accordance with the requirements of Washington State Department of Ecology *Dangerous Waste Regulations*, Washington Administrative Code 173-303-805(7). All revisions to Part A permit applications for treatment, storage, and/or disposal units operating under final status will be carried out in accordance with the requirements of Washington Administrative Code 173-303-830 as discussed in Chapter 1.0, Section 1.5, of this permit application.

The *Hanford Facility Dangerous Waste Part A Permit Application* comprises Set 1 of the *Hanford Facility Dangerous Waste Permit Application* volumes.

PART B

This Part B permit application for the Hanford Facility consists of 15 chapters and 12 appendices.

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1.0 INTRODUCTION

This chapter describes the permitting approach for the Hanford Facility and provides an overview of the Hanford Facility Part B Permit Application contents.

1.1 HANFORD FACILITY PERMITTING

This section describes the permitting approach for the Hanford Facility.

1.1.1 Regulatory Basis and Scope

The Hanford Site is owned by the U.S. Government and operated by the U.S. Department of Energy (DOE) Field Office, Richland (RL). The Hanford Site manages and produces dangerous waste and mixed waste (containing both radioactive and dangerous components). The dangerous waste is regulated in accordance with the *Resource Conservation and Recovery Act* (RCRA) *of 1976* and the *State of Washington Hazardous Waste Management Act of 1976* [as administered through the Washington State Department of Ecology (Ecology) *Dangerous Waste Regulations*, Washington Administrative Code (WAC) 173-303]. The radioactive component of mixed waste is interpreted by the U.S. Department of Energy to be regulated under the *Atomic Energy Act of 1954*; the nonradioactive dangerous component of mixed waste is interpreted to be regulated under the RCRA and WAC 173-303.

For purposes of the RCRA and WAC 173-303, the Hanford Site is considered to be a single facility. The single dangerous waste permit identification number issued to the Hanford Site by the U.S. Environmental Protection Agency (EPA) and Ecology is EPA/State Identification Number WA7890008967. All waste management activities carried out under the assigned identification number are considered to be 'onsite'.

The single EPA/State identification number encompasses over 60 treatment, storage, and/or disposal (TSD) units within the Hanford Site, hereinafter referred to as the Hanford Facility when cited in the context of the RCRA and WAC 173-303. These TSD units include containers, tank systems, surface impoundments, waste piles, landfills, and miscellaneous units. Over half of the TSD units are no longer operating and will be closed under interim status. Unit-specific interim status closure plans for these TSD units are not included in this permit application. The scope of this permit application is limited to those Hanford Facility TSD units for which a final status permit has been, or will be, sought.

1.1.2 Role of Hanford Federal Facility Agreement and Consent Order

The *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990) is the legal document covering Hanford Site

environmental compliance and cleanup. General purposes of the Tri-Party Agreement as related to permitting are as follows:

- To provide a framework for permitting TSD units and to promote an orderly, effective investigation and cleanup of contamination at the Hanford Site

- To ensure compliance with the RCRA, permit conditions, and the *State of Washington Hazardous Waste Management Act* for TSD units including requirements covering permitting, interim status, land disposal restrictions, closure, and postclosure care

- To establish a procedural framework for developing, prioritizing, implementing, and monitoring appropriate response actions at the Hanford Site in accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA) *of 1980*, the National Contingency Plan, the Superfund guidance and policy, and the RCRA guidance and policy

- To promote the integration of TSD unit closures with the remediation of surrounding past-practice waste management units.

The Action Plan, an enforceable part of the Tri-Party Agreement, provides the methods and procedures and establishes the plans for (1) compliance, permitting, and closure under RCRA and the *State of Washington Hazardous Waste Management Act* and (2) cleanup of the Hanford Site under CERCLA response action and RCRA corrective action provisions. Within the Action Plan, Section 2.4 addresses those actions necessary to satisfy interim status requirements and to obtain final operating permits for TSD units on the Hanford Facility. Section 2.4 of the Action Plan includes the identification of major milestones established to achieve compliance with the RCRA and the Ecology dangerous waste program TSD requirements. Such milestones (M) include those for submittal of permit applications (M-20-00), installation of RCRA groundwater monitoring wells (M-24-00), and RCRA past-practice site investigations and remedial actions. Schedules for these milestones are contained in the Tri-Party Agreement or amendments thereof. Amendments to these milestones will be in accordance with Article XL of the Tri-Party Agreement.

Pursuant to the Tri-Party Agreement, a single RCRA/State of Washington Dangerous Waste Permit will be issued to cover the entire Hanford Facility. The Tri-Party Agreement specifies that the EPA and Ecology initially will issue the dangerous waste permit for less than the entire Hanford Facility because all of the TSD units cannot be permitted simultaneously. Using a step-wise permitting process will ensure proper implementation of the Tri-Party Agreement. This permit eventually will grow into a single permit for the entire Hanford Facility. The federal authority to issue a permit at a facility in this manner is found in 40 CFR 270.1(c)(4). Any units that are not included in the initial permit application normally will be incorporated through a permit modification.

The TSD unit permitting process is outlined in Sections 6.2 of the Tri-Party Agreement Action Plan. Figure 1-1 depicts a flowchart for processing all dangerous waste permits for operating TSD units. The permitting process applies to existing units, expansion of units under interim status, and new units (units that do not have interim status and must have a permit before construction). As stated in Section 6.3 of the Tri-Party Agreement Action Plan, there are TSD units that are no longer operating and will be closed under interim status. These interim status closure/postclosure plans will be developed using final status standards as described in WAC 173-303-610. Because these TSD units are being closed separately under interim status, these TSD units are not addressed in this permit application.

The closure process for TSD units is described in Section 6.3 of the Tri-Party Agreement Action Plan. In some cases, it might be possible to remove all dangerous waste and waste constituents associated with a TSD unit to Hanford Site background and thereby achieve 'clean closure'. If clean closure cannot be achieved, the TSD unit will be closed as a land disposal unit. The process to close any unit as a land disposal unit will be carried out in accordance with all applicable requirements described in WAC 173-303. To avoid duplication under the CERCLA for mixed waste, the radionuclide component of the waste will be addressed as part of the closure action, unless it is determined that the unit will be used for radioactive waste activities in the future. Although radionuclides (i.e., source, special, and by-product nuclear material) will be addressed in the closure plan, radionuclides are not subject to the RCRA or WAC 173-303.

In the case of closure as a land disposal unit, a postclosure permit will be required. The postclosure permit will cover maintenance and inspection activities, groundwater monitoring requirements, and corrective actions, if necessary, that will occur during the postclosure period.

The dangerous waste permitting process, including closure, will be conducted in accordance with the Tri-Party Agreement Action Plan or amendments thereof.

1.1.3 Role of Hanford Facility Dangerous Waste Permit Application

The *Hanford Facility Dangerous Waste Permit Application* serves as the basis and application for the *Hanford Facility Permit* and currently consists of three sets of documents as follows:

- Set 1 -- *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b)

- Set 2 -- *Hanford Facility Dangerous Waste Part B Permit Application* (this volume)

- Set 3 -- Treatment, storage, and/or disposal unit-specific permitting documentation contained in the following chapters:

- Chapter 1.0 -- *616 Nonradioactive Dangerous Waste Storage Facility Dangerous Waste Permit Application* (DOE-RL 1989a)

- Chapter 2.0 -- *Hanford Waste Vitrification Plant Dangerous Waste Permit Application* (DOE-RL 1989c).

Set 1, the *Hanford Facility Dangerous Waste Part A Permit Application*, consists of two "Dangerous Waste Permit General Information, Form 1s" and over 60 "Dangerous Waste Permit Application, Form 3s." Two Form 1s have been submitted at the facility level. A Form 3 has been submitted for each of the over 60 TSD units located on the Hanford Facility.

Set 2, the *Hanford Facility Dangerous Waste Permit Application*, consists of 15 chapters. This permit application contains 'umbrella-type' documentation with overall application to the Hanford Facility. This documentation is broad in nature and applies to all TSD units that have final status under the Hanford Facility Permit.

Set 3, unit-specific permit applications, contains two TSD unit-specific chapters (i.e., for the 616 Nonradioactive Dangerous Waste Storage Facility and the Hanford Waste Vitrification Plant). These TSD unit-specific chapters contain references to requirements that are intended to ensure that each unit is operated in an efficient and environmentally protective manner.

Once the Hanford Facility permit is issued, the following process will be used. As documents are developed in accordance with the Tri-Party Agreement Action Plan Schedule for the M-20-00 milestone, additional unit-specific permits will be incorporated as chapters into the *Hanford Facility Dangerous Waste Permit* through the permit modification process. Additions of TSD unit-specific chapters will be conducted as specified in Section 1.5 that addresses the permit modification process.

1.1.4 Relationship Between the Tri-Party Agreement and the Hanford Facility Permit

In accordance with the Tri-Party Agreement, the Hanford Facility will undergo changeover from interim status to final status on a unit-by-unit basis. The proposed approach and schedule is as follows.

- The initial Hanford Facility Permit will be developed in accordance with the Tri-Party Agreement, WAC 173-303-600, and the RCRA. All activities associated with TSD units for which 'final administrative disposition' can be incorporated into permit conditions will be subject to final facility standards. For example, because the 616 Nonradioactive Dangerous Waste Storage Facility is included in the initial permit, activities at this storage unit will be subject to final facility standards. Other interim status TSD units not included in the initial Hanford Facility Permit, or subsequent modifications of the Permit, will continue to qualify for interim status pursuant to Section 3005 of RCRA.

- Additional TSD units will be added to the permit through the permit modification process. As these TSD units become part of the permitted facility, these TSD units too will be subject to final facility standards.

- As the final input on individual TSD units (in accordance with the Tri-Party Agreement) is processed by Ecology and the EPA, termination of interim status for those units will occur as identified in WAC 173-303-805(8)(a).

- Final facility standards will become applicable to the entire Hanford Facility only after administrative disposition of information submitted to complete milestone M-20-00.

The U.S. Department of Energy will take all necessary steps and make efforts to obtain timely funding to meet its obligations as stipulated in Article XLVIII of the Tri-Party Agreement.

Appeals from the Hanford Facility Permit will be managed under WAC 173-303-845, or other applicable law, except for those appeals that are governed by the dispute resolution provisions of Articles VIII or XX of the Tri-Party Agreement, as appropriate. Where there is a potential conflict between the Tri-Party Agreement and the Hanford Facility Permit, the wording of the Tri-Party Agreement will prevail and conflicts between the Tri-Party Agreement and the Permit will be resolved under Part Four of the Tri-Party Agreement. This approach will enable the DOE-RL and its contractors to follow the Tri-Party Agreement without concern that adherence to the Tri-Party Agreement could result in a violation of the Permit.

Paragraph 5 of the Tri-Party Agreement governs any assertion of inconsistency with the *Atomic Energy Act*. Paragraphs 79 and 80 of the Tri-Party Agreement address Physically Inconsistent Action provisions.

Ecology and the EPA or their authorized representatives will enter the Hanford Site in accordance with WAC 173-303-960(2)(a) and Articles XXXVII and XLV of the Tri-Party Agreement. The specifics of entry protocol will be defined in a DOE-RL Hanford Site access protocol document.

1.1.5 Solid Waste Management Units

A solid waste management unit (SMU) is "any discernable unit at which solid waste has been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid waste routinely and systematically has been released [40 CFR 264.501 (proposed)]." A discussion of solid waste management units on the Hanford Facility is provided in Appendix 1A. The Tri-Party Agreement outlines the approach for addressing SMUs on the Hanford Facility.

1.2 THE HANFORD FACILITY PART B PERMIT APPLICATION CONTENTS

This section provides an overview of the Hanford Facility Part B Permit Application contents. The Hanford Facility Part B Permit Application consists of 15 chapters that address the contents of the Part B checklists prepared by Ecology (Ecology 1987) and the EPA (40 CFR 270), with additional information requirements mandated by the *Hazardous and Solid Waste Amendments of 1984*, and revisions of WAC 173-303. For ease of reference, the Ecology checklist section numbers, in brackets, follow the chapter headings and subheadings. The Hanford Facility Part B Permit Application consists of the following 15 chapters:

- Introduction (Chapter 1.0)
- Facility Description and General Provisions (Chapter 2.0)
- Waste Characteristics (Chapter 3.0)
- Process Information (Chapter 4.0)
- Groundwater Monitoring (Chapter 5.0)
- Procedures to Prevent Hazards (Chapter 6.0)
- Contingency Plan (Chapter 7.0)
- Personnel Training (Chapter 8.0)
- Exposure Information Report (Chapter 9.0)
- Waste Minimization Plan (Chapter 10.0)
- Closure and Postclosure Requirements (Chapter 11.0)
- Reporting and Recordkeeping (Chapter 12.0)
- Other Relevant Laws (Chapter 13.0)
- Certification (Chapter 14.0)
- References (Chapter 15.0).

A brief description of each chapter is provided in the following sections.

1.2.1 Facility Description and General Provisions (Chapter 2.0)

This chapter provides a general description of the Hanford Facility. This chapter also contains a discussion of facility performance standards, spill management, manifesting, and the quality assurance and quality control program.

1.2.2 Waste Characteristics (Chapter 3.0)

This chapter briefly addresses the physical, chemical, and biological characteristics of the waste types treated, stored, and/or disposed of on the Hanford Facility. Reference is made to the contents of the *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b) for waste characteristics information. This chapter also includes a schedule for the development of a Hanford Facility waste analysis plan and a discussion of the plan for handling land disposal restriction waste.

1.2.3 Process Information (Chapter 4.0)

This chapter provides a general discussion of the design, construction, and operation of TSD units on the Hanford Facility. This chapter also provides a discussion of the handling of design information related to permitting considerations.

1.2.4 Groundwater Monitoring (Chapter 5.0)

This chapter discusses the hydrogeologic characteristics of the Hanford Facility and the general groundwater monitoring program.

1.2.5 Procedures to Prevent Hazards (Chapter 6.0)

This chapter discusses hazard prevention and emergency preparedness equipment, structures, and procedures.

1.2.6 Contingency Plan (Chapter 7.0)

This chapter provides information on contingency planning to ensure that the Hanford Facility has measures in place to lessen the potential impact on the public health and environment in the event of an emergency.

1.2.7 Personnel Training (Chapter 8.0)

This chapter outlines the training program for Hanford Facility employees whose primary duties are identified as being associated with dangerous waste management.

1.2.8 Exposure Information Report (Chapter 9.0)

This chapter provides information and conclusions concerning the potential exposure to dangerous waste from operations of surface impoundment or land disposal units on the Hanford Facility.

1.2.9 Waste Minimization Plan (Chapter 10.0)

This chapter discusses the program to minimize the volume or quantity and toxicity of waste generated on the Hanford Facility. The regulatory basis for, and objectives of, the waste minimization program are discussed.

1.2.10 Closure and Postclosure Requirements (Chapter 11.0)

This chapter describes how final status TSD units and the Hanford Facility will be decontaminated and closed, and discusses the interrelationship of RCRA and CERCLA activities related to closure.

1.2.11 Reporting and Recordkeeping (Chapter 12.0)

This chapter summarizes commitments for reporting and recordkeeping that are applicable to the Hanford Facility.

1.2.12 Other Relevant Laws (Chapter 13.0)

This chapter discusses federal, state, and local laws that govern the operation of the Hanford Facility, other than the RCRA, as amended, and the *State of Washington Hazardous Waste Management Act*, as amended.

1.2.13 Certification (Chapter 14.0)

This chapter contains the required certification signed by officials of the DOE-RL (the facility owner/operator) indicating that the information provided is true, accurate, and complete.

1.2.14 References (Chapter 15.0)

References used throughout this Part B permit application are listed in this chapter. All references listed here, which generally are not available from other sources, will be made available for review upon request to any regulatory agency or public commentor. References can be obtained by contacting the following:

Administrative Records Specialist
Public Access Room H4-22
Westinghouse Hanford Company
P. O. Box 1970
Richland, Washington 99352

1.3 ACRONYMS AND ABBREVIATIONS

Acronyms and abbreviations used throughout this Part B permit application are located at the beginning of the document between the Foreword and the Part A permit application section.

1.4 DEFINITIONS

Definitions specific to this permit application are provided in this section. These definitions supplement those provided in WAC 173-303-040.

Contractor--Firm under contract to the U.S. Department of Energy to provide Hanford Site services. Currently, there are the following four Hanford Site prime contractors:

- An Operations and Engineering Contractor
- A Research and Development Contractor
- An Engineer and Construction Contractor
- A Medical and Health Services Contractor.

Throughout the remainder of this permit application, the term contractor, except where specified, is used to refer to the operations and engineering contractor and the research and development contractor.

Dangerous or hazardous waste--In addition to the definition in WAC 173-303-040, means the nonradioactive dangerous component of waste commonly called mixed waste (i.e., waste that is both dangerous and radioactive). Dangerous waste commonly is used to refer to hazardous, dangerous, or extremely hazardous waste within this permit application.

Facility--Dependent on context, the term 'facility', as used in this permit application, could refer to:

- The Hanford Facility (refer to definition)
- Building nomenclature commonly used at the Hanford Facility. In this context, the term 'facility' remains as part of the title for various TSD units (e.g., 616 Nonradioactive Dangerous Waste Storage Facility, Grout Treatment Facility)
- For purposes of complying with RCRA corrective action provisions, all contiguous property under the control of the owner or operator seeking a permit under Subtitle C of RCRA.

Generating unit--Term inferred to have the same meaning as 'generator' as defined in WAC 173-303-040. For purposes of RCRA and the *Dangerous Waste Regulations*, the Hanford Facility is considered to be a single generator comprised of a number of generating units.

Hanford Facility--A single RCRA facility identified by the EPA/State Identification Number WA7890008967 that consists of over 60 TSD units conducting dangerous waste management activities. These TSD units are included in the *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b). Also, the contiguous portion of the Hanford Site that contains these TSD units and, for the purposes of the RCRA, is owned and operated by the U.S. Department of Energy (excluding lands north and east of the Columbia River, river islands, state owned or leased lands, lands owned by the Bonneville Power Administration, lands leased to the Washington Public Power Supply System, and the Ashe Substation). The physical description of the property (including structures, appurtenances, and improvements) as set forth in Appendix 2A. The Hanford Facility is a single site for purposes of provisions regulating 'offsite' or 'onsite' waste handling.

Hanford Site--The approximately 560 square miles (1,450 square kilometers) in southeastern Washington State owned by the United States Government and commonly known as the Hanford Reservation.

Hazardous waste management unit--Term inferred to have the same meaning as 'dangerous waste management unit' as defined in WAC 173-303-040.

Offsite shipments--Shipments not considered to be onsite.

Onsite shipments--Shipments (1) from waste generating units to TSD units operated by the DOE-RL or (2) between TSD units operated by the DOE-RL.

Operable unit--Because of the relatively large number of past-practice units at the Hanford Site, a process has been established for organizing these units into groups called operable units. The concept of operable units is to group the numerous units (primarily by geographic area) into manageable components for investigation and remedial action and to prioritize the cleanup work to be done at the Hanford Site (Ecology et al. 1990).

Operator--The U.S. Department of Energy and its successors.

Past-practice unit--A waste management unit where wastes or substances (intentionally or unintentionally) have been disposed of and that is not subject to regulation as a TSD unit (Ecology et al. 1990).

Reasonable times--Normal business hours, hours during which production, treatment, storage, construction, disposal or discharge occurs.

Treatment, storage, and/or disposal (TSD) unit--A unit used for treatment, storage, and/or disposal of dangerous waste that is required to be permitted and/or closed pursuant to RCRA requirements as determined in the Tri-Party Agreement Action Plan. Also refers to a grouping of TSD units for the purpose of preparing and submitting a permit application pursuant to the requirements under RCRA, as determined in the Tri-Party Agreement Action Plan. Each individual TSD unit property (including structures, appurtenances, and improvements) is described in the unit-specific chapters.

Tri-Party Agreement--The term Tri-Party Agreement means the *Hanford Federal Facility Agreement and Consent Order*, dated May 1989, as amended August 1990, and as it may be amended from time to time, including the Action Plan incorporated in the Tri-Party Agreement.

A glossary of technical terms used within this permit application is provided in Appendix 1B.

1.5 PERMIT MODIFICATIONS

All modifications to the Hanford Facility Dangerous Waste Permit will be made in accordance with the requirements identified in WAC 173-303-830, with the following exception. The notifications required by WAC 173-303-830(4)(a)(i)(A) and (B) for Class 1 changes will be submitted to the required regulatory agencies, appropriate units of state and local government, and individuals on the facility mailing list maintained by Ecology on an annual basis. Annual notifications that a Class 1 change is to be made will be submitted by March 1 of each year.

Upon successful completion of the unit-specific TSD permitting process (Figure 1-1), a unit will be incorporated into the Hanford Facility Permit in accordance with the Class 3 permit modification procedure. Particular modifications could be identified as Class 1, 2, or 3 in these unit-specific permits.

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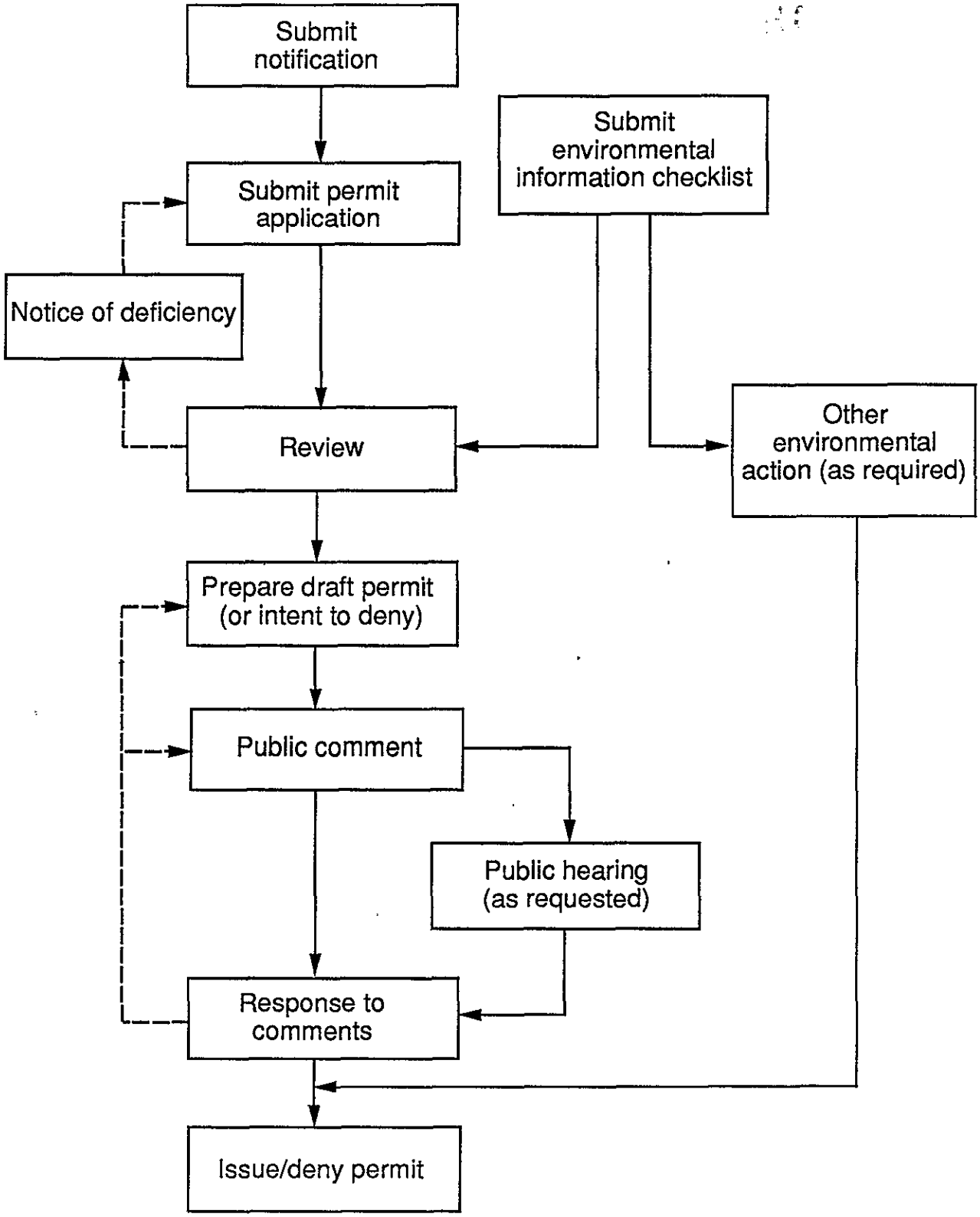

Figure 1-1. Permitting Process Flowchart. (Ecology et al. 1990)

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2.0 FACILITY DESCRIPTION AND GENERAL PROVISIONS [B]

This chapter briefly describes the Hanford Site and provides a general overview of the Hanford Facility, including the following:

- General description
- Topography
- Location information
- Traffic information
- Performance standards
- Buffer monitoring zones
- Spills and discharges
- Manifest system
- Quality assurance and quality control.

2.1 GENERAL DESCRIPTION [B-1]

The Hanford Facility consists of over 60 TSD units (Table 2-1). The TSD units treat, store, and/or dispose of dangerous and/or mixed waste. Dangerous waste means hazardous, dangerous, or extremely hazardous waste as defined by the RCRA and/or WAC 173-303 (Chapter 1.0, Section 1.4). Mixed waste means waste that contains both hazardous and dangerous waste subject to the RCRA, as amended, and the Ecology *Dangerous Waste Regulations*, and radioactive waste subject to the *Atomic Energy Act* (Chapter 1.0, Section 1.4). The radioactive portion of mixed waste can be high-activity, low-activity, and/or transuranic. Because radionuclides are not subject to regulation under WAC 173-303, any discussion of the treatment, storage, and/or disposal of radionuclides in this permit application is included for information only.

The TSD units on the Hanford Facility include tank systems, surface impoundments, container storage areas, waste piles, landfills, and miscellaneous units. An overview of the various TSD units on the Hanford Facility for which a final status permit has been, or will be, sought is provided in Chapter 4.0. As stated in Chapter 1.0, TSD units that are undergoing interim status closure are not included in this permit application.

2.1.1 The Hanford Site

The Hanford Site covers approximately 560 square miles (1,450 square kilometers) of semiarid land that is owned by the U.S. Government and managed by the DOE-RL. The Hanford Site is located northwest of the city of Richland,

Washington (Figure 2-1a). The city of Richland adjoins the southeastern most portion of the Hanford Site boundary and is the nearest population center. In early 1943, the U.S. Army Corps of Engineers selected the Hanford Site as the location for reactor, chemical separation, and related activities for the production and purification of special nuclear materials and other nuclear activities. The mission of the Hanford Site recently has focused on environmental remediation and restoration.

Activities on the Hanford Site are centralized in numerically designated areas (Drawing H-6-958 in Appendix 2A). The reactors are located along the Columbia River in the 100 Areas. The reactor fuel reprocessing units are in the 200 Areas, which are on a plateau approximately 7 miles (11 kilometers) from the Columbia River. The 300 Area, located adjacent to and north of Richland, contains the reactor fuel manufacturing plants and the research and development laboratories. The 400 Area, 5 miles (8 kilometers) northwest of the 300 Area, contains the Fast Flux Test Facility used for testing liquid metal reactor systems. The 600 Area covers all locations not specifically given an area designation. Adjacent to and north of Richland, the 1100 Area contains offices associated with administration, maintenance, transportation, and materials procurement and distribution. The 3000 Area, between the 1100 Area and 300 Area, contains engineering offices and administrative offices. Administrative offices also are located in the 700 Area, which is in downtown Richland.

2.1.2 The Hanford Facility

The Hanford Facility is defined as a single RCRA facility, identified by the EPA/State Identification Number WA7890008967, that consists of over 60 TSD units conducting dangerous waste management activities. These TSD units are included in the *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b). The Hanford Facility consists of the contiguous portion of the Hanford Site that contains these TSD units and, for the purposes of RCRA, is owned and operated by the U.S. Department of Energy (excluding lands north and east of the Columbia River, river islands, state owned or leased lands, lands owned by the Bonneville Power Administration, lands leased to the Washington Public Power Supply System, and the Ashe Substation). A map of the Hanford Facility is provided in Figure 2-1b. A legal description of the Hanford Facility is set forth in Appendix 2B. The Hanford Facility is a single site for purposes of provisions regulating 'offsite' or 'onsite' waste handling.

As noted above, the Hanford Facility does not include the Bonneville Power Administration Midway Site, the U.S. Department of Energy lands north and east of the Columbia River nor lands owned or leased by the state of Washington. The Midway Site is owned by the Bonneville Power Administration, and the DOE-RL has no ownership or control over this site. The U.S. Department of Energy lands north and east of the Columbia River contain no TSD units and are not considered to be contiguous to the Hanford Facility because these lands are separated by the state-owned Columbia River bed.

In addition, the Washington Public Power Supply System will be applying for a RCRA permit for the U.S. Department of Energy lands leased to the Washington Public Power Supply System. These lands will be covered by a separate permit and, therefore, will not be included in the Hanford Facility Permit.

The TSD units addressed by this permit application (i.e., those TSD units for which a final status permit has been, or will be, sought) are limited to the 200, 300, 400, and 600 Areas of the Hanford Site. The specific locations of these TSD units are specified in the *Hanford Facility Dangerous Waste Part A Permit Application* and on maps provided in Appendix 2A.

2.1.3 Overview of Waste Management on the Hanford Site

Figure 2-2 provides an overview of waste management activities on the Hanford Site. A brief discussion of the interrelationship among major operating TSD units, keyed to Figure 2-2, follows:

- The Double-Shell Tank System--This unit stores and treats radioactive and mixed waste generated on the Hanford Site before final treatment and disposal. The Double-Shell Tank System storage space is maximized through the use of the 242-A Evaporator. Additional tank space is used to support the Hanford Site environmental remediation and restoration mission (e.g., closure of single-shell tanks).

- The 242-A Evaporator--This treatment unit concentrates the double-shell tank waste by removal of water and volatile organics through evaporation. The concentrated slurry is returned to the Double-Shell Tank System and the condensate is transferred for storage to the Liquid Effluent Retention Facility.

- Liquid Effluent Retention Facility (not shown on Figure 2-2)--This unit will store after-filter process condensate from the 242-A Evaporator.

- B Plant--This unit is planned to support pretreatment of the double-shell tank waste. Pretreatment is for the purpose of separating high-activity and low-activity waste streams for routing to the Hanford Waste Vitrification Plant or the Grout Treatment Facility, respectively. A risk assessment currently is underway to evaluate the viability of using B Plant as a pretreatment unit.*

- Hanford Waste Vitrification Plant--This unit will treat the high-activity portion of waste stored in the Double-Shell Tank System

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* Pretreatment currently is planned to be conducted in B Plant. Upgrades to B Plant will be required before conducting the pretreatment process. Several alternatives are under consideration such as upgrades to the PUREX Plant, an annex to the HWVP, and a separate new unit in the event that pretreatment at B Plant is not viable.

by converting the waste into glass, with ultimate disposal of the vitrified waste in a national repository.

- Grout Treatment Facility--This unit processes (treats and disposes of) mixed waste by combining selected double-shell tank waste with grout-forming solids and, if necessary, chemical additives. The grouted waste is disposed of in vaults located on the Hanford Facility.

- Low-Level Burial Grounds--This unit disposes of solid low-level radioactive waste and mixed waste. Since 1987, most mixed waste, other than submarine reactor compartments, is being stored at the Central Waste Complex until a lined disposal trench is constructed.

- Hanford Central Waste Complex--This unit consists of the Radioactive Mixed Waste Storage Facility and the Waste Receiving and Processing Facility. The Radioactive Mixed Waste Storage Facility stores radioactive and/or mixed waste. The Waste Receiving and Processing Facility will treat mixed waste, low-level waste, and transuranic waste. The treated transuranic waste eventually will be transported for disposal to the Waste Isolation Pilot Plant (WIPP) in New Mexico (when WIPP becomes operational) or to another transuranic waste disposal site.

- The 616 Nonradioactive Dangerous Waste Storage Facility--This unit stores nonradioactive dangerous waste before shipment offsite for treatment, storage, and/or disposal.

- The 305-B Storage Unit (not shown on Figure 2-2)--This unit stores and labpacks dangerous waste before shipment offsite for treatment, storage, and/or disposal. Small-quantity mixed waste also is stored at the 305-B Storage Unit before being transported to the Hanford Central Waste Complex.

- The 242-A Evaporator/PUREX (plutonium-uranium extraction) Plant Condensate Treatment Facility (not shown on Figure 2-2)--This unit will treat mixed waste process condensate from the 242-A Evaporator and two nonregulated PUREX Plant waste streams. A research, development, and demonstration permit currently is being pursued for a waste water pilot plant supporting the design of this unit and other planned liquid effluent treatment units.

The operating TSD units discussed are, or will be, used to support RCRA closure and CERCLA remediation activities.

2.1.4 Treatment, Storage, and Disposal Units

Table 2-1 identifies the TSD units to be permitted under final status. Table 2-1 also indicates the classification of waste management activities conducted at each of these TSD units. Location maps for these TSD units are provided in Appendix 2A. The following sections provide a brief discussion of these TSD units, by area.

2.1.4.1 200 Areas. The 200 Areas are centrally located on the Hanford Site. There are two separate areas, referred to as the 200 East Area and the 200 West Area (Figure 2-1b). Underground piping connects the 200 East Area and 200 West Area for purposes of liquid waste transfer. The following TSD units are included in the 200 Areas:

- 242-A Evaporator
- Grout Treatment Facility
- T Plant Treatment Tank
- 241-Z Treatment Tank
- B Plant
- 222-S Laboratory Complex Treatment and Storage Tanks and Storage Area
- 204-AR Waste Unloading Station
- PUREX Plant
- Hanford Waste Vitrification Plant
- 242-A Evaporator/PUREX Plant Condensate Treatment Facility
- Double-Shell Tank System
- 2727-WA SRE Sodium Storage Building*
- PUREX Storage Tunnels
- TRUSAF (Transuranic Waste Storage and Assay Facility)
- Hanford Central Waste Complex--Radioactive Mixed Waste Storage Facility and the Waste Receiving and Processing Facility
- Liquid Effluent Retention Facility
- Low-Level Burial Grounds.

2.1.4.2 300 Area. The 300 Area is located adjacent to and north of Richland, Washington, along the Columbia River. The 300 Area contains the fuels fabrication units and research and development units for the Hanford Site. The following TSD units are included in the 300 Area:

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* Ecology has approved the petition to withdraw the Part A permit application but has not yet completed the full administrative process necessary to formally complete this withdrawal.

- 325 Waste Treatment Facility
- Biological Treatment Test Facilities
- Physical and Chemical Treatment Facilities
- Thermal Treatment Test Facilities
- 305-B Storage Unit
- 332 Storage Facility*.

2.1.4.3 400 Area. The 400 Area is located approximately 5 miles (8 kilometers) northwest of the 300 Area and contains the experimental nuclear reactor, Fast Flux Test Facility, and support and research buildings. The single TSD unit in the 400 Area is the Maintenance and Storage Facility.

2.1.4.4 600 Area. The 600 Area covers all locations not specifically given an area designation. The TSD units within the 600 Area are primarily in support of the overall waste management activities throughout the Hanford Facility. The following units are included in the 600 Area:

- Hanford Patrol Academy Demolition Site
- 616 Nonradioactive Dangerous Waste Storage Facility
- 600 Area Purgewater Storage and Treatment Facility.

2.2 TOPOGRAPHIC MAP [B-2]

Drawing H-6-958 in Appendix 2A provides a general overview of the Hanford Site and surrounding area. The drawing illustrates the following:

- Legal boundary of the Hanford Site
- Contours [at 20-foot (6.1-meter) intervals] sufficient to show surface water flow
- Fire control services on the Hanford Site
- Access roads, internal roads, railroads, perimeter gates, and barricades
- Longitudes and latitudes.

Prevailing wind speeds and directions across the Hanford Site are presented in Figure 2-3.

The relationship between the boundaries of the Hanford Site and the Hanford Facility is shown in Figure 2-1. A legal description of the Hanford Facility is contained in Appendix 2B.

Each TSD unit-specific permit application includes a topographic map, showing a distance of at least 1,000 feet (305 meters) around the unit. These TSD unit-specific maps are often drawn at a scale of 1 centimeter equal to 20 meters (1:2,000). The contour interval (0.5 meter or 1.6 feet) clearly shows the pattern of surface water flow in the vicinity of each TSD unit. In addition, these maps contain the following information:

- Map scale
- Date
- Prevailing wind speed and direction
- A north arrow
- Surrounding land use
- Location of the unit
- Access road location
- Access control
- Groundwater monitoring wells (if applicable).

Legal descriptions of the boundaries of individual TSD units are provided in the unit-specific permit applications.

2.3 LOCATION INFORMATION [B-3]

This section describes the location of the Hanford Facility in relation to seismic, floodplain, and shoreline considerations.

2.3.1 Seismic Risk Consideration [B-3a]

The Hanford Facility is located in Zone 2B as identified in the *Uniform Building Code* (ICBO 1991). Seismic risk considerations for individual TSD units are addressed in the unit-specific permit applications.

2.3.2 Floodplain Standard [B-3b]

Three sources of potential flooding of the Hanford Facility are considered during the permitting of individual TSD units: (1) the Columbia River, (2) the Yakima River, and (3) storm-induced run-off in ephemeral streams draining the Hanford Facility. No perennial streams occur in the central part of the Hanford Facility.

The Federal Emergency Management Agency has not prepared floodplain maps for the Columbia River through the Hanford Site. The flow of the Columbia

River is largely controlled by several upstream dams that are designed to reduce major flood flows. Based on a U.S. Army Corps of Engineers study of the flooding potential of the Columbia River that considered historic data and water storage capacity of the dams on the Columbia River (COE 1969), the U.S. Department of Energy (ERDA 1976) has estimated the probable maximum flood (Figure 2-4). The estimated probable maximum flood would have a larger floodplain than either the 100- or 500-year floods.

The 100-year floodplain for the Yakima River, as determined by the Federal Emergency Management Agency (FEMA 1980), is shown in Figure 2-5.

The only other potential source of flooding of the Hanford Facility is run-off from a large precipitation event in the Cold Creek watershed. This event could result in flooding of the ephemeral Cold Creek. Skaggs and Walters (1981) have given an estimate of the probable maximum flood using conservative values of precipitation, infiltration, surface roughness, and topographic features. The 100-year flood is less than the probable maximum flood as shown in Figure 2-6.

The location of individual TSD units with respect to the identified floodplains is addressed in the unit-specific permit applications.

2.3.2.1 Demonstration of Compliance [B-3b(1)]. Demonstration of compliance for individual TSD units, where applicable, is detailed in the unit-specific permit applications.

2.3.2.1.1 Flood Proofing and Flood Protection Measures [B-3b(1)(a)]. Demonstration of compliance for individual TSD units, where applicable, is detailed in the unit-specific permit applications.

2.3.2.1.2 Flood Plan [B-3b(1)(b)]. Demonstration of compliance for individual TSD units, where applicable, is detailed in the unit-specific permit applications.

2.3.2.2 Plan for Future Compliance with Floodplain Standard [B-3b(2)]. Demonstration of compliance for individual TSD units, where applicable, is detailed in the unit-specific permit applications.

2.3.3 Shoreline Standard [B-3c]

The TSD units on the Hanford Facility are not located within regulated 'shorelines of the state' or 'wetlands' as defined in the *Shoreline Management Act of 1971*. The Hanford Facility is located on the Hanford Site, which is owned by the U.S. Government and operated by the DOE-RL. The Hanford Site is not classified as natural, conservancy, rural, or residential.

2.3.4 Sole Source Aquifer Criteria [B-3d]

The Hanford Facility is not located over a 'sole source aquifer' as defined in Section 1424(e) of the *Safe Drinking Water Act of 1974*. Therefore, no demonstration of compliance is required.

2.4 TRAFFIC INFORMATION [B-4]

The regional public highway network traversing the Hanford Site (Washington State Highways 24 and 240), nonrestricted access roadways (Route 10, and portions of Route 4S located south of the Wye Barricade), and restricted access roadways are shown in Figure 2-7.

Roadways on the Hanford Site north of the Wye Barricade and within the 300 and 400 Areas always are restricted to authorized personnel. Other U.S. Department of Energy roadways are subject to such restrictions or closure as the U.S. Department of Energy might require. Estimated traffic volumes for the 1986 to 1987 timeframe, in vehicles per day, are shown in Figure 2-7. The majority of traffic is passenger vehicles used for commuting and conducting company business. Approximately 10 percent of the traffic volume is trucks, and these trucks are mainly delivery, construction, and maintenance vehicles.

2.4.1 Hanford Site Roadways

Figure 2-7 shows the major roads throughout the Hanford Site. These roads are classified as either primary or secondary routes. The primary routes include Routes 4S, 10, 2N, 3, 6, and 11A, as well as various avenues within each area. The primary routes are constructed of bituminous asphalt [usually 2 inches (5 centimeters)] thick, but the thickness of the asphalt layer will vary with each road) with an underlying aggregate base in accordance with U.S. Department of Transportation requirements. The secondary routes are constructed of layers of an oil and rock mixture with an underlying aggregate base. The aggregate base consists of various types and sizes of rock found onsite. Currently, no load-bearing capacities of these roads are available; however, loads as large as 140 pounds per square inch (9.8 kilograms per square centimeter) have been transported without observable damage to road surfaces. All roads meet the requirements for the American Association of State Highway and Transportation Officials HS-20-44 load rating (AASHTO 1983). An HS-20-44 loading represents a two-axle tractor [front axle loading of 8,000 pounds (3,630 kilograms) and rear axle loading of 32,000 pounds (14,500 kilograms)] plus a single-axle trailer with a 32,000-pound (14,500 kilogram) axle loading.

2.4.2 Traffic Control Signs, Signals, and Procedures

Standard traffic control signs are used throughout the Hanford Site (e.g., hexagonal stop signs, triangular yield signs). Speed limits are posted throughout the Hanford Site, and the maximum posted speed is 55 miles (88 kilometers) per hour on major thoroughfares. Inside the various areas,

posted speeds are reduced to a maximum of 35 miles (56 kilometers) per hour and held to speeds as low as 15 miles (24 kilometers) per hour.

The *Hazardous Materials Transportation Act* was amended by the *Hazardous Materials Transportation Uniform Safety Act of 1990*. In accordance with interpretations of the applicability of this amendment, government-owned roads used by members of the general public, without the public having to gain access through a controlled access point, are roads that are 'in commerce'. A means of preventing hazardous materials transportation on government property from being 'in commerce' is to temporarily block the road from public access. Shipments of RCRA/WAC 173-303 waste on such roads on the Hanford Facility are carried out using access-restriction procedures.

2.4.3 Hanford Site Railroad System

Some dangerous and mixed waste is transported to and/or from TSD units (e.g., Double-Shell Tank System, Low-Level Burial Grounds) in railroad cars. The general location of rail lines can be found on Drawing H-6-958 in Appendix 2A. Typically, shipments are made during periods of low traffic activity (i.e., between 9:00 a.m. and 3:00 p.m., on weekends, or during off-peak traffic hours). All roads that cross the waste route are barricaded by the Hanford Patrol during shipments to prevent motor vehicle accidents. Based on evaluation of risk, railroad shipments are prohibited during periods of low visibility, when there are winds in excess of 15 miles (25 kilometers) per hour, and during heavy rain, snow storms, or icy conditions.

All railroad track, track beds, and related equipment are maintained to the requirements of Federal Railroad Association track safety standards for Class III track as detailed in 49 CFR 213. Class III track is sufficient for the loads and train speeds on the Hanford Site.

2.5 PERFORMANCE STANDARDS [B-5]

The Hanford Facility TSD units are designed to minimize the exposure of personnel to dangerous waste and hazardous substances and to prevent dangerous waste and hazardous substances from reaching the environment. In addition, measures are taken to ensure that the active TSD units are maintained and operated in a manner that prevents the following:

- Degradation of groundwater quality
- Degradation of air quality by open burning or other activities
- Degradation of surface water quality
- Destruction or impairment of flora or fauna
- Excessive noise
- Negative aesthetic impacts

- Unstable hillsides or soils
- Use of processes that do not treat, detoxify, recycle, reclaim, and recover waste material to the extent economically feasible
- Endangerment to the health of employees or the public.

The measures taken to prevent each of the negative effects from occurring are described in the following sections. Closure performance standards are discussed in Chapter 11.0, Section 11.2.

2.5.1 Measures to Prevent Degradation of Groundwater Quality

The Hanford Facility is located in an area having a semiarid climate with an average annual rainfall of about 6.3 inches (16 centimeters). Therefore, aerial recharge that could transport contamination to groundwater is limited. In addition, many TSD units use double containment piping and leak detection, grading and ground cover, and/or other measures to prevent degradation of groundwater quality. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.2 Measures to Prevent Degradation of Air Quality by Open Burning or Other Activities

On the Hanford Facility, open burning and other activities that might degrade air quality are curtailed to the extent practicable. In addition, the arid climate limits vegetation within the Hanford Facility. Vegetation around many TSD units is removed routinely, so that there is a low potential for accidental open burning. Measures to be taken for individual TSD units are detailed, where applicable, in unit-specific permit applications.

2.5.3 Measures to Prevent Degradation of Surface Water Quality

The potential for degradation of surface water is extremely low. There are two natural surface water bodies on the Hanford Facility, the Columbia River and West Lake. The Columbia River is located along the northern and eastern boundary of the Hanford Facility. West Lake is located southwest of Gable Mountain (Drawing H-6-958 in Appendix 2A) and is approximately 10 acres (4.07 hectares) in size and 3 feet (0.91 meter) deep. Final status TSD units are sufficiently removed from these surface water bodies to reduce the potential for degradation.

Because of the drainage characteristics of the native soils, rainwater generally soaks into the sandy soil rather than running on the surface. Small pools can be observed occasionally after rapid snowmelt, but the pools usually dissipate within 72 hours. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.4 Measures to Prevent Destruction or Impairment of Flora or Fauna Outside of the Treatment, Storage, and/or Disposal Units

Most of the Hanford Facility beyond the bounds of the 200, 300, 400, and 1100 Areas is maintained as a natural habitat. Many TSD units and areas within the Hanford Facility are surrounded by perimeter chain link fences to prevent access by larger animals. The continued practice of removing flora from inside TSD unit boundaries discourages fauna from entering these areas in search of food. Measures to be taken by individual TSD units to prevent destruction or impairment of flora or fauna outside the units are detailed, where applicable, in the unit-specific permit applications.

2.5.5 Measures to Prevent Excessive Noise

The Hanford Facility is sufficiently removed from residential and offsite industrial areas (Drawing H-6-958 in Appendix 2A) to preclude excessive noise impacts. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.6 Measures to Prevent Negative Aesthetic Impacts

Most of the TSD units on the Hanford Facility are located in restricted areas. These units are not visible from offsite or are visible only from a great distance. This aspect helps to eliminate any significant negative aesthetic impacts from these TSD units. Measures taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.7 Measures to Prevent Unstable Hillsides or Soils

There are no naturally unstable hillsides or soils within or adjacent to existing TSD units. Compaction of the soil is used to stabilize the soil during and after any construction activities. Native vegetation often is planted to eliminate erosion potential of soils due to wind and water. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.8 Measures to Prevent the Use of Processes That Do Not Treat, Detoxify, Recycle, Reclaim, and Recover Waste Material to the Extent Economically Feasible

Measures to prevent the use of processes that do not treat, detoxify, recycle, reclaim, and recover waste material to the extent economically feasible are, or will be, taken into consideration in the operation of Hanford Facility TSD units. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.5.9 Measures to Prevent Endangerment to the Health of Employees or the Public Near the Hanford Facility

Measures to prevent endangerment of the health of employees or the public near the Hanford Facility include monitoring of released effluents, monitoring of groundwater, monitoring of ambient air, and training of employees in the handling and management of dangerous waste. Measures to be taken for individual TSD units are detailed, where applicable, in the unit-specific permit applications.

2.6 BUFFER MONITORING ZONES [B-6]

Buffer monitoring zones, where applicable, will be in accordance with the National Fire Protection Association, NFPA-30, Chapter 7, and WAC 173-303-640(9)(b). Additional information for individual TSD units can be found in the unit-specific permit applications.

2.7 SPILLS AND DISCHARGES INTO THE ENVIRONMENT [B-7]

The procedures followed to ensure immediate response to a nonpermitted spill or discharge of dangerous waste to the environment within the Hanford Facility are detailed in the DOE-RL emergency plan and procedures manual, the *Emergency Plan* (WHC 1989e), and *Emergency Preparedness* (PNL 1991) (Chapter 7.0). Additional information for individual TSD units can be found in the unit-specific building emergency plans included in the unit-specific permit applications.

2.7.1 Notification [B-7a]

The following are details of notification of the DOE-RL, Ecology, and the National Response Center. Additional information for individual TSD units can be found in the unit-specific permit applications.

- The building emergency director or coordinator or line management, for the unit in question, documents all emergencies on an occurrence report (Figure 2-8), which must be completed within 24 hours. The occurrence report is used to provide management with facts about an unplanned event and to disseminate information to those responsible for preventing recurrence of similar events. The DOE-RL is notified by either line management or the assigned overview organization, depending on the consequences of the event. Copies of the occurrence reports are retained by the TSD unit.

- All spills to the environment and/or the atmosphere will be reported immediately to the Occurrence Notification Center. The Occurrence Notification Center notifies Ecology of the release of dangerous waste.

- Upon detection, immediate notification will be made to Ecology at (206) 438-7016 of all spills required under applicable regulations.

- In addition, if a spill exceeds the reportable quantities established under CERCLA, according to 40 CFR 302, the Occurrence Notification Center will notify the National Response Center at 800-424-8802.

- The report to Ecology and the National Response Center will contain the following information:

  - Name and telephone number of reporter
  - Name and location of waste unit or zone
  - Time and type of incident
  - Name and quantity of material(s) involved to the extent known
  - Extent of injuries if any
  - Possible hazards to human health and the environment outside the Hanford Facility boundary.

- All releases of dangerous waste, including those that do not exceed a CERCLA limit, are reported to the Hanford Fire Department and the appropriate contractor's environmental protection organization. The appropriate contractor's environmental protection organization compiles a report for submittal to the DOE-RL. The reports are kept on file at the TSD unit and are available for review by the appropriate regulatory agencies. The DOE-RL submits the report to the following address:

  Washington State Department of Ecology
  7601 West Clearwater, Suite 102
  Kennewick, WA 99336
  Phone: (509) 546-2990.

- All spills or releases that occur during transportation onsite will be reported by the transporter to the Occurrence Notification Center, the DOE-RL, and Ecology. In addition, a written report will be submitted to the following address:

  Director, Office of Hazardous Material Regulations
  Materials Transport Bureau
  Department of Transportation
  Washington, D.C. 20990.

2.7.2 Mitigation and Control [B-7b]

The following is a discussion of typical mitigation and control measures to be taken on the Hanford Facility. Additional information for individual TSD units can be found in the unit-specific permit applications.

2.7.2.1 Cleanup of Released Wastes or Substances [B-7b(1)]. Immediately after an emergency, the responsible building emergency director or coordinator for the unit in question, arranges for the treatment, storage, and/or disposal

of recovered waste, contaminated soil, run-off, or other material resulting from the incident. Support, as appropriate, is provided from other Hanford Site organizations (such as the hazardous materials response team, chemical response team, industrial safety and fire protection, and/or operations). All treated soil, water, or other materials contaminated by a spill or discharge are treated, stored, or disposed of in accordance with WAC 173-303. The responsible building emergency director or coordinator activates any equipment necessary to perform this task and to protect public health and the environment.

As soon as possible following the end of an emergency, all cleanup debris and materials resulting from the incident are identified. The identification process could include using container labels, manifests, placards, process knowledge, or sampling. If the identity of any dangerous waste constituents involved in an incident is in question, it is the responsibility of the responsible building emergency director or coordinator to coordinate the identification of unknowns. If necessary, the building emergency director or coordinator arranges for samples of the materials to be collected for laboratory analysis. High-reliability portable instrumentation could be used in the field to provide real-time analysis, with confirmation of results through samples sent to a laboratory. The analysis would determine the hazards associated with handling the materials. Also, the collected materials would be designated in accordance with applicable standards of 40 CFR 261 and WAC 173-303-070.

Immediately after the released waste and the extent of contamination are identified, cleanup of the affected area is initiated. The cleanup process could include the following actions:

- Determining proper personnel protection requirements
- Treating small spills with absorbent material, collecting the residue, and placing the residue in approved containers for disposal
- Gathering all contaminated soils and cleanup debris, and placing the soil and cleanup debris in approved containers
- Segregating any incompatible waste and placing the waste in separate containers
- Applying markings and/or labels to containers
- Sampling the spill site to verify cleanliness
- Decontaminating all emergency and cleanup equipment and readying the equipment for future service
- Documenting verification of the spill site and equipment cleanliness in the log book.

2.7.2.2 Management of Contaminated Soil, Waters, or Other Materials [B-7b(2)]. In cases involving soil contamination, the lateral and vertical

extent of contamination must be determined, and a decision must be made on the method and extent of cleanup. Onsite organizations are trained and equipped for sampling and removing soils contaminated with radioactive or dangerous materials. The responsible building emergency director or coordinator coordinates the activities of onsite organizations for characterization and cleanup of soil contamination. The following are general steps for determining the extent of soil contamination in the cleanup process.

- Immediately after an emergency, the responsible building emergency director or coordinator, for the unit in question, takes additional steps as necessary to isolate the area and stabilize the soil surface to prevent the spread of contamination by wind or precipitation run-off if necessary.

- The responsible building emergency director or coordinator, for the unit in question, determines, with the assistance of the emergency response organization, the level of personnel protective equipment required to protect workers from the types of hazards to be encountered.

- Representative soil samples are collected using the appropriate sampling equipment. Sampling is conducted in accordance with sampling and testing methods specified in WAC 173-303-110 and/or SW-846 (EPA 1986b). An appropriate number of background and blank samples are collected to aid in data analysis. If contamination is not easily detectable visually or with the appropriate detection instruments, this step might need to be repeated until the full extent of lateral and vertical contamination is known.

- Samples are transported to, and analyzed by, an analytical laboratory in accordance with methods specified in WAC 173-303-110 and/or SW-846.

- After the extent of soil contamination is quantified, an appropriate method for removal or permanent stabilization of the contaminated soil is determined.

- After the contaminated soil is removed, soil testing is performed to confirm complete decontamination of the area to initial background or protection cleanup levels.

The management of potentially contaminated groundwater is addressed in Chapter 5.0.

Mixed or dangerous waste recovered from a release, a fire, or an explosion is placed in containers approved for the purpose and prepared for transfer to an onsite TSD unit. The waste shipments are tracked as discussed in Section 2.8.

Any incompatible waste formed as a result of an emergency incident will be physically segregated, placed in containers, and prepared for shipment to an onsite TSD unit. The responsible building emergency director or coordinator ensures that no additional waste that could be incompatible with

the waste produced during the emergency is handled in the affected area until cleanup is complete.

2.7.2.3 Restoration of Impacted Area [B-7b(3)]. The remote location of most TSD units (near the center of the Hanford Site) and the size of the Hanford Site, make spills or discharges occurring from TSD units on property that is not owned by the U.S. Government unlikely. Information for individual TSD units not located near the center of the Hanford Site can be found in unit-specific permit applications.

2.8 MANIFEST SYSTEM [B-8]

The Hanford Facility handles dangerous waste from onsite sources and mixed waste from both onsite and offsite sources. This section briefly discusses the system that is in place to track waste shipments.

2.8.1 Onsite Waste Shipments

The Hanford Site has one EPA/State identification number as required by WAC 173-303-060, and all TSD units on the Hanford Facility are part of a single dangerous waste facility. Therefore, onsite shipments of dangerous or mixed waste are not subject to the manifesting requirements specified in WAC 173-303-370 and -180. However, all onsite waste shipments are conducted in a manner to ensure protection of onsite workers, the environment, and the public. Four onsite waste tracking systems, similar to a manifest system, are voluntarily used for transporting waste on the Hanford Facility. The following four systems are used to track the transfer of waste:

- Liquid mixed waste via underground pipelines
- Liquid mixed waste via railroad tank car or tank truck or via barrels transported by truck
- Containerized mixed waste (e.g., rags, failed equipment, contaminated soil) via trucks and railroad cars
- Containerized nonradioactive dangerous waste via truck before being shipped offsite for treatment, storage, and/or disposal at a permitted facility.

Onsite waste transfer records for individual TSD units are maintained on file and can be accessed by contacting the Regulatory File Custodian (Chapter 12.0).

2.8.2 Offsite Waste Shipments

Offsite shipments of dangerous waste to and from the Hanford Facility are subject to the manifesting requirements specified in WAC 173-303-370 and -180, respectively. The EPA Uniform Hazardous Waste Manifest is used for

transporting dangerous waste from the Hanford Facility to an offsite permitted TSD facility. Mixed waste could be shipped offsite in the future to the WIPP or to a national repository when these sites become operational. Offsite waste transfer information for individual TSD units can be found in the unit-specific permit applications. Offsite waste transfer records for individual TSD units are maintained on file and can be accessed by contacting the Regulatory File Custodian.

2.8.3 Receipt of Offsite Waste

The Hanford Facility receives dangerous and mixed waste from offsite (including foreign) sources. Such waste is subject to the manifesting requirements specified in WAC 173-303-370 and -390(1). Notification for foreign waste receipt is made in accordance with WAC 173-303-290. Notification of subsequent shipments of the same waste from the same foreign source in the same calendar year is not required.

Offsite waste receipt information specific to individual TSD units can be found in the unit-specific permit applications. Offsite waste receipt records for individual TSD units are maintained on file and can be accessed by contacting the Regulatory File Custodian (Chapter 12.0).

2.9 QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM FOR THE HANFORD FACILITY

This section briefly discusses the quality assurance and quality control program for the Hanford Facility and the procedures that are in place to control Hanford Facility RCRA activities.

A quality assurance and quality control program for the Hanford Facility is provided in Appendix 2C. This program will be integrated with the quality assurance and control program in the Tri-Party Agreement, as specified in Article XXX, and Sections 6.5 and 7.8 of the Tri-Party Agreement Action Plan. The quality assurance and quality control information for individual TSD units can be found in the unit-specific permit applications.

Operational activities at the Hanford Facility are governed by procedures that are maintained by the specific TSD unit. Copies of these procedures are retained on file in the unit operating record and are accessible for inspection through the Regulatory File Custodian (Chapter 12.0). In accordance with WAC 173-303-806, a description of procedures pertinent to dangerous waste management activities is included in the unit-specific permit application.

Of particular relevance to Hanford Facility groundwater monitoring and closure activities are the Environmental Investigation Instructions (EIIs) (WHC 1988). Applicable EIIs are briefly described in TSD unit-specific permit applications. Current copies of the EIIs also are maintained on file and are accessible to the regulatory agencies through the Regulatory File Custodian (Chapter 12.0). In accordance with the Tri-Party Agreement, EIIs are

designated as 'secondary documents' and will be reviewed by the regulators in accordance with Section 9.2.3 of the Tri-Party Agreement Action Plan. Descriptions of EIIs or other procedures used to conduct closure are included in Appendix 2D.

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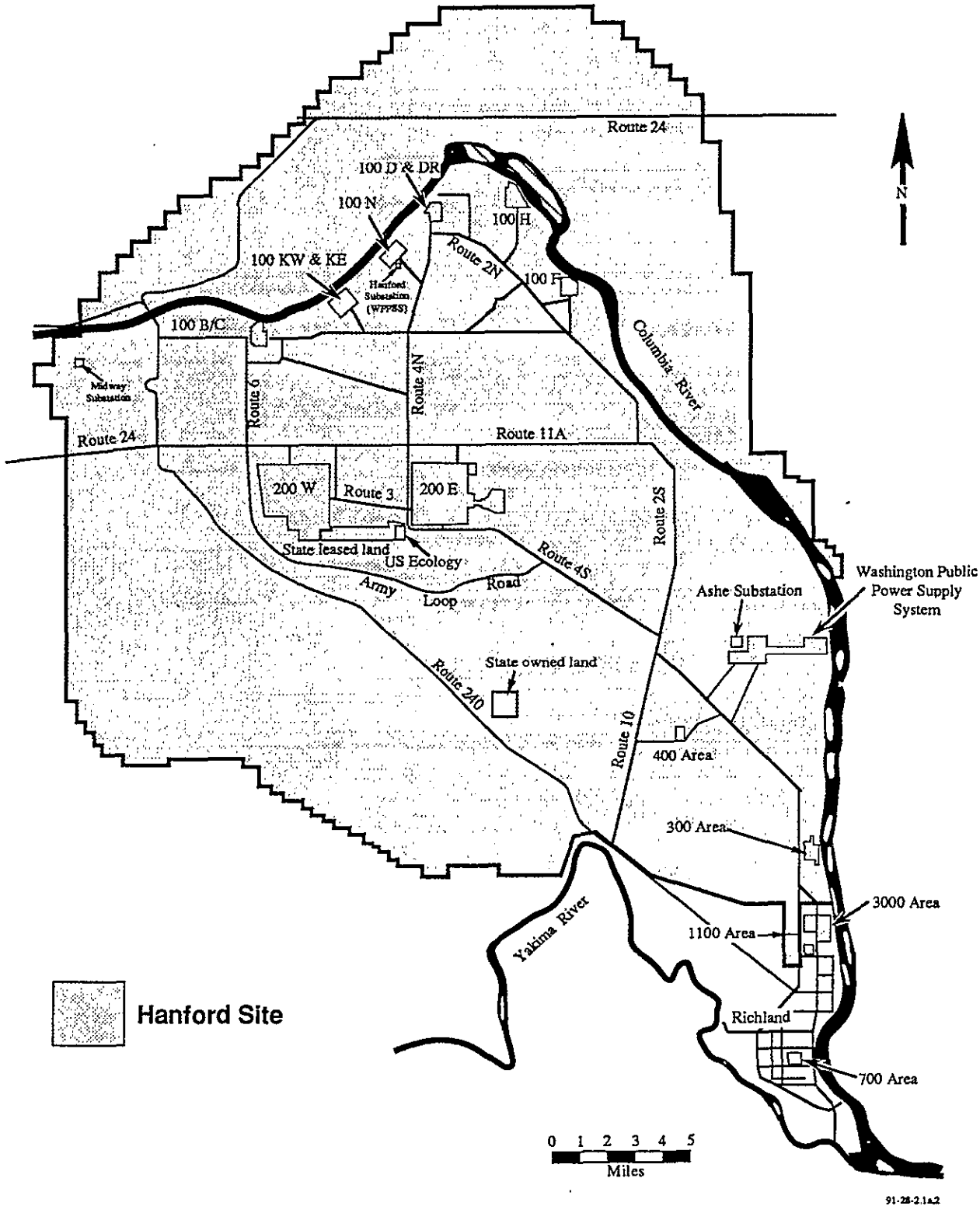


Figure 2-1a. Hanford Site Map.

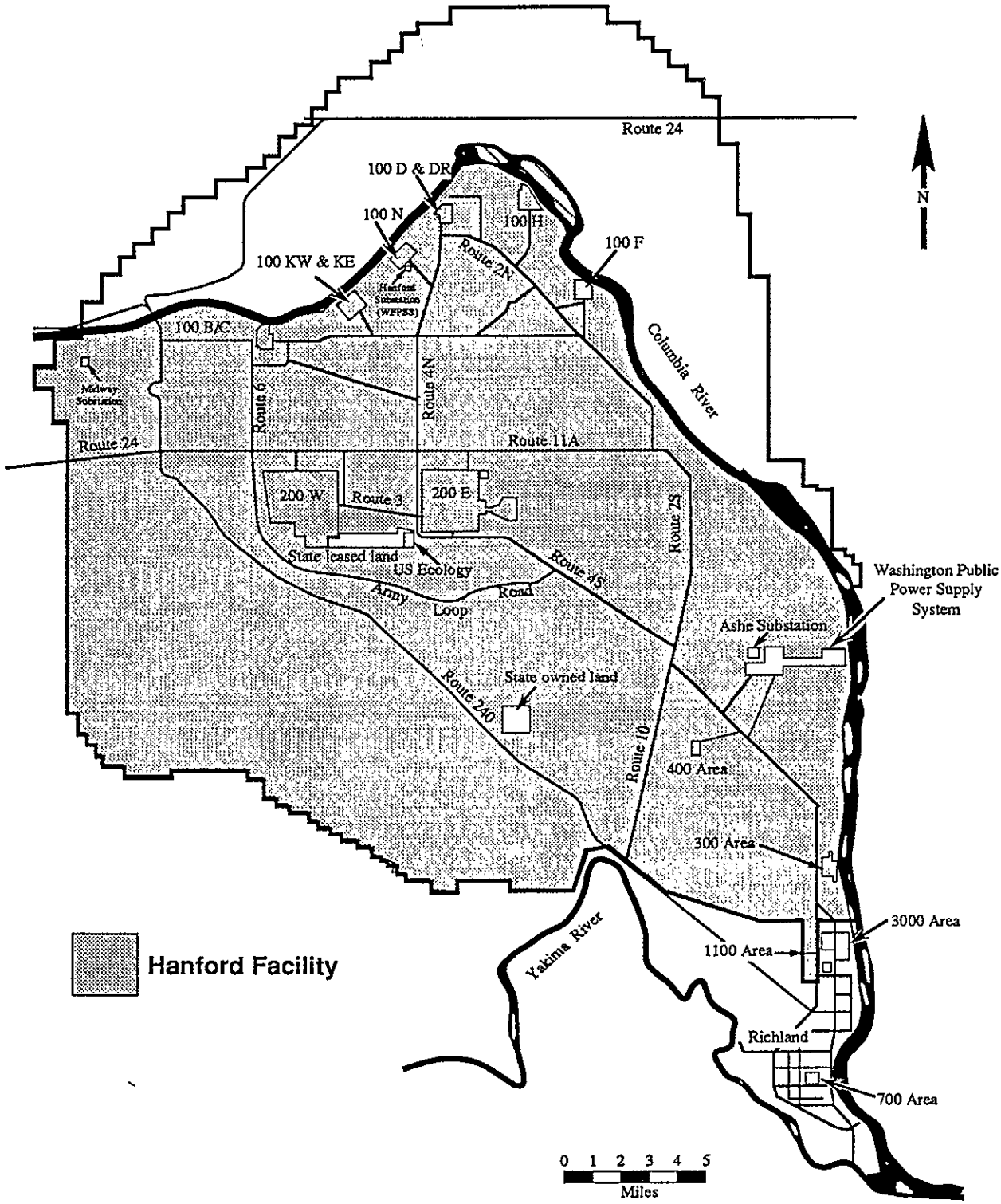
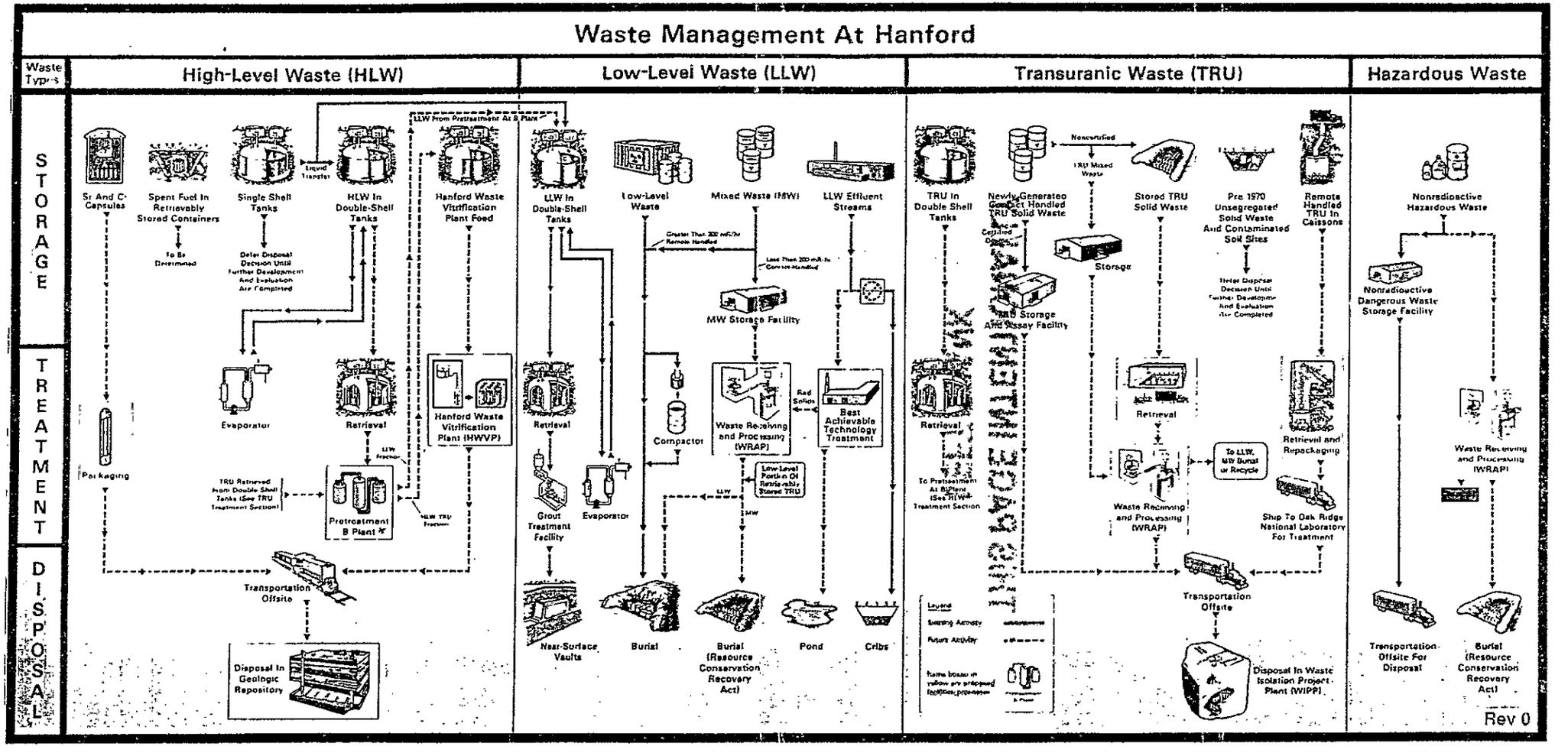


Figure 2-1b. Hanford Facility Map.

91-28-2.1b.2



Note: This figure is a generalized conceptual depiction of Waste Management at the Hanford Facility. This figure is included for illustrative purposes only.

* Pretreatment currently is planned to be conducted in B Plant. Upgrades to B Plant will be required before conducting the pretreatment process. Several alternatives are under consideration such as upgrades to the PUREX Plant, an annex to the HWVP, and a separate new unit in the event that pretreatment at B Plant is not viable.

Figure 2-2. Waste Management on the Hanford Facility.

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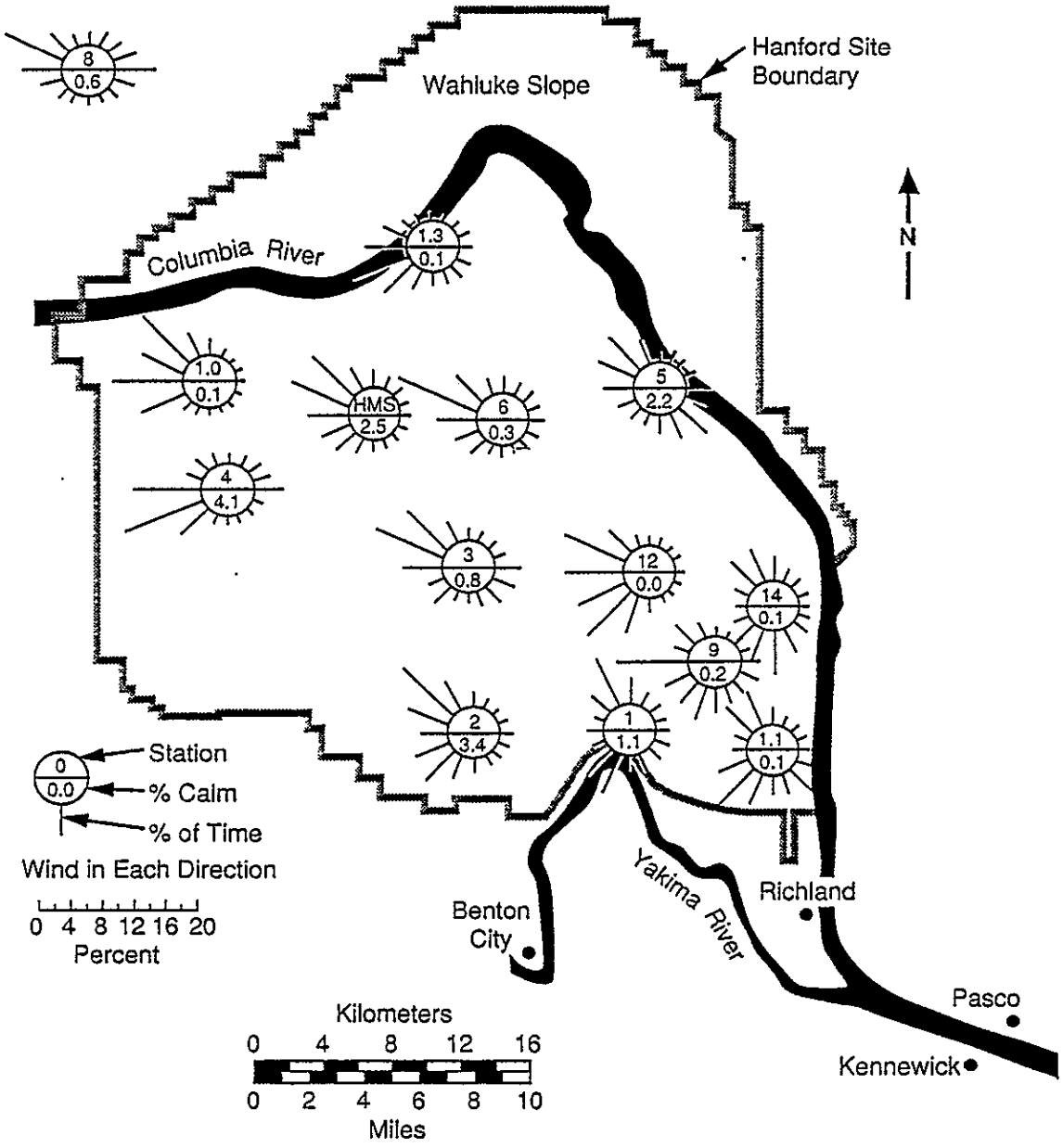

Figure 2-3. Prevailing Wind Speed and Direction for the Hanford Site.

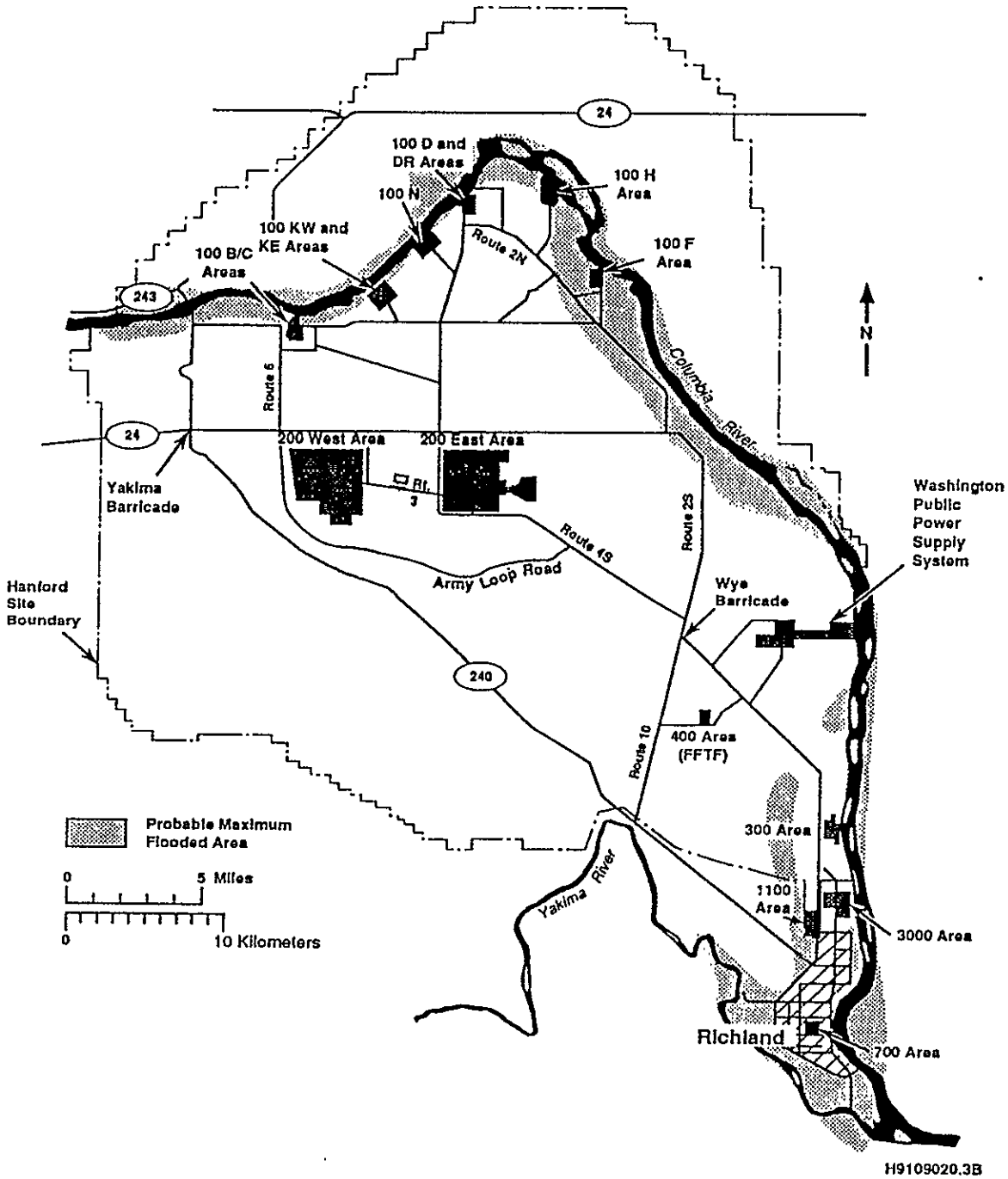

Figure 2-4. Columbia River Floodplain (probable maximum flood).

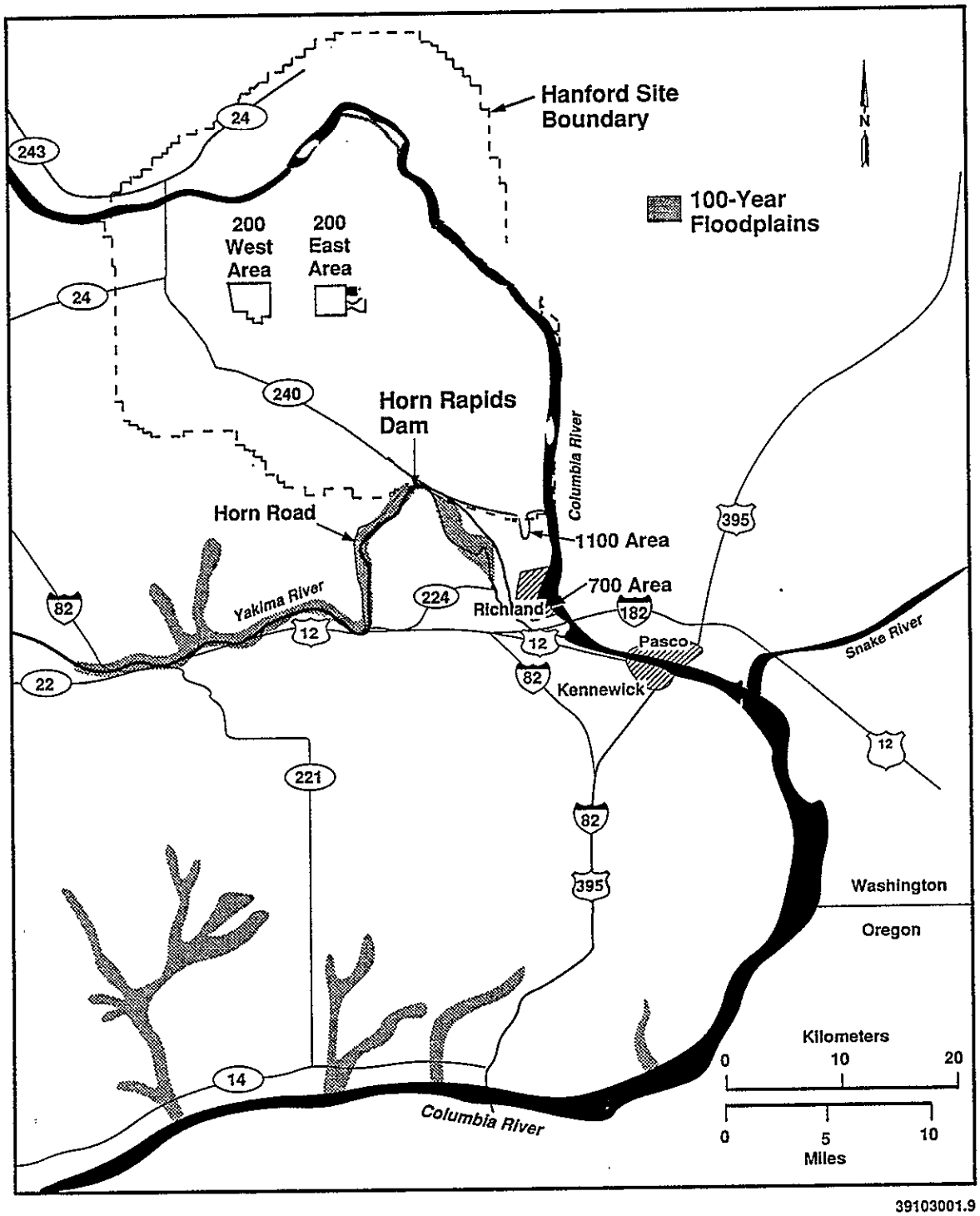

Figure 2-5. Yakima River Floodplain.

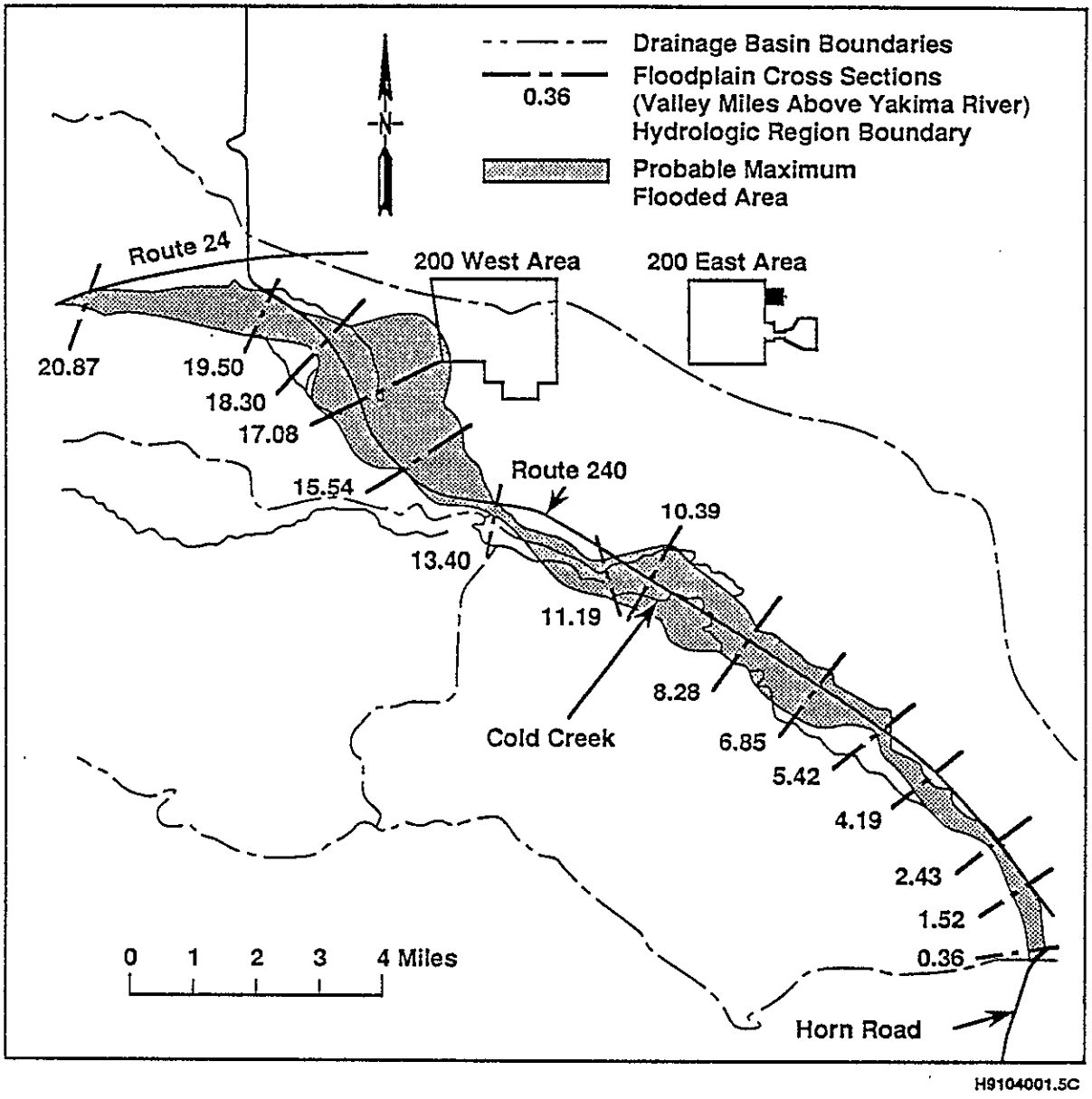

Figure 2-6. Cold Creek Watershed Floodplain (probable maximum flood).

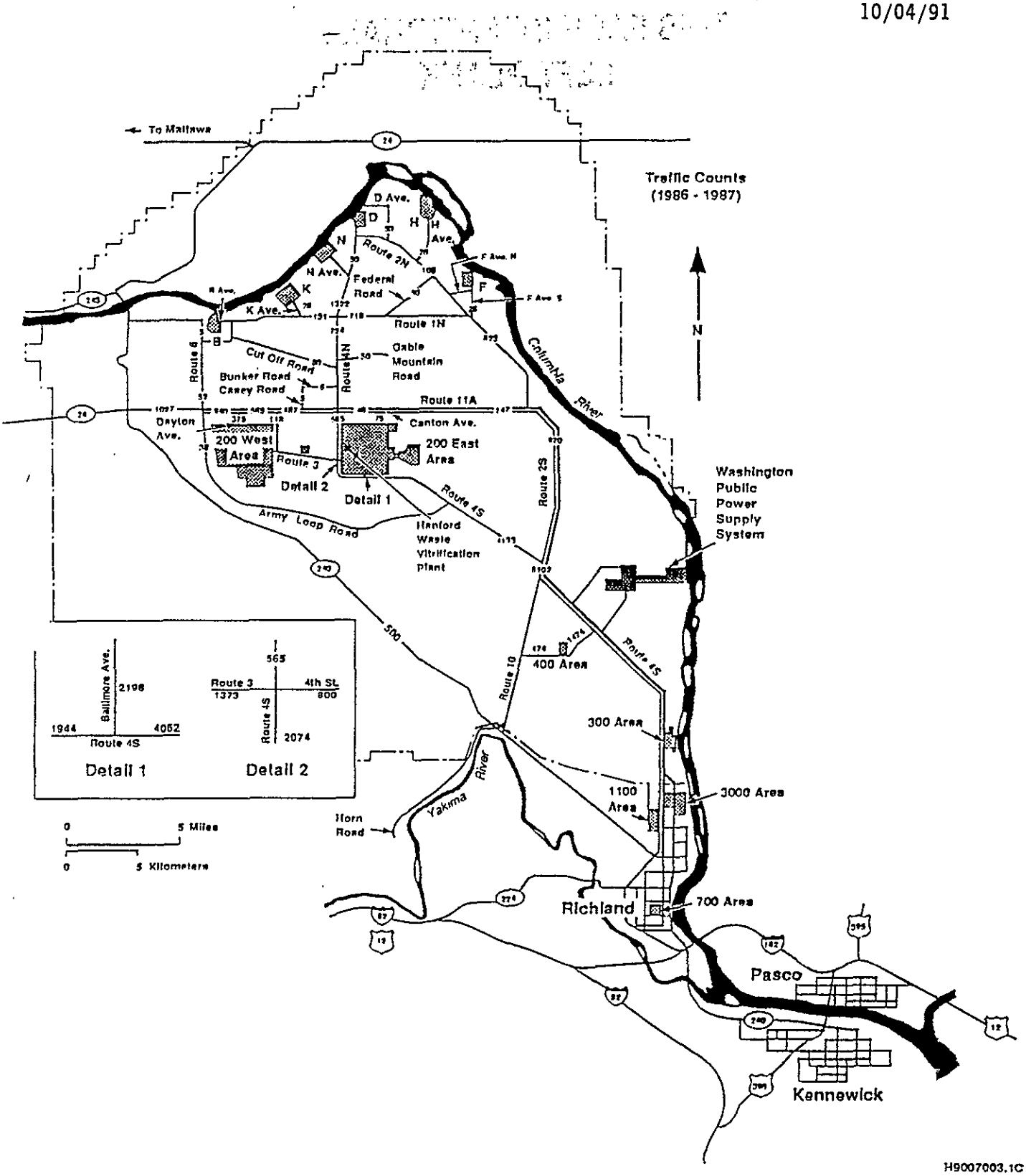

Figure 2-7. Estimated Traffic Volumes (vehicles per day).

PART I

OCCURRENCE REPORT

(Name of Facility)

[]
(Facility Function Involved)

(Name of Laboratory Site or Organization)

(Facility Manager/Designee and Org. Code)

(Originator)

1. OCCURRENCE REPORT NUMBER:

2. REPORT TYPE AND DATE: DATE TIME

[] Notification Report
[] 10-Day Report
[] Latest 10 Day Update
[] Final

3. OCCURRENCE CATEGORY: []

4. DIVISION OR PROJECT: []

5. DOE PROGRAM OFFICE: []

6. SYSTEM, BLDG., OR EQUIPMENT: 7. UNCI: 8. PLANT AREA

9. DATE AND TIME DISCOVERED:
10. DATE AND TIME CATEGORIZED:
11. DATE AND TIME OF DOE PROGRAM NOTIFICATION(S):
12. DATE AND TIME OF OTHER NOTIFICATIONS:

13. SUBJECT OR TITLE OF OCCURRENCE:

14. NATURE OF OCCURRENCE: []

Figure 2-8. Typical Occurrence Report. (sheet 1 of 4)

9 2 1 2 4 . 3 5 7

15. DESCRIPTION OF OCCURRENCE:

16. OPERATING CONDITIONS OF FACILITY AT TIME OF OCCURRENCE:

17. ACTIVITY CATEGORY: []

18. IMMEDIATE ACTIONS TAKEN AND RESULTS:

END OF NOTIFICATION REPORT

19. DIRECT CAUSE: []
20. ROOT CAUSE: []
21. CONTRIBUTING CAUSE(S): []

22. DESCRIPTION OF CAUSE:

23. EVALUATION: (By Facility Manager/Designee)

24. IS FURTHER EVALUATION REQUIRED? [] Yes [] No
IF YES, BEFORE FURTHER OPERATION? [] Yes [] No
BY WHOM:
BY WHEN:

25. CORRECTIVE ACTIONS:

TARGET COMPLETION DATE: COMPLETION DATE:

26. IMPACT ON ENVIRONMENT, SAFETY AND HEALTH:

Figure 2-8. Typical Occurrence Report. (sheet 2 of 4)

27. PROGRAMMATIC IMPACT:

28. IMPACT UPON CODES AND STANDARDS:

29. FINAL EVALUATIONS AND LESSONS LEARNED:

30. SIMILAR OCCURRENCE REPORT NUMBERS:

31. DOE FACILITY REPRESENTATIVE INPUT:

32. DOE FACILITY REPRESENTATIVE NAME AND POSITION:

END OF PART I

Figure 2-8. Typical Occurrence Report. (sheet 3 of 4)

PART II

OCCURRENCE REPORT NUMBER:

33. QUEST SUBJECT CODE:

34. QUEST CONTRIBUTING FACTOR CODE:

35. QUEST ROOT CAUSE CODE:

36. PRIORITY/SEVERITY CATEGORY:

37. FACILITY MANAGERS ORGANIZATION CODE:

38. SIGNATURES:

Approved by: _____ Date: _____
Facility Manager

Reviewed by: _____ Date: _____
Impacted Oversight Organization

Reviewed by: _____ Date: _____
Impacted Oversight Organization

Reviewed by: _____ Date: _____
Impacted Oversight Organization

Reviewed by: _____ Date: _____
ADC/UCNI

Figure 2-8. Typical Occurrence Report. (sheet 4 of 4)

Table 2-1. Hanford Facility Treatment, Storage, and/or Disposal Units.*

Unit	Area	Class
242-A Evaporator	200E	T
Grout Treatment Facility	200E	TD
T Plant Treatment Tank	200W	T
241-Z Treatment Tank	200W	T
B Plant	200E	TS
222-S Laboratory Complex Treatment and Storage Tanks and Storage Area	200W	TS
204-AR Waste Unloading Station	200E	T
PUREX Plant	200E	TS
Hanford Waste Vitrification Plant	200E	TS
242-A Evaporator/PUREX Plant Condensate Treatment Facility	200E	T
Double-Shell Tank System	200EW	TS
PUREX Storage Tunnels	200E	S
TRUSAF	200W	S
Hanford Central Waste Complex--Radioactive Mixed Waste Storage Facility and the Waste Receiving and Processing Facility	200W	TS
Liquid Effluent Retention Facility	200E	S
Low-Level Burial Grounds	200EW	D
325 Waste Treatment Facility	300	TS
Biological Treatment Test Facilities	300	TS
Physical and Chemical Treatment Facilities	300	TS
Thermal Treatment Test Facilities	300	TS
305-B Storage Unit	300	S
Maintenance and Storage Facility	400	T
Hanford Patrol Academy Demolition Site	600	T
616 Nonradioactive Dangerous Waste Storage Facility	600	S
600 Area Purgewater Storage and Treatment Facility	600	TS

Unit--Name of TSD unit that is designated to receive a final status permit as part of the Hanford Facility (EPA/State Identification Number WA7890008967).

Area--The area of the Hanford Facility in which the unit is located:

200E	-- 200 East Area	300	-- 300 Area
200W	-- 200 West Area	400	-- 400 Area
200EW	-- Parts of a unit are located in both the 200 East and the 200 West Areas	600	-- 600 Area.

Class--Waste unit operational classification
- T--Treatment
- S--Storage
- D--Disposal

* This table does not include the 2727-WA SRE Sodium Storage Building and the 332 Storage Facility. Ecology has approved the petition to withdraw the Part A permit applications for these units but has not yet completed the full administrative process necessary to formally complete the withdrawal.

CONTENTS

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3.0 WASTE CHARACTERISTICS [C]

This chapter provides general information on the chemical, biological, and physical characteristics of the waste treated, stored, and/or disposed of on the Hanford Facility. General information provided in this chapter covers the following areas:

- Chemical, biological, and physical analysis
- Waste analysis plan
- Land disposal restrictions.

Detailed information on the characteristics of the waste treated, stored, and/or disposed of at individual TSD units will be contained in unit-specific permit applications.

3.1 CHEMICAL, BIOLOGICAL, AND PHYSICAL ANALYSIS [C-1]

The Hanford Facility treats, stores, and/or disposes of dangerous and/or mixed waste designated as: (1) characteristic dangerous waste; (2) toxic, carcinogenic, and persistent (by WAC 173-303 criteria); and (3) listed (because the waste contains small amounts of spent solvents and discarded pure chemical products). The waste form ranges from liquid to hard crystalline material (e.g., salt cake stored in tank farms), as well as contaminated equipment, paper, rags, etc. A general overview of waste characteristics and process information for each TSD unit is contained in Chapter 4.0.

Specific information on the characteristics and volume of waste that could be handled by each TSD unit is contained in the *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b), Set 1 of this permit application. Part A permit application information is based primarily on process information with supplemental information provided by sampling and analysis programs.

3.2 WASTE ANALYSIS PLAN [C-2]

The RCRA and WAC 173-303 regulations require that all dangerous waste be properly managed. 'Properly managed' in this context means having sufficient knowledge to ensure proper handling of the waste. For offsite shipments of waste, the regulations specifically require that verification be made using 'chemical, physical (visual), or biological analysis'. For onsite shipments, such analytical verification is not specifically required.

At present, Hanford Facility waste moved onsite is designated by a waste designation organization, and is verified through certification audits. This approach is considered to comply with the regulatory requirement to ensure proper waste management.

To more fully evaluate and to further define the requirements for waste moved onsite and for waste received from offsite generators, a Hanford Facility waste analysis plan will be prepared in accordance with RCRA and WAC 173-303 regulations. The plan for waste to be managed onsite will use the current Hanford Facility program as its basis. Additional quality assurance and quality control requirements will be imposed in the plan to further ensure that waste generating operations properly manage waste (i.e., require waste analyses adequate to ensure proper designation, appropriate and reliable packaging, safe and secure storage, and proper treatment and disposal). The Hanford Facility waste analysis plan will be designed to complement the unit-specific waste analysis plans.

The Hanford Facility waste analysis plan will be approached in two phases.

Phase I: Develop and obtain consensus on an overall waste analysis plan, including the waste verification strategy. This will include contractor development and review, U.S. Department of Energy review, and Ecology and EPA review. The plan will include an implementation strategy and schedule that defines the actions needed to implement this plan and the timetable for doing so.

Phase II: Implement the waste analysis plan. Implementation will include establishment of the organization to do the quality assurance reviews and to develop or upgrade procedures for the Hanford Facility and at each of the impacted TSD units. Implementation also would include defining the procedures used to gather laboratory samples or the extent of physical verification.

Because of the complexity of the Hanford Facility waste analysis plan, this plan is not available for incorporation in the initial *Hanford Facility Dangerous Waste Permit Application*. The plan will be prepared in accordance with a schedule enabling a final product for Phase I to be provided to EPA and Ecology by February 28, 1992. The completed Phase I plan will be incorporated in the Hanford Facility permit as a future permit modification. A schedule for implementing Phase II will be contained in the Hanford Facility waste analysis plan.

3.3 LAND DISPOSAL RESTRICTIONS

The Hanford Facility generates and/or manages dangerous waste that is subject to the land disposal restrictions of 40 CFR 268 and WAC 173-303. Under the regulations, some waste is prohibited from land disposal. Other waste can be land disposed of, if the waste can meet certain treatment standards specified in 40 CFR 268, Subpart D. The best demonstrated available technologies also are specified in the regulations for some waste in lieu of meeting a specific concentration requirement.

Provisions in the Tri-Party Agreement allow for the storage of land disposal restricted waste in lieu of compliance with 40 CFR 268.50.

Waste analysis or process knowledge will be used (Section 3.2) to determine if land disposal restrictions apply to the waste. If the waste does not meet the applicable treatment standards, the following information will be provided in a written notification with each shipment sent to the offsite TSD facility:

- The waste code(s)
- The applicable treatment standards
- The waste transfer document number associated with the waste shipment
- The waste analysis data (if available).

If the waste meets the applicable treatment standards, notification and a certification will be sent to each offsite TSD facility that the waste meets the treatment standards. Generating units retain copies of these records and all waste analysis data until closure of the unit.

For waste managed at onsite TSD units, a waste tracking system is in place to document the transfer of waste subject to land disposal restrictions. Copies of land disposal restriction documentation are available by contacting the Regulatory File Custodian.

Should it become necessary to seek an exemption from a disposal prohibition pursuant to 40 CFR 268.6, an extension to the effective date of any land disposal restriction pursuant to 40 CFR 268.5, a variance from a treatment standard pursuant to 40 CFR 268.44, or an exemption pursuant to WAC 173-303-140(6), the records documenting the quantities and date each waste was placed in onsite or offsite land disposal units under such exemption, extension, or variance will be maintained as required by 40 CFR 264.73(10).

Required manifests will be completed for waste shipped to an offsite TSD facility. The records documenting that the waste, shipped from the Hanford Facility to an offsite TSD facility, meets the standards required by 40 CFR 268, Subpart D, will be maintained by the TSD unit as required by 40 CFR 264.73. All demonstration and certification records required for exempting waste from land disposal prohibitions, for extension of an effective date, or variance from a treatment standard will be maintained by the appropriate contractor. The notifications required by 40 CFR 268.7(a)(1) for a treatment facility and by 40 CFR 268.7(a)(2) for a disposal facility will be prepared to accompany the offsite waste shipments. Copies of the notifications will be maintained as an operating record as required by 40 CFR 264.73. Copies are accessible by contacting the Hanford Facility Regulatory File Custodian (Chapter 12.0).

3.4 ORGANIC AIR EMISSIONS

The organic air emissions released from Hanford Facility process vents are regulated under RCRA (40 CFR 264 Subpart AA and 40 CFR 265 Subpart AA). These regulations apply to process vents associated with specific separation

processes, identified in 40 CFR 264.1030(b) and 40 CFR 265.1030(b), that are used to manage hazardous waste with organic concentrations of at least 10 parts per million by weight. Threshold limits that require emission controls apply to the summation of all applicable emission sources for the entire Hanford Facility. To determine whether the threshold limits are exceeded, thereby requiring emission controls, the applicable processes were identified first for each TSD unit. The TSD units that have the potential processes identified in the regulations are as follows:

- B Plant
- PUREX Plant
- 242-A Evaporator
- Double-Shell Tank System
- 222-S Laboratory Complex
- Maintenance and Storage Facility.

These TSD units were evaluated for purposes of addressing the Subpart AA regulations. A conservative summation of the organic air emissions resulted in a release rate of 0.1 pound (0.045 kilogram) per hour or 0.438 ton (398 kilograms) per year. This release is well below the threshold of 3 pounds (6.6 kilograms) per hour or 3.1 tons (2,818 kilograms) per year. The amount of organic emissions might change as new TSD units (e.g., Hanford Waste Vitrification Plant) or standby TSD units (e.g., PUREX Plant) are brought on line. These actions would require a new determination of emissions and, possibly, a permit modification at that time.

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4.0 PROCESS INFORMATION [D]

This chapter presents information on the various processes that are used in the management of dangerous waste and mixed waste at the Hanford Facility. Dangerous waste and mixed waste units on the Hanford Facility that will be permitted under final status include a variety of TSD units. These TSD units include container storage units, surface impoundments, waste piles, tank systems, and miscellaneous units, unique units not fitting into an established category for a TSD unit.

Part A permit applications have been submitted and are included in the *Hanford Site Dangerous Waste Part A Permit Application* (DOE-RL 1988b) for all known TSD units at the Hanford Facility. For each TSD unit requiring development of a final status permit, the following information is provided in this chapter: the classification of the TSD unit (e.g., surface impoundment, container storage unit etc.); the type of waste processed at the TSD unit (dangerous and/or mixed waste); and a brief description of the waste management process or processes conducted at the TSD unit.

Also included in this chapter is a description of processes used to control the design and operation of TSD units located on the Hanford Facility. The transmittal of design information to the regulatory agencies and certification of permitting activities by an independent registered professional engineer are addressed. Activities conducted on the Hanford Site that do not involve the management of dangerous waste or mixed waste are not regulated under RCRA and therefore are not addressed in this chapter.

Information presented in this chapter has been compiled from existing documents and is current as of September 15, 1991. The following documents have been used as sources of information: *Hanford Site Dangerous Waste Part A Permit Application*, *Environmental Restoration and Waste Management Site-Specific Plan for the Richland Operations Office: Hanford Cleanup Five-Year Plan* (DOE-RL 1989b), and the Tri-Party Agreement.

4.1 OVERVIEW

The Hanford Facility generates dangerous and mixed waste, and treats, stores, and disposes of dangerous and mixed waste that is generated onsite. Mixed waste that is generated offsite also is managed within certain TSD units on the Hanford Facility. A further discussion of waste generating units is provided in Chapter 2.0.

The waste managed on the Hanford Facility includes low-activity and high-activity waste, low activity and high-activity mixed waste, transuranic waste, transuranic mixed waste, and nonradioactive dangerous waste. As presently planned, high-activity waste and high-activity mixed waste will be treated at the Hanford Waste Vitrification Plant (as required) and transported offsite for disposal in a national repository. Low-activity waste and low-activity mixed waste will be treated (as required) and disposed of at an appropriate location on the Hanford Facility. Stored transuranic waste and

transuranic mixed waste will be packaged (as required) and transported offsite for disposal at the WIPP (when WIPP becomes operational) or another transuranic waste disposal site. Nonradioactive dangerous waste either will be recycled, transported offsite for treatment, storage, and/or disposal, or processed and disposed of on the Hanford Facility in a RCRA-compliant disposal unit.

The TSD units to be permitted on the Hanford Facility are centralized in four numerically designated areas, the 200, 300, 400, and 600 Areas. These areas and their relationship are discussed in Chapter 2.0. Process information for TSD units in each of the four areas is presented in this chapter in the same order as the *Hanford Facility Dangerous Waste Part A Permit Application*. The individual Part A permit applications (Form 3s) should be referred to for the identification of specific dangerous waste codes, process design capacities, and estimated quantities of waste handled on an annual basis. The TSD units are located on maps contained in Appendix 2A.

All units to be discussed, except where noted, will be operated under interim status until a final facility permit chapter for that unit is issued.

4.2 THE 200 AREAS

The 200 Areas encompass the chemical separations plants for the reprocessing of nuclear materials as well as radioactive waste storage and disposal. These processing plants generated various dangerous, radioactive, and mixed waste that were discharged to the soil column or stored in underground storage tanks (referred to as tank farms). The original mission for the plants in the 200 Areas was in support of nuclear weapons development and production. The current mission has recently focused on environmental remediation and restoration.

A total of 16 Part B permit applications will be developed and submitted for TSD units located in the 200 Areas. The TSD units include RCRA treatment, storage, and/or disposal units. On finalization, the TSD permits will be included as chapters in the Hanford Facility Permit.

4.2.1 Treatment Units

Treatment units located in the 200 Areas to be permitted for final status are discussed in the following sections.

4.2.1.1 The 242-A Evaporator. The 242-A Evaporator is a miscellaneous treatment unit located in the 200 East Area. The 242-A Evaporator consists of process vessels and support systems for heating, evaporating, and condensing waste stored in the Double-Shell Tank System. The 242-A Evaporator receives a mixed waste stream from the Double-Shell Tank System that contains organic and inorganic constituents and radionuclides. Processing of the waste at the 242-A Evaporator results in two mixed waste streams. One mixed waste stream (slurry) contains the majority of the radionuclides and inorganic constituents (an extremely hazardous mixed waste) and one mixed waste stream (process

condensate) contains greatly reduced concentrations of radionuclides and the volatile organic materials (a dangerous waste containing de minimus quantities of radionuclides). The slurry is routed back to the Double-Shell Tank System where the slurry is stored pending further treatment. The process condensate will be discharged to the Liquid Effluent Retention Facility where the condensate is stored until an effluent treatment system becomes operational.

This unit will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.2 Grout Treatment Facility. The Grout Treatment Facility, located in the 200 East Area, is categorized as a surface impoundment, miscellaneous treatment unit, and a landfill disposal unit. The Grout Treatment Facility receives selected mixed waste from the Double-Shell Tank System. The waste is mixed with grout forming solids and, if necessary, chemical liquid additives in an in-line mixer. This process (miscellaneous treatment) forms a cementious slurry, which is pumped to a lined concrete disposal vault. The disposal vaults are managed as surface impoundments when the grout slurry is liquid and closed as landfills after the grout slurry has hardened. A total of 43 individual disposal vaults are planned for the Grout Treatment Facility.

The Grout Treatment Facility will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.3 The T Plant Treatment Tank. The T Plant Treatment Tank is a treatment tank located in the 200 West Area. Mixed waste decontamination solutions (corrosive mixed waste) resulting from decontamination activities conducted at T Plant are collected and transferred into the T Plant Treatment Tank. In the treatment tank, the pH of the waste is adjusted by the addition of chemicals to meet the corrosion protection requirements of the Double-Shell Tank System. Once the pH of the waste is within the desired range, the waste is transferred to the Double-Shell Tank System for storage.

This unit will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.4 The 241-Z Treatment Tank. The 241-Z Treatment Tank is a tank treatment unit located in the 241-Z Building of the 200 West Area. Mixed waste generated at the Plutonium Finishing Plant (234-5Z) is transferred into the 241-Z Treatment Tank. In the treatment tank, chemicals are added to adjust the pH of the waste to meet the corrosion protection requirements of the Double-Shell Tank System and to ensure aluminum compounds remain solubilized. Following treatment, the waste is pumped to a collection tank and transferred to the Double-Shell Tank System for storage.

The 241-Z Treatment Tank will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.5 The B Plant. The B Plant is located in the 200 East Area and is categorized as a tank and miscellaneous treatment unit as well as a container, tank, and waste pile storage unit. The B Plant receives and treats neutralized current acid waste feed generated by the PUREX Plant, as well as

waste received from the Waste Encapsulation and Storage Facility. Settle-decant operations (tank treatment) are used for the primary solid and liquid separation and solid washing steps. The decanted solution and solid wash waste are treated by polishing filtration accomplished with a sintered metal filter. Cesium is removed from the decant stream by ion exchange. Ion exchange wash streams, flush solutions, process building drainage, and waste received from the Waste Encapsulation and Storage Facility are concentrated in a single-stage thermal siphon reboiler (miscellaneous treatment). The treated waste is transferred to the Double-Shell Tank System for storage.

Mixed waste is stored at B Plant in containers, tanks, and waste piles. Radioactively contaminated lead and chromium based paint waste, and radioactively contaminated spent sodium and mercury vapor light bulbs are stored in 55-gallon (208-liter) drums (container storage). Radioactive organic waste solvents are stored in seven tanks (TK-26-1, TK-27-3, TK-27-4, TK-28-3, TK-28-4, TK-29-4, and TK-30-3) (tank storage). Storage of mixed waste in waste piles also is performed on the canyon deck at B Plant. The waste stored in the waste piles consists primarily of radioactive process jumpers with lead counterbalances.

The B Plant will be operated under interim status until the final facility permit chapter for this unit is issued. A risk assessment also is underway for B Plant that has the potential to influence the permitting of B Plant. (Refer to footnote in Section 2.0, page 2-3.)

4.2.1.6 The 222-S Laboratory Complex Treatment and Storage Tanks and Storage Area. The 222-S Laboratory Complex is a container storage and tank storage and treatment unit located in 200 West Area. The 222-S Laboratory Complex provides analytical support services for the Hanford Site and includes tanks for treatment and storage of dangerous and mixed waste generated from analytical operations. The treatment and storage tanks associated with the 222-S Laboratory Complex consist of the 219-S Waste Handling Facility and the Dangerous and Mixed Waste Storage Area. The 219-S Waste Handling Facility consists of a primary treatment/storage tank (TK-102), a backup storage tank (TK-103), and a third storage tank (TK-101). Mixed waste generated by the 222-S Laboratory flows by gravity to the 219-S Waste Handling Facility tank(s). In the 219-S Waste Handling Facility treatment tank (TK-102), the pH of the waste is adjusted to meet the corrosion protection requirements of the Double-Shell Tank System before transfer to the Double-Shell Tank System. The Dangerous and Mixed Waste Storage Area is a concrete area located on the north side of the 222-S Laboratory that contains six metal storage containers. The two containers on the east end of the storage area are used for the storage of 55-gallon (208-liter) drums (labpacks) containing dangerous and/or mixed waste. The other four containers store nonregulated materials.

The 222-S Laboratory Complex Treatment and Storage Tanks and Storage Area will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.7 The 204-AR Waste Unloading Station. The 204-AR Waste Unloading Station is a miscellaneous treatment unit that is used for the unloading and treatment of liquid mixed waste received from railroad tank cars. The waste

is generated from decontamination and regeneration operations in the 100 Area; from processing operations at the 200 Areas; from recovery, fuels fabrication, and laboratory operations in the 300 Area; and from decontamination operations in the 400 Area. During unloading operations, the pH of the waste is adjusted chemically in-line during pump out to meet the corrosion protection requirements of the Double-Shell Tank System.

The 204-AR Waste Unloading Station will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.8 The PUREX Plant. The PUREX Plant is a tank treatment and waste pile storage unit located in the 200 East Area. The PUREX Plant treats and stores mixed waste generated during nuclear fuel processing operations. There are seven tanks used at the PUREX Plant for the treatment of mixed waste, tanks E-5, E-F11, F-15, F-16, F-18, U-3, and U-4. Various treatment processes are conducted in the tanks. Treated mixed waste is transferred to the Double-Shell Tank System for storage.

Process equipment containing mixed waste (lead) and lead removed from jumpers is stored on the canyon deck in waste piles. Periodically, the mixed waste in the waste pile is removed and transferred to another Hanford Facility TSD unit for further storage or treatment.

The PUREX Plant has been placed in standby and will remain in this condition until the record of decision on the irradiated fuel environmental impact statement is issued. The record of decision (not expected to be issued before July 1993) will determine if irradiated fuel will be processed in the future at the PUREX Plant. Should the determination be made not to process irradiated fuel at the PUREX Plant, alternate missions that might or might not include closure will be considered.

The PUREX Plant will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.1.9 Hanford Waste Vitrification Plant. The Hanford Waste Vitrification Plant is a treatment and storage and miscellaneous unit. The Hanford Waste Vitrification Plant will be located in the 200 East Area and will treat and store the high-activity and transuranic fraction of waste contained within the Double-Shell Tank System. This mixed waste, received from a pretreatment unit, will be treated in a series of tanks and a melter, classified as a miscellaneous unit. Treatment will include concentration by evaporation, adjustment with chemicals and glass forming materials, and immobilization in borosilicate glass (vitrification). The melter and the waste treatment tanks will be capable of storing dangerous waste under offnormal conditions.

Secondary liquid mixed waste generated by the Hanford Waste Vitrification Plant will be collected and treated in a series of tanks. Treatment will include neutralization, filtration, sorption, and evaporation. The high-activity fraction from the treatment process will be recycled. The remainder will be transferred to the Double-Shell Tank System.

Secondary nonradioactive dangerous waste generated from leaks, spills, and/or overflows from chemical storage, makeup, and feed tanks will be collected, treated in a series of tanks, and stored at the HWVP. Treatment will include neutralization, concentration by solar evaporation, and decomposition of dangerous constituents during storage.

The vitrified waste will be cast into stainless steel canisters and stored at the Hanford Waste Vitrification Plant until the canisters are shipped to a national repository. Canisters of vitrified waste will be stored at the Hanford Waste Vitrification Plant.

A final facility permit chapter for this unit will be issued before the initiation of construction of the Hanford Waste Vitrification Plant. The unit-specific permit application for this unit is provided as Chapter 2.0 of Set 3 of this permit application.

4.2.1.10 The 242-A Evaporator/PUREX Plant Condensate Treatment Facility. The 242-A Evaporator/PUREX Plant Condensate Treatment Facility is a tank treatment unit that will be located in the 200 East Area. This unit will be operated to treat mixed waste process condensate from the 242-A Evaporator and two nonregulated PUREX Plant waste streams. The treatment process is expected to include filtration, pH adjustments, ultraviolet light oxidation, reverse osmosis, and ion exchange. Treated effluent will be collected in the quality verification tanks, sampled to verify treatment standards have been met, and discharged to the soil. The secondary waste generated by the process will be concentrated and disposed of at a solid waste disposal site.

The 242-A Evaporator/PUREX Plant Condensate Treatment Facility will be constructed and operated under interim status expansion until the final facility permit chapter for this unit is issued. A research, development, and demonstration permit currently is being pursued for a waste water pilot plant supporting this unit.

4.2.2 Storage Units

Storage units located in the 200 Areas to be permitted for final status are discussed in the following sections.

4.2.2.1 Double-Shell Tank System. The Double-Shell Tank System is a tank treatment and storage unit located in the 200 East and West Areas. The Double-Shell Tank System is used to treat and store mixed waste generated by Hanford Site operations. The Double-Shell Tank System includes 28 one-million gallon tanks, four smaller tanks in concrete vaults, and ancillary equipment such as diversion boxes and waste transfer pipelines. The tanks provide long-term storage for mixed waste generated at several locations on the Hanford Facility. Waste is treated by evaporation and by the addition of chemicals to control corrosion. The waste eventually will be retrieved, treated as necessary, and disposed of.

The Double-Shell Tank System will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.2.2 The PUREX Storage Tunnels. The PUREX Storage Tunnels are miscellaneous storage units located in the 200 East Area next to the PUREX Plant. The PUREX Storage Tunnels include two underground railroad storage tunnels that are used for the long-term storage of process equipment removed from the PUREX Plant. Since being placed into service, various types of equipment containing mixed waste have been stored in the tunnels on railroad cars. The major components of the PUREX Storage Tunnels include the water-fillable doors, the storage area, and the ventilation system. Tunnel number 1 provides storage space for eight railroad cars. Between June 1960 and January 1965, all eight railroad car positions were filled and the tunnel subsequently sealed. Tunnel Number 2 is considerably longer that Tunnel Number 1 and provides storage space for 40 railroad cars. The first railroad car was placed in Tunnel Number 2 in December 1967.

The PUREX Storage Tunnels will be operated under interim status until the final facility permit chapter for this unit is issued.

4.2.2.3 Transuranic Waste Storage and Assay Facility. The Transuranic Waste Storage and Assay Facility (TRUSAF) is a container storage unit located in the 200 West Area. The TRUSAF is used to store and analyze mixed waste generated nationally by various U.S. Department of Energy processing facilities. The waste is shipped to the Hanford Facility for interim storage and handling and eventually will be shipped to the WIPP (when WIPP becomes operational) or another transuranic waste disposal site. The TRUSAF operation consists of a nondestructive analysis of transuranic waste. The analysis is used as an overview for sealed, transuranic solid-waste packages to verify general compliance with the WIPP waste acceptance criteria. Those containers meeting WIPP waste acceptance criteria are stored at TRUSAF and maintained in a manner to retain the container certification. Those containers not meeting WIPP waste acceptance criteria are repackaged or returned to the generator.

The TRUSAF will be operated under interim status the final facility permit chapter for this unit is issued.

4.2.2.4 Hanford Central Waste Complex. The Hanford Central Waste Complex, located in the 200 West Area, is categorized as a container storage and miscellaneous treatment unit. The Hanford Central Waste Complex is used to treat and store mixed waste. The mixed waste includes waste generated from various operations both on and off the Hanford Facility. The Hanford Central Waste Complex consists of a Radioactive Mixed Waste Storage Facility (existing) and a consolidated Waste Receiving and Processing Facility (to be constructed). The Radioactive Mixed Waste Storage Facility currently consists of 13 buildings, eight low-flash-point modules, two pads, and various support units. The Waste Receiving and Processing Facility will be a treatment unit and will have the capability to change the physical form of the mixed waste through compaction (volume reduction), repackaging, solidification of liquids, and through neutralization of corrosives.

The Radioactive Mixed Waste Storage Facility and the Waste Receiving and Processing Facility will be operated and expanded under interim status until the final facility permit chapter (or chapters) for this unit is issued.

4.2.2.5 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility, located in the 200 East Area, is categorized as a surface impoundment and miscellaneous storage unit. The Liquid Effluent Retention Facility will be used to provide interim storage of mixed waste effluent (process condensate) received from the 242-A Evaporator. The mixed waste will be stored until a treatment unit is available. The Liquid Effluent Retention Facility is a retention basin consisting of four cells (surface impoundments). Each cell of the basins is constructed with two liners: a leachate collection system between the liners and a floating cover.

The Liquid Effluent Retention Facility will be constructed and operated under interim status expansion until the final facility permit chapter for this unit is issued.

4.2.3 Disposal Units

The only disposal unit located in the 200 Areas to be permitted for final status is the Low-Level Burial Grounds.

The Low-Level Burial Grounds are categorized as a landfill. The Low-Level Burial Grounds are divided into eight burial grounds. Each burial ground consists of a number of trenches. Six burial grounds are located in the 200 West Area and two burial grounds are located in the 200 East Area. The Low-Level Burial Grounds currently accepts for disposal low-level radioactive waste and disposes of mixed waste according to its characteristics. The mixed waste is generated by many different operations, both on and off the Hanford Facility. The waste is packaged in steel, concrete, or wooden containers and placed in the burial trenches. Since 1987, most mixed waste, other than submarine reactor compartments, is being stored at the Central Waste Complex until a lined disposal trench is constructed.

The Low-Level Burial Grounds will be operated under interim status until the final facility permit chapter for this unit is issued.

4.3 THE 300 AREA

The 300 Area historically was used for the fabrication of the 100 Area reactor fuels and for the main research and development activities for the Hanford Site. Fuels fabrication activities ceased when N Reactor was placed in standby. Current activities include research and development supporting the environmental remediation and restoration mission, including the development of new technologies for the treatment and disposal of the waste accumulated throughout the life of the Hanford Site. A total of 14 TSD units are located at the 300 Area.

A total of five Part B permit applications will be developed and submitted for TSD units located in the 300 Area. The TSD units include both treatment and storage units.

4.3.1 Treatment Units

Treatment units located in the 300 Areas to be permitted for final status are discussed in the following sections.

4.3.1.1 The 325 Waste Treatment Facility. The 325 Waste Treatment Facility, categorized as a miscellaneous treatment unit, is located in rooms 520, 522, 524, 528, and 530 of the 325 Building. The 325 Waste Treatment Facility is used to treat small quantities of diverse chemicals and mixed waste generated from ongoing research and development activities. The 325 Waste Treatment Facility treats mixed waste by grouting and other processes and also serves as a research and development area to test and evaluate the effectiveness of thermal, physical, chemical, and biological treatment technologies.

This unit will be operated under interim status until the final facility permit chapter for this unit is issued.

4.3.1.2 Biological Treatment Test Facilities. The Biological Treatment Test Facilities are categorized as a miscellaneous treatment unit. The Biological Treatment Test Facilities are used to perform research, development, and testing of biological waste treatment technologies capable of treating dangerous waste. These technologies can treat various chemical constituents, such as organics, nitrates, chromium, and cyanide waste constituents in soil; effluents; and groundwater through the use of microorganisms (naturally present or organisms that are environmentally enhanced). Technologies are tested in selected laboratories in the 324, 325, and 331 Buildings; however, the technologies are being developed for future uses in other units and at dangerous waste remedial action locations.

The Biological Treatment Test Facilities will be operated under interim status until the final facility permit chapter for this unit is issued.

4.3.1.3 Physical and Chemical Treatment Test Facilities. Physical and Chemical Treatment Test Facilities are categorized as a miscellaneous treatment unit. The Physical and Chemical Treatment Test Facilities are used to perform research, development, and testing of physical and chemical waste treatment technologies for the treatment of mixed waste. These technologies are tested in hot cell complexes in the 324 and 325 Buildings and in selected laboratories in the 324 Building. The technologies are being developed for future uses in other units and at dangerous waste remedial action locations.

This unit will be operated under interim status until a final facility permit chapter for this unit is issued.

4.3.1.4 Thermal Treatment Test Facilities. The Thermal Treatment Test Facilities are categorized as a RCRA miscellaneous treatment unit. The Thermal Treatment Test Facilities are used to perform research, development, and testing of waste treatment technologies capable of treating mixed waste. These technologies are tested in the high bay and hot cell complex of the 324 Building, the in situ vitrification test site west of the 300 Area, the 116-B-6-1 Crib, and in other selected laboratories in the 324, 325, and

331 Buildings. The technologies are being developed for future uses in other units and at dangerous waste remedial action locations.

This unit will be operated under interim status until the final facility permit chapter for this unit is issued.

4.3.2 Storage Units

The only storage unit located in the 300 Area is the 305-B Storage Unit.

The 305-B Storage Unit is categorized as a container storage unit. The 305-B Storage Unit is used to receive, store, and prepare for shipment dangerous and mixed waste generated from Hanford Site programs. Waste managed at this unit is generated primarily in support of research and development activities. Waste is characterized by the generating unit as required for designation and transported to the 305-B Storage Unit by truck or light utility vehicle. On receipt at the 305-B Storage Unit the waste is placed into the proper storage areas depending on the waste type and quantity. When a sufficient quantity of waste has been accumulated, the waste is inspected for shipment, and transported to an onsite TSD unit (for mixed waste) or an offsite treatment, storage, and/or disposal facility (for dangerous waste).

This unit will be operated under interim status until the final facility permit chapter for this unit is issued.

4.4 THE 400 AREA

The 400 Area was developed for the experimentation of breeder reactor technologies, development of isotopes for medical uses, and development and testing of equipment and materials under high radiation fields. The Fast Flux Test Facility is the main reactor used in this experimentation. The TSD units located at the 400 Area supports operations of the Fast Flux Test Facility.

The only treatment unit in the 400 Area is the Maintenance and Storage Facility.

The Maintenance and Storage Facility is categorized as a tank treatment unit and is used for the maintenance and repair of equipment used in the Fast Flux Test Facility. The Maintenance and Storage Facility is used for the treatment of alkali metal waste, which consists primarily of sodium, a reactive dangerous waste. The Maintenance and Storage Facility treats dangerous waste by removing residual sodium from waste material. The process consists of placing sodium contaminated material in a tank and reacting surface sodium contamination with water.

The Maintenance and Storage Facility will be operated under interim status until the final facility permit chapter for this unit is issued.

4.5 THE 600 AREA

The 600 Area includes everything within the Hanford Facility boundary that is not within any other specific area, including but not limited to a centralized fire station (located between 200 East and West Area), a weather station, and a centralized waste handling and storage facility, the 616 Nonradioactive Dangerous Waste Storage Facility.

A total of three Part B permit applications will be developed and submitted for the TSD units located in the 600 Area. The TSD units include both RCRA treatment and storage units.

4.5.1 Treatment Unit

The only treatment unit in the 600 Area is the Hanford Patrol Academy Demolition Site.

The Hanford Patrol Academy Demolition Site, located west of the 300 Area, is categorized as a miscellaneous treatment unit. The Hanford Patrol Academy Demolition Site is used for the treatment, by detonation, of shock-sensitive or potentially explosive chemical waste. This waste exhibits the dangerous waste characteristic of reactivity and might be reactive in combination with various other waste.

The Hanford Patrol Academy Demolition Site will be operated under interim status until the final facility permit chapter for this unit is issued.

4.5.2 Storage Units

Storage units located in the 600 Area are discussed in the following sections.

4.5.2.1 The 616 Nonradioactive Dangerous Waste Storage Facility. The 616 Nonradioactive Dangerous Waste Storage Facility, located between the 200 East and 200 West Areas, is categorized as a container storage unit. The 616 Nonradioactive Dangerous Waste Storage Facility provides a centralized unit to receive, store, and prepare for offsite shipments of nonradioactive dangerous waste generated on the Hanford Facility. Before receipt of dangerous waste at the 616 Nonradioactive Dangerous Waste Storage Facility, the generating unit characterizes the waste, assigns waste codes according to Ecology *Dangerous Waste Regulations*, and packages the waste according to U.S. Department of Transportation regulations for hazardous materials. The waste is shipped to the 616 Nonradioactive Dangerous Waste Storage Facility by truck. Once a waste shipment is accepted from the transporter, 616 Nonradioactive Dangerous Waste Storage Facility personnel select an appropriate storage cell for each container, depending on the dangerous waste designation. Approximately 18 times per year, depending on the rate of waste accumulation, containers are remanifested, inspected for offsite shipment, and transported to a permitted offsite treatment, storage, and/or disposal facility.

This unit will be operated under interim status until a final facility permit chapter for this unit is issued. The unit-specific permit application for this unit is provided as Chapter 1.0 of Set 3 of this permit application.

4.5.2.2 The 600 Area Purgewater Storage and Treatment Facility. The 600 Area Purgewater Storage and Treatment Facility, located north of the 216-B-3 Pond System, is categorized as a miscellaneous storage and treatment unit. The 600 Area Purgewater Storage and Treatment Facility is used for interim storage and treatment of purgewater generated from the groundwater monitoring wells located throughout the Hanford Facility. The purgewater is generated when a groundwater monitoring well is developed or groundwater samples are obtained. The purgewater from a groundwater monitoring well is transported by tank truck and pumped directly into the 600 Area Purgewater Storage and Treatment Facility aboveground units. These units consist of six aboveground evaporation units. Treatment of the purgewater by evaporation is carried out in the six units.

The designation of purgewater as a dangerous waste is presently being evaluated. This unit will be operated under interim status until the Part A permit application is withdrawn or a final facility permit chapter for this unit is issued.

4.6 DESIGN AND OPERATIONAL INFORMATION

This section addresses the transmittal of design and operational information to the regulatory agencies. Also addressed in this section is the certification by an independent, registered professional engineer as required to support RCRA/dangerous waste permitting activities.

4.6.1 Transmittal of Design Information to Regulatory Agencies

Design of TSD units on the Hanford Facility is controlled in accordance with an established engineering control system. Standard engineering practices ensure that uniform methods are in place to control tasks such as design review, configuration control, change control, specification preparation, and review and approval requirements. These practices are used on all engineering, development, and project work on the Hanford Facility, which result in a documented design or deliverable hardware end item.

Development of and changes to design specifications and drawings related to TSD units on the Hanford Facility are carried out in accordance with the engineering practices of the contractor responsible for the activity. Although there is some variation among contractors, no work affecting design (excluding emergency response activities that will be conducted in accordance with unit contingency plans) is allowed to be performed at a TSD unit until an approved design drawing or appropriate engineering design directive has been issued. This process ensures that components and materials selected meet system requirements while providing a means for configuration control.

The regulation in WAC 173-303-830 requires that design changes, at a minimum, be submitted as Class 1 permit modifications. This requires that permit holders submit specific information regarding the design change to the regulatory agencies within 7 days after the change is put into effect. The magnitude of the work on the Hanford Facility that involves modifications to existing approved designs is very substantial, and the following approach will be used to address the modification process. Requirements specified in WAC 173-303-830 will be followed for design changes categorized as Class 2 or Class 3 permit modifications and for design changes categorized as Class 1 permit modifications requiring regulatory agency approval before implementation. Other Class 1 changes will be submitted on an annual basis in accordance with Chapter 1.0, Section 1.5, of this Part B permit application. Classification of permit modifications will be as established in Appendix I of WAC 173-303-830.

On an ongoing basis, a tabulation of design changes will be accessible through the Regulatory File Custodian (Chapter 12.0).

4.6.2 Utilization of Aperture Cards

Individual permit application chapters for TSD units on the Hanford Facility are prepared according to the requirements prescribed in WAC 173-303-806. These requirements specify inclusion of certain design information in the permit application including design drawings as well as other engineering data.

Design drawings included as part of a permit application will be provided in an 11-inch by 17-inch format. Drawings provided in this format, for the most part, will provide a sufficient degree of legibility to support permit application review. In selected cases, it might be necessary to enlarge certain portions of drawings to enhance legibility. To support this need, drawings included as part of a permit application also will be provided in an aperture card format.

4.6.3 Replacement or Upgrading With Functionally Equivalent Components

All maintenance on the Hanford Facility is controlled and performed in accordance with an established job control system. The job control system ensures that the proper documentation is prepared for the activity, and also provides a means to track work from initiation to completion.

The regulations in WAC 173-303-830, Appendix I, identify equipment replacement or upgrading with functionally equivalent components (e.g., pipes, valves, pumps, conveyors, controls) as a Class 1 modification to a permit. This requires that permit holders submit specific information regarding the use of functionally equivalent components to the regulatory agencies within 7 days after the change is put into effect. The magnitude of the work on the Hanford Facility that involves the use of functionally equivalent components is very substantial, and the following approach will be used to address the modification process. On an ongoing basis, a tabulation of functional

equivalency information (i.e., a listing of equivalent equipment substitutions) will be available through the Regulatory File Custodian (Chapter 12.0). Class 1 changes relating to functionally equivalent components will be submitted on an annual basis in accordance with Chapter 1.0, Section 1.5, of this permit application.

4.6.4 Independent Registered Professional Engineer Certification

Certification by an independent registered professional engineer is required to support RCRA/dangerous waste permitting activities on the Hanford Facility (e.g., tank integrity assessments, closure). Such certification, where required, will be conducted using a U.S. Department of Energy contractor or subcontractor. Employees of the U.S. Department of Energy will not be used to make the certifications. Contractor and/or subcontractor engineers conducting certification will be registered within Washington State or within a state having a reciprocal agreement with Washington State.

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5.0 GROUNDWATER MONITORING [E]

This chapter describes the groundwater monitoring activities for the Hanford Facility. These activities are structured to provide groundwater monitoring systems for individual TSD units that are operated as a dangerous waste surface impoundment, a waste pile, land treatment unit, or a landfill. The groundwater monitoring activities also support Milestone M-24-00 contained in the Tri-Party Agreement Action Plan. A description of the groundwater monitoring programs for individual TSD units are, or will be, provided in unit-specific permit applications or postclosure permit applications. These unit-specific groundwater monitoring programs are, or will be, designed to comply with Ecology regulations. These regulations are for units operating under both interim status (WAC 173-303-400) and final status (WAC 173-303-645 and WAC 173-303-806). The following is a generalized discussion of the RCRA groundwater monitoring requirements for a TSD unit. This discussion provides background information relevant to subsequent, more specific groundwater monitoring discussions.

The RCRA is implemented under two groundwater monitoring programs: interim-status and final-status monitoring. A TSD unit operating under interim status must have implemented a monitoring program to determine the impact of the unit on groundwater quality in the uppermost aquifer beneath the unit. The interim status program can take the form of either detection monitoring or assessment monitoring. At a minimum, a detection monitoring system must include one upgradient and three downgradient groundwater monitoring wells. A generalized configuration for such a system is shown in Figure 5-1.

Before the installation of a detection monitoring system, a groundwater monitoring plan must be developed and followed. This plan details well locations, procedures, and techniques for well installation; sample collection, preservation, and transportation; and sample analysis. Chain-of-custody control must be developed and followed. Additionally, data quality objectives related to precision, accuracy, representativeness, completeness, and comparability (PARCC parameters) requirements are specified [e.g., in a site-specific groundwater monitoring plan and a quality assurance project plan (QAPP)]. Also specified are statistical methods to be used to interpret groundwater monitoring data.

The detection monitoring system is used to establish background groundwater quality through quarterly sampling and analysis of several water quality parameters (as specified in 40 CFR 265.92) for 1 year. After the first year, sampling and analysis must be conducted annually for the parameters related to groundwater quality, and semiannually for the indicator parameters related to groundwater contamination [e.g., pH, specific conductance, total organic carbon (TOC), and total organic halogen (TOX)].

If a statistically significant increase in the groundwater concentration of an indicator parameter (or pH decrease) is observed in the downgradient wells (Figure 5-1) of the monitoring system, the regulatory agency is notified and a groundwater assessment monitoring program developed. The objective of

assessment monitoring is to determine if dangerous waste constituents have entered the groundwater and, if so, the concentration, rate, and extent of migration of the constituents. This determination is achieved through quarterly sampling and could require the installation of additional wells. Monitoring must continue at the TSD unit through the postclosure care period.

For the final status (permitted) TSD units, there is a three-stage groundwater monitoring program that involves detection, compliance, and corrective action, as warranted. A diagram depicting the sequence of the three stages of final status groundwater monitoring can be found in EPA (1989b, Figure 2.1). A final status detection monitoring system must include both background (generally upgradient) and compliance (generally downgradient) wells (Figure 5-1). Wells installed to support interim status may be used as final status monitoring wells. A groundwater monitoring plan, similar to the plan described for interim status monitoring, is developed to address each final status monitoring stage. Also specified in each plan, are statistical methods to be used to conduct and interpret groundwater monitoring data. The choice of an appropriate statistical method depends on the monitoring stage and the nature of the data. A flow chart that guides the selection of the appropriate statistical method to be used for data interpretation is presented in Figure 5-2.

In a final status detection monitoring program, the monitoring objective is to detect any impact of the TSD unit on groundwater quality in the uppermost aquifer beneath the unit. This is achieved by establishing appropriate background concentrations and statistically comparing the compliance well data to the background well data (Figure 5-1). If there is a statistically significant increase (or pH decrease) over background concentrations, a compliance monitoring program must be initiated.

In a compliance monitoring program, the monitoring objective is to determine whether groundwater protection standards have been exceeded. This is accomplished by comparing the concentration of a constituent of concern to groundwater protection standards, such as an alternate concentration limit, maximum concentration limit, area or natural background, or any other standards that constitute applicable, relevant, and appropriate requirements. Monitoring must continue at the TSD unit through the postclosure care period.

A third stage, a corrective action program, is initiated if a condition exists that warrants corrective action, e.g., significant exceedance of groundwater protection standards. Corrective action could consist of the removal or treatment in place of the dangerous constituents.

The remainder of this chapter includes a more specific discussion of the implementation of the Hanford Facility groundwater monitoring activities.

5.1 EXEMPTION FROM GROUNDWATER MONITORING REQUIREMENTS [E-1]

A waiver from the groundwater monitoring requirements as allowed under WAC 173-303-645 is not requested in this permit application. Any requests for

waivers from groundwater monitoring requirements will be included in unit-specific permit applications.

5.2 INTERIM STATUS PERIOD GROUNDWATER MONITORING DATA [E-2]

In 1986, interim status groundwater monitoring for four Hanford Facility TSD units was implemented through a *Consent Agreement and Compliance Order* (Ecology 1986). Three of these units are to be closed under interim status, and are not within the scope of the Hanford Facility Permit Application. As specified in the Tri-Party Agreement Action Plan, a permit application for the remaining unit, the Low-Level Burial Grounds, was submitted in 1989. Final status permits also will be sought for two other TSD units requiring groundwater monitoring systems, the Grout Treatment Facility and the Liquid Effluent Retention Facility. The permit applications for these two units were submitted in November 1988 and June 1991, respectively. The status of interim status monitoring programs for the subject TSD units is shown in Table 5-1.

The interim status groundwater monitoring program implemented for a TSD unit during the interim status period is summarized in the following sections. The information presented includes (1) discussion of the groundwater monitoring system design, (2) a summary of the existing hydrogeologic data, (3) a description of the general well design, (4) a summary of the interim status groundwater sampling and analysis plan for monitoring wells, and (5) a preliminary description of the statistical procedures used to assess water quality results. In addition, a summary is presented on the techniques and methods used to characterize the uppermost aquifer beneath the Hanford Site in support of the monitoring well system design.

5.2.1 Interim Status Groundwater Monitoring Approach

A specific investigative approach is taken to support the design of each TSD unit groundwater monitoring system in the interim status period. This approach consists of the following elements.

- Establish an initial groundwater monitoring well system from which stratigraphic, hydrogeologic, and background water quality information can be obtained. Data from this initial system are used to determine the need for additional monitoring wells.

- Provide hydrogeologic properties of the uppermost aquifer system beneath the TSD unit using data collected from the monitoring well system and from previously collected or published data.

Groundwater monitoring plans are developed for each TSD unit to address these elements. These groundwater monitoring plans contain specific details regarding characterization needs and details regarding the monitoring system design for each TSD unit. The groundwater monitoring plans also contain the sampling and analysis plan.

Groundwater monitoring plans have been developed for all three TSD units for which a final status permit is to be sought. Citations for these plans are as follows: (1) Low-Level Burial Grounds (WHC 1989c); (2) the Grout Treatment Facility (WHC 1989a), and (3) Liquid Effluent Retention Facility (WHC 1991d). Two assessment monitoring plans have also been prepared for the Low-Level Burial Grounds (WHC 1990b, 1990c).

As part of groundwater monitoring system installation, subsurface sediment samples usually are collected during drilling at each well location. These samples, if collected, are described and classified in the field. Selected samples are submitted to a laboratory for analyses to determine various physical and chemical parameters. Table 5-2 lists the investigative methods that have been used to characterize sediment samples collected during well installation.

Data collected from installation of the monitoring system and from previously collected or published data are summarized in a characterization report. Characterization reports have been completed for all three TSD units for which a final status permit will be sought and are summarized in the respective Part B permit applications (i.e., Low-Level Burial Grounds, Grout Treatment Facility, and the Liquid Effluent Retention Facility).

Groundwater is collected and analyzed from monitoring wells under the interim status program. During the first year of monitoring, samples are collected quarterly to establish background water quality for each well. This background is an 'area background' as defined in the *Model Toxics Control Act Cleanup Regulations* (MTCA) (WAC 173-340-200). Statistical evaluation of subsequent analyses are compared with these background concentrations to provide an indication of whether dangerous constituents from the TSD unit are significantly affecting the groundwater.

The annual RCRA groundwater monitoring report provides an interpretation of the data obtained through the sampling programs for the interim status groundwater systems, including such information for the Low-Level Burial Grounds, Grout Treatment Facility, and Liquid Effluent Retention Facility. Groundwater monitoring results have been, and will continue to be, reported in the annual RCRA groundwater monitoring report released by March 1 of each calendar year.

Pertinent information has been abstracted from groundwater monitoring plans and characterization reports for inclusion in the unit-specific permit applications for the Low-Level Burial Grounds, Grout Treatment Facility, and Liquid Effluent Retention Facility. The annual RCRA groundwater monitoring report will be the documentation used to provide updates of groundwater monitoring data relevant to each of these permit applications.

5.2.2 Investigative Methods

The techniques and methods used to assess the hydrogeologic properties of the uppermost aquifer beneath the Hanford Site are summarized in this section. This summary includes the following:

- Sources used for existing hydrogeologic information

- Design and construction details for interim status wells

- Descriptions of investigative techniques, including geologic sampling methods, geophysical well logging methods, hydrochemical sampling methods, and hydrogeologic testing methods.

5.2.2.1 Existing Hanford Site Hydrogeologic Information. Hydrogeologic information has been collected since activities began on the Hanford Site in the mid-1940s. Much of the information on subsurface geology of the Hanford Site is derived from the analyses and interpretations of boreholes and wells completed in and around the Hanford Site. Raw data have been compiled into the following databases:

- Hanford Groundwater Database (PNL 1990)

  - Summarized well completion reports
  - Water level data
  - Groundwater quality data
  - Well elevation data

- ROCSAN Database System

  - Particle size distribution from borehole sediment samples
  - Calcium carbonate content from borehole sediment samples.

The Hanford Groundwater Database is in the process of being replaced by a new database system, the Hanford Environmental Information System (HEIS). This more comprehensive system will accommodate all data related to environmental activities on the Hanford Site.

Borehole samples have been archived in the Hanford Geotechnical Sample Library. Geophysical logs from the boreholes are maintained by the appropriate contractor.

There are numerous reports that provide interpretations of raw data. Much of what is known about the geology, hydrology, climatology, and meteorology of the Hanford Site has been compiled in the Consultation Draft Site Characterization Plan (DOE 1988, volumes 1, 2, and 3). More recent Hanford Site studies include a summary of groundwater quality (WHC 1989b), and a compilation of semiannual water table elevation maps (WHC 1991c).

5.2.2.2 General Well Design. As required by WAC 173-303-400(3)(a) and 40 CFR 265.91, the interim status groundwater monitoring system includes the completion of monitoring wells to obtain representative groundwater samples from the uppermost aquifer beneath each of the TSD units.

In some circumstances, wells that existed before implementing the RCRA groundwater monitoring requirements are used as part of the monitoring network. Carbon steel casing frequently was used in the older wells for the permanent casing in combination with stainless steel screens. Some of the

oldest wells have perforations in the carbon steel casing that act as the well screen. Authorization and criteria for using groundwater wells that existed before the lists of RCRA parameters were established are provided in a letter from Ecology and the EPA dated July 16, 1990 (EPA and Ecology 1990).

Details on the individual well completion methods are provided in the site-specific groundwater monitoring plans. Procedures for performing the well installations are contained in contractor manuals. Specifications for well designs are provided in the *Generic Specification for Groundwater Monitoring Wells* (WHC 1990a).

5.2.2.3 Well Locations. The locations of the interim status monitoring wells for the individual TSD units are documented in the site-specific groundwater monitoring plans and unit-specific permit applications.

5.2.2.4 Downgradient and Upgradient Interim Status Wells. At least one monitoring well is installed hydraulically upgradient from each TSD unit. The number, location(s), and depth(s) must be sufficient to yield groundwater samples that are representative of the background groundwater quality in the uppermost aquifer beneath the unit and not impacted by the TSD unit.

There must be at least three groundwater monitoring wells located hydraulically downgradient at the limit of the waste management area (e.g., point of compliance) (Figure 5-1). The number, locations, and depths of the wells are designed for the detection of any statistically significant amount of dangerous waste constituents that might migrate from the TSD unit to the uppermost aquifer.

The upgradient and downgradient well locations for each TSD unit are selected on the basis of water table elevations and any other applicable information available at the time of well installation. The well locations for TSD units are found in the interim status groundwater monitoring plans and unit-specific permit applications.

5.2.2.5 General Hydrogeologic Investigative Techniques. Characterization of the hydrogeologic properties of the TSD unit on the Hanford Site is based on information gained from borehole sediment samples, geophysical logging, aquifer testing, water level measurements, and other pertinent sources of information.

Borehole sediment samples can be collected using any of three different sampling methods: split-barrel continuous core, drive-barrel grab samples, and hard-tool and bailer grab samples. Alternative sampling methods can be used as appropriate. Samples usually are collected at 5-foot (1.52-meter) intervals. Additional samples are collected at lithologic contacts, in moist zones, and in zones where organic substances are detected. The following list describes the testing that could be conducted on selected sediment samples:

- Field lithologic characterization

- Laboratory petrographic and mineralogic analyses (thin sections, x-ray diffraction, x-ray fluorescence)

- Grain-size distribution
- Field moisture content
- Water retention capacity
- Calcium carbonate content
- Total and inorganic carbon analysis
- Cation exchange capacity
- Hydraulic conductivity.

Field moisture content, water retention capacity, and hydraulic conductivity analyses usually are not performed on bailed samples because of the high degree of physical disturbance. A summary of the methods is listed in Table 5-2. The unit-specific permit applications contain details regarding sample collection intervals and tests performed.

Historically, the following types of geophysical borehole logging were available and might have been conducted:

- Natural gamma (gross gamma ray)
- Porosity (neutron-epithermal neutron)
- Density (gamma-gamma).

Currently, gross gamma ray logging is the primary geophysical tool used. Usually during construction, the borehole is logged with a gross gamma probe after each size of temporary casing is placed and again on completion of the well. Other tools available that might have been used are the downhole video camera, caliper logging tool, and spectral gamma ray logging tool.

Limited hydraulic properties have been obtained from field determinations as well as permeameter testing in the laboratory. Aquifer testing (constant-discharge production and recovery phases) was performed primarily before 1989. Increased restrictions on purgewater disposal resulted in the use of alternative testing methods from 1989 through September 15, 1991. During this period, slug testing was the preferred method used to obtain field information on the aquifer properties. This method entailed instantaneously changing the aquifer hydraulic head by suddenly removing a cylinder of known volume. The water level recovery response was observed over time. Descriptions of the test method used to obtain hydraulic property information are provided in the unit-specific permit applications.

5.2.3 Interim Status Data

Groundwater monitoring activities performed during the interim status period are summarized in this section.

5.2.3.1 Sampling and Analysis Plan. Sampling and analysis plans are found in the unit-specific groundwater monitoring plans. The aspects of the groundwater sampling and analysis plans that have been and currently are being used for the interim status program monitoring wells are described in this section. Representative groundwater samples from the uppermost aquifer beneath the Hanford Site are obtained and analyzed for the purpose of detecting potential contaminant releases from the regulated units. All interim status sampling activities on the Hanford Site currently are performed in accordance with SW-846 protocol (EPA 1986b). Through May 1990, United States Testing Company, Incorporated was the lead laboratory for sample analyses. A new lead laboratory currently is being selected.

The interim status groundwater sampling program is designed to provide initial water quality information on groundwater in the uppermost aquifer beneath the TSD units. Dedicated sampling equipment is provided for most of the wells, thus minimizing the potential for cross-contamination between the wells. The dedicated components of the system consist of a pump, well cap, and access for a water-level measurement device.

The static water-level is measured before obtaining groundwater samples. The well is purged to obtain a representative sample. The samples are collected and submitted for analyses. Samples are collected in accordance with established procedures (PNL 1989a). The following sections describe the general methods used in the acquisition of groundwater samples.

5.2.3.1.1 Static Water-Level Measurements. The static water level is measured, recorded, and remeasured until reproducible results are obtained before purging or sampling monitoring wells. Steel tape measurements are taken as depth-to-water from the top of the well casing and are subtracted from the surveyed elevation of the casing to obtain the elevation of the water level. Measurements are reported to the nearest 0.01 foot (0.3048 centimeter) and are repeated until two readings agree to within plus or minus 0.02 foot (0.6096 centimeter).

5.2.3.1.2 Well Purging. Interim status monitoring wells are purged before sample collection to obtain groundwater samples that are representative of groundwater rather than of the stagnant water from the well casing. Groundwater that has occupied the well undergoes chemical changes that cause its composition to differ from that of true groundwater. Monitoring wells are purged until a minimum of three casing volumes of water have been removed from the well. The pumping rate during purging is approximately 3 to 5 gallons (11.36 to 18.93 liters) per minute for high-yield wells. If a monitoring well is not capable of sustaining this extraction rate, the pumping rate is reduced. Purging of low-yielding monitoring wells (i.e., wells that are pumped dry) will consist of removing all standing water.

5.2.3.1.3 Sample Withdrawal. Water samples are withdrawn from the well after the monitoring well has been purged. Multiple groundwater samples are obtained for laboratory analyses during the sampling event. Samples are typically collected and bottled in the following order:

- Bottles with septum caps (volatiles)
- Unfiltered samples (major-ions, cyanide, semivolatiles, metals)
- Filtered samples (metals).

5.2.3.1.4 Field Analyses. Temperature, pH, and specific conductivity are measured and recorded during well purging and sample withdrawal. Groundwater samples for laboratory analysis are not collected until each of these parameters has stabilized (PNL 1989a).

5.2.3.1.5 Sample Preservation and Handling. Measurements of temperature, specific conductance, and pH are taken in the field on unpreserved samples. Sample containers, preservatives, and holding times for each type of analysis performed under interim status monitoring are listed in Table 5-3.

Prelabeled sample bottles containing the appropriate preservative are supplied for each monitoring well. The containers for samples that are to be analyzed for volatile and semivolatile organic compounds and total organic halogen are filled so that the meniscus of the fluid is above the rim of the sample container to ensure that there is no free head space.

Sample bottles are placed in sealed, insulated coolers immediately after collection and packed with ice to cool the samples to approximately 40 °F (4 °C). The coolers are transported to the lead laboratory for analysis. Field parameter record forms are attached to the sealed containers. The temperature of the samples is measured on opening the cooler in the laboratory. If the temperature is approximately 40 °F (4 °C) and some of the original unmelted ice is found to remain in the cooler, the samples are considered to have been maintained at the appropriate temperature during the time the samples were in the cooler.

5.2.3.1.6 Chain of Custody. Chain-of-custody procedures are followed in collecting interim status data to ensure the compositional integrity of groundwater samples from the time of collection through laboratory analysis and data reporting. This program involves the use and control of sample labels, sample seals, field record forms, chain-of-custody forms, sample analysis request forms, and laboratory acceptance procedures.

5.2.3.1.7 Quality Assurance and Quality Control Procedures. Quality assurance and quality control procedures are applied to both field and laboratory interim status data to ensure the reliability and validity of the data. Data quality requirements such as PARCC parameters and detection limits are addressed in the *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1990d). The Tri-Party Agreement (Article XXXV, Paragraph 101, Article XXX, Paragraph 94, and Sections 6.5 and 9.6 of the Action Plan) also specifies quality assurance and quality control requirements that are implemented. Site-specific quality assurance and quality control procedures for the groundwater monitoring program are documented in *Quality Assurance Project Plan for RCRA Groundwater Monitoring Activities* (WHC 1990d) and in *RCRA Groundwater Monitoring Projects Quality*

Assurance Project Plan (PNL 1989b). Criterion for the monitoring of field and trip blanks, interlaboratory samples and other quality control measures (e.g., blind spiked samples, field duplicates) is described in the quality assurance project plan (WHC 1990d).

5.2.3.1.8 Disposal of Purgewater. All purgewater generated before May 1989 from sampling of interim status wells was released to the ground surface in the vicinity of the well. Beginning in May 1989, purgewater was contained in galvanized steel troughs located near the well head. Tanker trucks were used to collect and transport the purgewater from the troughs to an aboveground modular tank.

A strategy for purgewater disposal has been developed since that time (WHC 1989d). The collected purgewater is sampled and analyzed for contaminants in accordance with the requirements outlined in the strategy document (WHC 1989d).

5.2.3.2 Analytical Data. Analytical data on the interim status groundwater program are presented in the following sections.

5.2.3.2.1 Groundwater Elevations. Groundwater elevation data have been obtained for the interim status wells since RCRA groundwater monitoring began. Water levels also are available for existing wells prior to the RCRA groundwater monitoring program. Water level data are compiled into the Hanford Site groundwater database. Site-wide groundwater maps are produced semiannually (e.g., WHC 1991c; Newcomer et al. 1991). Water level data for the RCRA site-specific units are documented quarterly and groundwater elevation maps are produced annually (refer to quarterly and annual reports for RCRA groundwater monitoring).

5.2.3.2.2 Results of Water Quality Analyses--Quarterly Samples. Quarterly samples are collected for the first year to establish background water quality. Constituents analyzed for are specified by 40 CFR 265.92 (b)(1)(2)(3). Site-specific parameters are specified by the unit-specific permit application. The WAC 173-303-9905 chemical parameters are analyzed one time during the first year of sampling at each of the TSD units. After the first year, the wells are monitored for 40 CFR 265.92 (b)(2) groundwater quality parameters annually and 40 CFR 265.92 (b)(3) indicator parameters and site-specific parameters semiannually. The TSD units in assessment level monitoring require sampling quarterly. The constituents analyzed for are detailed in the unit-specific permit application.

All groundwater quality data from the monitoring well network are entered into a database for permanent storage and are published in Hanford Site quarterly groundwater monitoring reports.

5.2.3.2.3 Statistical Results. Statistical analyses of the sampling results for indicator parameters (including pH, specific conductivity, total organic carbon, and total organic halogens) are discussed in the unit-specific permit applications. Detailed statistical analysis methods have been documented (WHC 1991e). Results of statistical analyses are presented in the RCRA groundwater monitoring annual report (DOE-RL 1991a).

5.3 AQUIFER IDENTIFICATION [E-3]

The characteristics of the uppermost aquifer beneath the Hanford Site, and regional hydrogeologic factors influencing this aquifer are summarized in the following section. This summary begins with a brief description of the regional physiographic and geomorphic setting of the Hanford Site. The climate and meteorology of the region also is summarized to address aquifer recharge potential from precipitation. An overview of the regional geologic framework follows, as this framework provides a major influence on aquifer characteristics. A description of the physical characteristics of the uppermost aquifer and a summary of groundwater travel time determinations comprise the remainder of this section. Hydrogeologic terms used in this discussion are defined in the glossary contained in Appendix 1B. A brief parenthetical explanation follows the initial use of these terms within the text.

5.3.1 Physiographic and Geomorphic Setting

This section addresses the physiographic and geomorphic setting of the Hanford Site, or a description of the nature and origin of landforms. The Hanford Site is situated within the Pasco Basin of south-central Washington (Figure 5-3). The Pasco Basin is one of a number of topographic (land configuration) depressions located within the Columbia Plateau Physiographic Province (Figure 5-4). The Pasco Basin is bounded on the north by the Saddle Mountains, on the west by Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills, and on the south by Rattlesnake Mountain, all anticlinal folds of the Yakima Fold Belt (a physiographic subdivision of the Columbia Plateau characterized by anticlinal upwarps and synclinal downwarps of the underlying bedrock). The Pasco Basin is bounded on the east by the Palouse slope, a monocline (broad fold) that inclines to the east (Figure 5-3).

Surface topography seen at the Hanford Site is the result of: (1) anticlinal ridges, (2) Pleistocene cataclysmic flooding (flooding resulting from glacial activity occurring north of the Hanford Site 10,000 to 13,000 years ago), (3) Holocene eolian activity (relatively recent wind activity), and (4) landsliding. Since the end of the Pleistocene, winds have locally reworked the flood sediments, depositing dune sands in the lower elevations and loess (windblown silt) around the margins of the Pasco Basin. Sand dunes have largely stabilized except where these dunes have been reactivated because of the disturbance of anchoring vegetation (WHC 1991b).

5.3.2 Climate and Meteorology

The Hanford Site is in a semiarid desert area. The climate in the vicinity of the Hanford Site is largely influenced by the rain-shadow effect of the Cascade Range located in western Washington. This effect results in cold air drainage across the region that largely controls the wind regime of the Hanford Site.

Climatological data have been collected at the Hanford Meteorological Station, located between the 200 Areas, since 1945 (Cushing 1988). Temperature and precipitation data also are available from nearby locations for the period 1912 through 1943. A summary of these data through 1980 has been published by Stone et al. (1983). Data from the Hanford Meteorological Station are representative of the general climatic conditions for the region and describe the specific climate of the 200 Areas Plateau.

5.3.2.1 Wind. Prevailing wind directions on the 200 Areas Plateau are from the northwest in all months of the year (Figure 5-5). Secondary maxima occur for southwesterly winds.

Monthly average wind speeds are lowest during the winter months, averaging 6 to 7 miles (9.7 to 11.3 kilometers) per hour, and highest during the summer, averaging 9 to 10 miles (14.5 to 16.1 kilometers) per hour. Wind speeds that are well above average usually are associated with southwesterly winds. However, the summertime drainage winds generally are northwesterly and frequently reach 31 miles (49.9 kilometers) per hour. Estimates of wind extremes have been summarized by Stone et al. (1983). Information on the likelihood and frequency of strong winds and tornados in the region have been summarized in the final environmental impact statement (DOE 1987), the Hanford Meteorological Station climatological summary (Stone et al. 1983), and the National Severe Storms Forecast Center.

5.3.2.2 Temperature and Humidity. Ranges of daily temperatures vary from normal maxima of 35.6 °F (1.6 °C) in early January to 95 °F (35 °C) in late July. The record maximum temperature is 114.8 °F (46 °C), and the record minimum temperature is -27 °F (-32.7 °C).

The annual average relative humidity at the Hanford Meteorological Station is 54 percent. It is highest during the winter months, averaging approximately 75 percent, and lowest during the summer months, averaging approximately 35 percent.

5.3.2.3 Precipitation. Precipitation measurements have been made at the Hanford Meteorological Station since 1945. Average annual precipitation at the Hanford Meteorological Station is 6.3 inches (16 centimeters) per year. Most of the precipitation occurs during the winter, with nearly half of the annual amount occurring in the months of November through February. Days with greater than 0.5 inch (1.3 centimeter) precipitation occur less than 1 percent of the year. Rainfall intensities of 0.5 inch (1.3 centimeter) per hour persisting for 1 hour are expected once every 10 years. Rainfall intensities of 1 inch (2.54 centimeter) per hour for 1 hour are expected only once every 500 years. Winter monthly average snowfall ranges from 0.3 inch (0.76 centimeter) in March to 5.3 inch (13.5 centimeter) in January. The record snowfall of 24.4 inch (61.9 centimeter) occurred in February 1916. Snowfall accounts for approximately 38 percent of all precipitation during the months of December through February.

5.3.3 Regional Geology

The regional geology provides the framework for understanding the stratigraphic (rock layers) and structural (rock deformation) controls on the aquifers beneath the Hanford Site. An overview of the regional geology and a description of the primary stratigraphic units that comprise these aquifers are provided in this section.

The Hanford Site lies in the Pasco Basin near the eastern limit of the Yakima Fold Belt. The Pasco Basin is divided by the Gable Mountain anticline into the Wahluke syncline to the north and the Cold Creek syncline to the south. The Pasco Basin is underlain by Miocene-aged (approximately 17 to 8.5 million years before present) volcanic (molten rock) flows of the Columbia River Basalt Group and late Miocene- to Pleistocene-aged sediments (approximately 10.5 million to 12,000 years before present) that overlie the basalts. The basalts and sediments thicken into the Pasco Basin and generally reach maximum thicknesses in the Cold Creek syncline in the vicinity of the 200 Area. Hanford Site structure and stratigraphy are illustrated in Figures 5-3 and 5-6, respectively, and described in *Geology and Hydrology of the Hanford Site* (WHC 1991b, pp. 2-1 through 2-19). A brief review of this information follows.

The Columbia River Basalt Group is greater than 12,000 feet thick beneath the Pasco Basin. The sequence of volcanic flows within the Pasco Basin can be divided into the Grande Ronde, Wanapum, and Saddle Mountains formations (major rock divisions) (listed from oldest to youngest). The youngest formation of the Group, the Saddle Mountain Basalt, is characterized by a sequence of volcanic flows and intercalated sedimentary units called interbeds.

Late Miocene to Quaternary sediments overly the basalts. Most of this sedimentary sequence can be divided into two main units: the Ringold Formation of late Miocene to middle-Pliocene age (approximately 10.5 million to 3 million years before present) and the Hanford formation of Pleistocene to Recent age (approximately 1 million to 12,000 years before present).

The Ringold Formation was formed by fluvial-lacustrine (stream-lake) processes. This formation comprises the basal part of the sedimentary sequence above the basalt. The Ringold Formation is up to 600 feet (185 meters) thick at the Hanford Site in the deepest part of the Cold Creek syncline south of the 200 West Area, and up to 560 feet (170 meters) thick in the western Wahluke syncline. The Ringold Formation pinches out against Gable Mountain, Yakima Ridge, Saddle Mountains, and Rattlesnake Mountain anticlines. The Ringold Formation is largely absent in the northern and northeastern parts of the 200 East Area and adjacent areas to the north in the vicinity of West Lake, located south of Gable Mountain. The Ringold Formation is composed of semi-indurated (semi-hardened) clay, silt, mud, fine- to coarse-grained sand, and granule to cobble gravel that usually are divided into (1) gravel, sand, and paleosols (buried soils) of the basal unit; (2) clay and silt of the lower unit; (3) gravel of the middle unit; (4) mud and lesser sand of the upper unit; and (5) basaltic detritus of the

fanglomerate unit (detritus deposited from stream action at the foot of a slope) (DOE 1988, volume 1, pp. 1.2-121 to 1.2-129).

Other less extensive stratigraphic units within the Pasco Basin overlie the Ringold Formation and underlie the Hanford formation. These units include a laterally discontinuous Plio-Pleistocene unit, an early 'Palouse' soil, and pre-Missoula gravels. The pre-Missoula gravels are approximately equivalent in age to the early 'Palouse' soil and Plio-Pleistocene unit.

The Hanford formation was formed by glaciofluvial processes. During Pleistocene glaciation, eastern Washington was subjected to a number of cataclysmic floods which resulted from the breakup of ice dams impounding glacial lakes in Idaho, Montana, and northeastern Washington. The Hanford formation generally can be divided into two main facies (lateral subdivisions of rock type): coarse grained or gravelly deposits and largely clast free fine grained or sandy and silt deposits. The Hanford formation also is commonly divided into two informal members: the pasco gravels and the touchet beds (DOE 1988, volume 1, pp. 1.2-132). The pasco gravels generally correspond to the gravelly facies, and the touchet beds to the sandy to silty facies. The Hanford formation is thickest in the Cold Creek bar in the vicinity of 200 West and 200 East Areas where the formation is up to 210 feet (64 meters) thick. Hanford formation deposits are absent on ridges above approximately 1,180 feet (360 meters) above sea level.

Holocene surficial deposits consist of silt, sand, and gravel that form a thin [less than 16 feet (4.9 meters)] veneer across much of the Pasco Basin. These sediments were deposited by a mix of eolian and alluvial processes during the past 10,000 years.

5.3.4 Regional and Hanford Site Hydrology

The regional and Hanford Site surface and groundwater hydrology are discussed in the following sections. Primary surface-water features associated with the Hanford Site are the Columbia and Yakima Rivers, and their major tributaries, the Snake and Walla Walla Rivers. With regards to groundwater hydrology, the uppermost aquifer at the Hanford Site is primarily in the Ringold Formation and the vadose zone (unsaturated zone above the water table) is primarily in the Hanford formation. The Hanford formation comprises the upper 30 to 300 feet of the vadose zone throughout most of the Hanford Site, but extends below the regional water table in the 200 East Area and eastward towards the Columbia River.

5.3.4.1 Surface Hydrology. Surface drainage enters the Pasco Basin from several other surrounding basins. Within the Pasco Basin, the Columbia River is joined by major tributaries including the Yakima, Snake, and Walla Walla Rivers. Two intermittent streams traverse through the Hanford Site. These are Cold Creek and Dry Creek. Water drains through these creeks during the wetter winter and spring months. No perennial streams originate within the Pasco Basin.

Total estimated precipitation over the Pasco Basin averages less than 6.3 inches (16 centimeters) per year (Section 5.3.2.3). Mean annual run-off from the Pasco Basin is estimated to be less than 2.5 x 10^4 acre-feet per year, or approximately 3 percent of the total precipitation. The remaining precipitation is assumed to be lost through evapotranspiration with a small component (perhaps less than 1 percent) contributing to recharging of the groundwater system (DOE 1988, volume 2, p. 3.1-6).

Primary surface-water features associated with the Hanford Site are the Columbia and Yakima Rivers, and their major tributaries, the Snake and Walla Walla Rivers. West Lake, about 10 acres in size and less than 3 feet (0.9 meters) deep, is the only natural lake within the Hanford Site. Waste water ponds, cribs, and ditches associated with nuclear fuel reprocessing and waste disposal activities also are present on the Hanford Site.

5.3.4.2 Groundwater. An aquitard is defined as a less permeable (water transport capability) bed in a stratigraphic sequence. A confined aquifer system is an aquifer confined between two aquitards. A semiconfined aquifer system has some areas where the confining layer(s) might be absent. Representatives of these aquifer types are found beneath the Hanford Site.

Confined and semiconfined aquifer systems occur beneath the Hanford Site in the basalt flow tops, flow bottom zones, and sedimentary interbeds (DOE 1988, volume 2, pp. 3.6-1). These deeper aquifers are intercalated with aquitards consisting of basalt flow interiors. Vertical flow across the aquitards within the basalt aquifer system is inferred from water level or potentiometric surface data, but the leakage is not quantified and direct measurements are not available (DOE 1988, volume 2, p. 3.6-17). The multiaquifer system within the Pasco Basin has been conceptualized as consisting of four primary hydrogeologic units: (1) Hanford and Ringold Formation sediments, (2) Saddle Mountain Basalt, (3) Wanapum Basalt, and (4) Grande Ronde Basalt. The discussion in the following sections focuses on the uppermost aquifer systems within the Ringold and Hanford formations and within the Saddle Mountains Basalt, the aquifer comprised of the Rattlesnake Ridge interbed.

5.3.5 Uppermost Aquifer

The unconfined to semiconfined aquifer associated with the sedimentary units stratigraphically above the basalts is the uppermost regionally extensive aquifer beneath the Hanford Site. The water table ranges in depth from 0 feet at West Lake and the Columbia and Yakima Rivers, to greater than 350 feet (106.7 meters) near the center of the Hanford Site. Groundwater within this aquifer system is contained within the glaciofluvial sands and gravels of the Hanford formation and the fluvial-lacustrine sediments of the Ringold Formation. The position of the water table beneath the western portion of the Hanford Site is generally within the middle Ringold unit. In the northern and eastern portions of the Hanford Site, the water table is generally within the Hanford formation. Hydraulic conductivities for the Hanford formation [2,000 to 10,000 feet (609.6 to 3,048 meters) per day] are much greater than those of the middle unit of the Ringold Formation [610 to

3,050 feet (185.9 to 929.6 meters) per day] (Law et al. 1987). Stratigraphic divisions of these units and their hydrologic properties are discussed in detail in WHC (1991b, pp. 2-5 to 2-16, pp. 3-4 to 3-26).

This aquifer system is approximately 500 feet (152.4 meters) thick near the center of the Pasco Basin. Laterally, the aquifer system is bounded by anticlinal basalt ridges, which extend above the water table. A generalized east-west geologic cross section showing the position of the water table and major stratigraphic units beneath the Hanford Site is presented in Figure 5-7.

The base of the uppermost aquifer generally is regarded as the basalt surface. On a local scale where the Ringold Formation is present, the silts and clays of the lower Ringold and the fine-grained facies of the basal Ringold form a confining layer. Thus, in the strict sense, the groundwater is unconfined above this layer and semiconfined below this layer.

Water levels in the uppermost aquifer have risen because of artificial recharge mechanisms such as excessive application of imported irrigation water or impoundment of streams. Waste water ponds on the Hanford Site have artificially recharged the suprabasalt (sediments found above the basalt) aquifer below the 200 East and 200 West Areas. Recharge from the 200 Areas waste water disposal units is estimated to be approximately 10 times the natural recharge on the Hanford Site (Graham et al. 1981). The increase in water table elevations was most rapid from 1950 to 1960 and apparently stabilized between 1970 and 1980, when only small increases in water table elevations occurred. Waste water discharges from the 200 West Area significantly were reduced in 1984 and the water levels there are now slowly declining. A similar situation is expected to occur in the 200 East Area on the future discontinued use of the B Pond System (refer to Figure 5-10).

The general direction of groundwater flow is primarily from natural recharge areas west of the Hanford Site to discharge areas, toward the Columbia River. The general west-to-east flow pattern is interrupted locally by the groundwater mounds in the 200 Areas. From the 200 Areas, there is also a component of groundwater flow to the north, between Gable Mountain and Gable Butte. Figure 5-8 illustrates the water table conditions beneath the Hanford Site.

Hydraulic conductivities for the Hanford formation [2,000 to 10,000 feet (609.6 to 3,048 meters) day] are much greater than those of the middle member of the Ringold Formation [9 to 230 feet (2.7 to 70.1 meters) day] (Graham et al. 1981). The main body of the unconfined aquifer occurs within the middle member of the Ringold Formation. The effective porosity for the sediments in the unconfined aquifer ranges between 10 percent and 30 percent (Graham et al. 1981).

Details of the hydrology for the individual TSD units are provided in the unit-specific groundwater monitoring plans and permitting documents.

5.3.6 Uppermost Confined Aquifer

The Rattlesnake Ridge aquifer is the uppermost confined aquifer system that occurs beneath the Hanford Site. This aquifer consists of the flow bottom of the Elephant Mountain Basalt, the flow top of the Pomona basalt, and the Rattlesnake interbed. The thickness of the Rattlesnake Ridge interbed, which is the principal transmissive zone within the aquifer, ranges from 50 to 82 feet (15.2 to 25 meters) beneath the 200 Areas and generally thickens toward the west (Graham et al. 1981, 1984). Erosional windows (gaps in the rock) in the Elephant Mountain basalt confining layer exist locally. This could allow hydraulic communication between the Rattlesnake Ridge aquifer and the overlying unconfined aquifer (Graham et al. 1984).

Natural recharge to the Rattlesnake Ridge aquifer occurs in the higher elevations surrounding the Pasco Basin to the west, north, and northeast. The flow of groundwater generally is toward the northeast beneath the 200 West Area and possible east to north beneath the 200 East Area (Figure 5-9). The aquifer is heterogeneous in composition because the aquifer consists of basalt flow top and flow bottom, a clayey basalt conglomerate, an epiclastic fluvial-floodplain unit, an air-fall tuff, and a volcaniclastic unit derived from fluvial reworking of the tuff and detrital sediments (Graham et al. 1984). This heterogeneity produces variability of groundwater flow through the aquifer (Graham et al. 1984).

5.3.7 Groundwater Travel Times

The travel time of groundwater from the Hanford Site to the Columbia River is the sum of the time required for the contaminant to travel through the vadose zone to reach the water table and the time required for the contaminant to travel in the groundwater to the Columbia River. Travel time determinations can be based on small or large scale field measurements of transport rates or on calculations supported by laboratory scale measurements of the transport parameters.

The parameters that affect the travel time in the unconfined aquifer are the following:

- Distance
- Permeability
- Porosity
- Hydraulic gradient
- Dispersivity
- Retardation
- Heterogeneity (geologic structure).

In addition to these parameters, the vadose zone travel times are further affected by the relative permeability, the moisture content, and the recharge rate. Because of the variability of the sediments, the calculation of travel times based on laboratory derived parameters is considered less accurate than the large scale field measurements. The following sections summarizes the work that has been done in determining travel times in the vadose zone and unconfined aquifer.

5.3.7.1 Vadose Zone. The travel time through the vadose zone depends on the moisture content, which in turn depends on the recharge rate. In the cases of artificial recharge where near saturated conditions have been maintained down to the water table [e.g., B Pond (refer to Figure 5-10)], the flow velocity is nearly equal to the hydraulic conductivity of the soil column. This implies a travel time on the order of days. For other cases where the natural recharge is the driving force, the travel time becomes highly uncertain. Several calculations have been done (DOE 1987) for natural recharge in the 200 East area ranging from 0.2 inch (0.5 centimeter) per year to 2 inches (5.0 centimeters) per year. These values were chosen to reflect current and possibly future wetter conditions. The computational results indicated travel times on the order of 900 years to 100 years respectively for conservative contaminants.

5.3.7.2 Saturated Zone. More than 20 estimates of groundwater travel times from the 200 East and 200 West Areas to the Columbia River have been made by investigators using a number of different methodologies and assumptions. Freshley and Graham (1988) provided a review of the various travel time estimates that have been made over the past 40 years. These estimates can be classified as being based on one of the following methods: (1) extrapolation of local groundwater velocity measurements, (2) mathematical methods, and (3) monitoring the movement of contaminant plumes. Example travel times for conservative contaminants are presented in Table 5-4 for the operational areas of the Hanford Site.

The rate and direction of groundwater flow in the vicinity of the 100 Areas are greatly influenced by the level of the Columbia River (Section 5.3.5.1). This can severely alter the groundwater gradient and even cause flow to be reversed up to 1,000 feet (304.8 meters) inland during periods of high water. A similar effect occurs at the 300 Area (DOE-RL 1991a, p. 16-10).

5.4 CONTAMINANT PLUME DESCRIPTION [E-4]

Ecology regulations [WAC 173-303-806(4)(a)(xx)(D)] require "A description of any plume of contamination that has entered the groundwater from a regulated unit at the time that the application was submitted..." This section contains a description of contaminant plumes identified in the aquifers beneath the Hanford Site.

The status of groundwater contamination is monitored monthly. The results of the monitoring program along with isopleth maps are prepared and published annually (e.g., Evans et al. 1990). Contaminant plumes are

primarily delineated using isopleth maps (i.e., maps with lines connecting points of equal concentration or values).

5.4.1 Radionuclide Contamination

Isopleth maps are prepared routinely to show radioactive tritium and gross beta radiation, and nonradioactive nitrate contamination (plumes) in the unconfined groundwater flow system beneath the Hanford Site. Although these constituents are not considered to be subject to RCRA and Ecology *Dangerous Waste Regulations*, a study of these plumes can be used to provide an early indication of the rate and direction of contaminant movement. An example of an isopleth map delineating a contamination plume is shown in Figure 5-10 (Evans et al. 1990, p. 2.33). This figure depicts the distribution of tritium concentrations in the unconfined aquifer in 1989.

5.4.2 Nonradioactive Contamination

The most common nonradioactive inorganic contaminants that have been observed in groundwater are nitrate, cyanide, fluoride, and hexavalent chromium. Among the nonradioactive organic contaminants routinely observed in the groundwater samples are carbon tetrachloride, 1,1,1-trichloromethane, trichloroethylene, perchlorethylene, 1,1-dichloroethane, 1,2-dichloroethene, and chloroform (e.g., Evans et al. 1990).

Nitrate, like tritium, can be used to define the extent of contamination because nitrate is present in many waste streams at the Hanford Site and is mobile in the groundwater (Evans et al. 1990, p. 2.28). As mentioned previously, isopleth maps are prepared routinely that show levels of nitrate concentrations in the groundwater. The configuration of the nitrate plumes is similar to that shown for tritium in Figure 5-10.

It should be noted that the present extent of detectable contamination is primarily the result of past liquid waste discharges to the ground.

5.5 DETECTION MONITORING PROGRAM [E-5]

The final status detection monitoring program is designed to detect the impact of the TSD unit on groundwater quality in the uppermost unconfined aquifer beneath the unit. The final status detection monitoring program contains details regarding the following:

- Design of the monitoring well network (number and locations of monitoring wells, well construction)
- Frequency of groundwater monitoring
- Type and behavior of chemical parameters that will be used to indicate the presence of groundwater contamination

- Sampling, analysis, and statistical procedures that will be used

- Methods by which regular determinations of the groundwater flow rate and direction will be determined.

A description of the unit-specific monitoring network is found in the unit-specific permit applications. These final status requirements are applicable to TSD units on issuance of the unit-specific permits.

The following sections provide the necessary data and information to support the implementation of a final status detection monitoring program at each TSD unit.

5.5.1 Monitored Indicator Parameters, Waste Constituents, Reaction Products [E-5a]

The monitoring parameters are selected on the basis of their suitability to groundwater monitoring at individual TSD units, and do not necessarily apply to the entire Hanford Site. The following criteria are considered in the selection of monitoring parameters for each TSD unit:

- Present in significant quantity within the waste that has been disposed of

- Relative mobility and low retardation with respect to groundwater flow, and the stability and persistence in the environment

- Lack of significant natural presence of the parameters in the groundwater

- Ease of detection and minimal sampling and analytical interferences (detectability)

- Usefulness as indicators of other potential contaminants

- Lack of data interpretation problems caused by common laboratory and field contaminants.

5.5.1.1 Dangerous Waste Characterization [E-5a(1)]. A compilation of the dangerous waste that has been disposed of in each TSD unit is a part of the unit-specific permit application. This compilation will include, to the degree possible, compositions, quantities, and dates of waste disposal, and will form the basis for the selection of the unit-specific monitoring parameters and constituents.

5.5.1.2 Behavior of Constituents [E-5a(2)]. The mobility, stability, and persistence of waste constituents and their reaction products that have been disposed of at a TSD unit are of prime importance in determining the proper unit-specific monitoring parameters and constituents. Those constituents that generally are mobile and persistent through the soil zone and into the

saturated zone are useful indicators of chemical migration from a waste disposal site.

Parameters such as distribution or sorption coefficients for inorganic (e.g., Freeze and Cherry 1979, pp. 402-408) and organic constituents (Lyman et al. 1982) and chemical solubilities are used in these evaluations. Other important properties that are considered for organic constituents are vapor pressure and the Henry's Law constant (used to evaluate to what degree compounds will be partitioned into the aqueous phase and to what degree this phase is likely to migrate as a vapor).

5.5.1.3 Detectability [E-5a(3)]. The detectabilities of the groundwater sampling parameters for each TSD unit are to be given in terms of practical quantification limits for each of the constituents listed. The practical quantification limits represent the lowest concentrations of analytes in groundwater that can be reliably determined within specified limits of precision and accuracy by the standard analytical methods under routine laboratory operating conditions. Data quality objectives regarding detection levels are addressed in the quality assurance project plan (WHC 1990d).

5.5.2 Groundwater Monitoring Program [E-5b]

This section describes a comprehensive program of monitoring wells for each TSD unit to be used during the final status detection monitoring program. The final status detection monitoring system is designed to detect the migration of chemical releases within the uppermost aquifer at compliance points immediately downgradient from potential leak sources in regulated units. The groundwater will be monitored as required during the operational period for regulated units.

5.5.2.1 Description of Wells [E-5b(1)]. The analytical basis for locating the monitoring wells around individual TSD units, and the well locations selected to achieve detection level coverage with the minimum number of wells are discussed in the following sections.

5.5.2.1.1 Background. Groundwater monitoring wells that are required to be installed will be in compliance with the detection level monitoring requirements of WAC 173-303-645(9). These wells will yield groundwater samples from the uppermost unconfined aquifer that are representative of the quality of area background water immediately upgradient of the unit and the quality of water passing beneath the unit.

5.5.2.1.2 Design Approach for Monitoring Wells. Tentative locations for monitoring wells are identified along the downgradient sides (point of compliance) of the TSD unit. Initial well locations are determined based on consideration of the interpreted direction of groundwater flow crossing the unit.

The groundwater monitoring system must be capable of yielding groundwater samples for analysis and must consist of the following:

- Monitoring wells installed hydraulically upgradient from the limit of the TSD unit. The number, location, and depths of the wells must be sufficient to yield groundwater samples that are: (1) representative of area background groundwater quality in the uppermost aquifer near the unit and (2) not affected by the unit.

- Monitoring wells installed hydraulically downgradient at the limit of the TSD unit. The number, location, and depth of the wells must ensure that the wells detect immediately any statistically significant amounts of dangerous waste or dangerous waste constituents that migrate from the TSD unit to the uppermost aquifer.

- All monitoring wells must be cased in a manner that maintains the integrity of the monitoring well borehole. This casing must be screened and packed with gravel or sand, where necessary, to enable sample collection at depths where appropriate aquifer flow zones exist. The annular space above the sampling depth must be sealed with suitable material to prevent contamination of samples and the groundwater.

Existing wells might be used as part of the monitoring network provided the wells are in compliance with the Ecology position (EPA and Ecology 1990). The reasoning behind the location of the individual wells is documented in the unit-specific permitting documents.

5.5.2.1.3 Monitoring Well Locations and Design. To comply with Ecology groundwater monitoring requirements, monitoring wells at dangerous waste units are located at intervals along "the hydraulically downgradient limit of the waste management area..." [WAC 173-303-645(6)(a)]. The waste management area is defined as "the limited projection in the horizontal plane of the area on which waste will be placed during the active life of the regulated unit" [WAC 173-303-645(6)(b)]. These regulations, therefore, require that monitoring wells be placed as close as reasonably possible to the edge of the regulated unit. Installation of monitoring wells will be based on the following criteria.

- Satisfy the regulatory requirements for a groundwater monitoring system that consist of a sufficient number of wells installed to yield groundwater samples that:

  (1) represent the composition of groundwater that has not been impacted by a TSD unit

  (2) represent the composition of groundwater passing beneath the TSD unit

- Location of monitoring wells should ensure a high level of confidence that dangerous waste migrating from a regulated unit would be reliably detected (Section 5.5.4.7).

- Wells should provide area background hydrochemical information for areas in which waste has yet to be placed.

- Wells should be placed in locations that will afford the collection of hydrogeologic information.

5.5.2.1.4 Monitoring Efficiency Model. The monitoring efficiency model (MEMO) was designed specifically for the well location evaluations (Wilson et al. 1991) and based on work described in Domenico and Robbins (1985). When combined with planar and vertical flow nets, stratigraphic cross sections, and estimates of aquifer and transport properties, MEMO becomes an effective tool used for guidance in locating monitoring wells at the Hanford Site. A MEMO allows the calculation of the probability of detecting contamination released from inside the boundary of the TSD unit. Acceptable limits to this probability will be defined before the network design is initiated.

For a selected plume length, given the actual site parameters (e.g., transverse dispersivity), releases occurring at most locations within the waste management area would be expected to be detected, but releases occurring at restricted locations between the monitoring wells and near the downgradient boundary would be less likely to be detected within the same constraints. Given that monitoring wells always will be spaced some finite distance apart, and given the uncertainties inherent in predicting the behavior of a natural geologic system, a level of uncertainty always will be present in the functioning of any groundwater monitoring network design. The MEMO provides a simple way to begin to quantify the effectiveness of a given network design.

5.5.2.2 Equipment Decontamination [E-5b(2)]. All field equipment decontamination and sampling activities will comply with aspects of a health and safety plan and procedures manuals. The procedures are intended to prevent cross-contamination between boreholes during drilling activities. Field equipment decontamination activities will be documented in the field logbook.

5.5.3 Background Values [E-5c]

Background values are defined as the concentrations of chemical, physical, biological, or radiological constituents, or other characteristics in or of groundwater at a particular point in time and upgradient of a unit that have not been affected by that unit. This background is regarded as an 'area background' as defined in *Model Toxics Control Act Cleanup Regulation* (WAC 173-340). Background groundwater quality for detection monitoring can be based (1) on sampling of wells that are not upgradient from the unit if hydrogeologic conditions do not allow the owner or operator to determine what wells are upgradient or (2) sampling at other wells will provide a better indication of area background groundwater composition that is as or more representative than that obtained from samples from upgradient wells [WAC 173-303-645(8)(g)(iii) and 40 CFR 264.97(a)(1)].

Area background levels will be determined for any final status detection-level groundwater monitoring parameters. These include general contamination indicator parameters such as specific conductance, pH, TOC,

TOX, or heavy metals and site-specific parameters (waste constituents or reaction products) that will provide a reliable indication of the presence of dangerous constituents in groundwater. The site-specific parameters (described in the unit-specific permit applications) will be selected based on (1) the types and quantities of waste constituents present; (2) the mobility, stability, and persistence of the waste constituents; (3) the detectability of the parameters; and (4) existing data.

Area background values address two objectives: (1) to provide information concerning the baseline values for waste constituents of concern and (2) to determine whether there is any evidence of contamination in the compliance wells (downgradient) that could result from a release from the TSD unit. To address the first objective, baseline values will be established for the final status indicator parameters (specified in the unit-specific permit) from a minimum of 1 year of quarterly sampling and analysis of upgradient wells. These baseline values can be used as concentration limits in compliance monitoring [40 CFR 264.99(a)(2) and 264.94(a)(1)]. Four independent samples will be obtained at each background well during each sampling event. The downgradient wells also will be sampled and analyzed at the same frequency during this time. For a detection monitoring program a statistical evaluation is required to address the second objective. Requirements for sampling frequency are discussed in Section 5.5.4.5.1. Statistical analyses are presented in Section 5.5.4.7.

Area background data subsequently will be reviewed for seasonal variations, trends, and significant differences among the wells. The background statistics and/or statistical methodology might be modified, if required, to address temporal or spatial variation. Background data also will be reevaluated if changes in groundwater flow directions result in changes in definition of upgradient wells.

5.5.4 Sampling, Analysis, and Statistical Procedures [E-5d]

This section provides information on the groundwater sampling, analysis, and statistical evaluation procedures that are proposed for use with the monitoring well system. The choice of an appropriate statistical test depends on the type of monitoring (i.e., detection or compliance) and the nature of the data (e.g., the proportion of values in the data set that are below detection limit) (Figure 5-2). Statistical procedures under final detection or compliance monitoring program status are discussed in Section 5.5.4.7 and Section 5.6.7.4, respectively. As the postclosure monitoring program will be implemented at least 30 years in the future, actual protocols and procedures likely will be equivalent to those cited in this section.

5.5.4.1 Sample Collection [E-5d(1)]. The groundwater monitoring system proposed for use at the Hanford Site is designed to provide representative groundwater quality data from the uppermost aquifer beneath each identified TSD unit. Procedures to be followed during the collection of groundwater samples from the network have been developed and will be available to all

onsite personnel and to the regulators. These procedures will be consistent with those listed in SW-846.

5.5.4.1.1 Static-Water Level Measurements. Before purging or sampling the monitoring well, the static-water elevation will be measured, recorded, and remeasured until reproducible results are obtained. The measurements will be taken as depth-to-water from the top of the well casing and the values will be subtracted from the surveyed elevation of the casing to obtain the elevation of the water table. Graduated steel measuring tapes or other approved devices will be used for the measurements. Measurements will be reported to the nearest 0.01 foot (0.3 centimeter).

5.5.4.1.2 Well Purging. Monitoring wells will be purged using a dedicated pump before samples are collected. This action will be taken to obtain groundwater samples that are representative of the formation water, rather than of the stagnant water from the well casing. Groundwater that has occupied the well casing for a long duration often is oxidized and might not be indicative of true formation water.

As a guideline, high-yielding monitoring wells will be purged until a minimum of three casing volumes have been removed. However, a well will not be considered ready for sample collection until concurrent measurements of pH, specific conductivity, and water temperature have stabilized to at least plus or minus 10 percent over two well volumes pumped (Barcelona et al. 1985). The quantity of the casing volume is computed from the values of the casing diameter and the height of the water column in the monitoring well such that

one purge volume = (total well depth - water table depth) x
(0.653 gallon per foot 4-inch well)

Purging of low-yielding monitoring wells (i.e., those that are pumped dry) will consist of removing all standing water.

The pumping rate at each well will be chosen to minimize turbidity and aquifer stress. Generally, the rate of pumping during sampling will be kept below the rate used during well development (Barcelona et al. 1985).

Water levels, pumping rates, and values of sampling parameters (i.e., pH, specific conductivity, and temperature) will be recorded in field logbooks and transferred to a sample groundwater field record form.

5.5.4.1.3 Field Analysis. During well purging and sample withdrawal, field determinations of temperature, pH, and specific conductivity will be measured and recorded. The stabilization of these parameters will be an indication that well water has been purged and formation water is being sampled. Other methods of determining the presence of formation water (e.g., measuring the concentration of specific ionic species during the well purging process) might be proposed at a future time.

5.5.4.1.4 Sample Withdrawal. After the monitoring well has been purged, water samples will be withdrawn from the well using a dedicated pump.

The sample withdrawal rate will be kept to approximately 0.26 gallon (0.98 liter) per minute as recommended for groundwater sampling when volatile organic compounds are involved (Barcelona et al. 1985).

Groundwater samples will be containerized according to the specifications listed in Table 5-3. Samples will be collected and containerized in the order of volatilization sensitivity of the parameters to be analyzed. Samples to be analyzed for volatile organic compounds or other organics will not be filtered. Samples for metals will be split and handled in accordance with Section 5.5.4.2.

5.5.4.2 Sample Preservation and Shipment [E-5d(2)]. A list of the sample containers that will be used during the groundwater monitoring program is presented in Table 5-3. Measurements of pH and specific conductivity will be taken in the field on unpreserved samples.

Precleaned and prelabeled sample containers will be supplied for each monitoring well and will include the appropriate preservatives. To ensure zero head space, the containers for samples analyzed for volatile organic compounds will be filled to slightly more than full before being capped. Samples typically are collected in the following order:

- Bottles with septum caps (volatiles)
- Unfiltered samples (major-ions, cyanide, semivolatiles, metals)
- Filtered samples (metals).

Immediately after collection, the sample containers will be placed in sealed, insulated coolers packed with ice to cool the ambient temperature to approximately 40 °F (4 °C). The coolers will be transported to the laboratory for arrival within 24 hours. Field parameter record forms and approved sample analysis request forms will be attached to the sealed containers.

5.5.4.3 Analytical Procedures [E-5d(3)]. The laboratory approved for the groundwater monitoring program will operate under the requirements of Appendix 2C and will use standard laboratory procedures as listed in SW-846 or an alternate equivalent. Alternate procedures, when used, will meet the guidelines of SW-846, Chapter 1.0 (EPA 1986).

Field samples will be compared to determine if the results obtained from the lead laboratory are comparable to the results from other laboratories. Comparisons will be conducted for volatile organic compounds, dissolved metals, and inorganic anions. A minimum of two different laboratories will be used for the comparison testing. If the lead laboratory results are found to be statistically different, necessary action will be initiated to investigate and/or correct the situation.

Spiked samples will be submitted to the lead laboratory to estimate the bias of analytical laboratory procedures. Spiked samples could consist of metals, herbicides, pesticides, volatile organic compounds, and other

constituents. The spiked samples will be prepared with materials issued by Ecology, EPA, and/or the implementing DOE-RL contractor.

Duplicate analyses of field samples will be conducted to estimate the variability of laboratory measurements. Trip blanks and field blanks also will be prepared for analysis along with the principal groundwater samples. At least one trip blank will be prepared for each transported shipment of groundwater samples. At least one field blank will be prepared for each sample period or at the rate of one blank for every 20 samples collected.

5.5.4.4 Chain of Custody [E-5d(4)]. Chain-of-custody procedures will be followed to ensure the integrity of groundwater samples and to trace the possession and handling of the individual samples from the time of collection through laboratory analyses and data reporting. A single form will be used for each sample transport shuttle and will trace the handling of as many samples as possible. Each person handling one or more of the listed samples on the form will sign and return a copy of the form to the implementing DOE-RL contractor identified on the top line of the form.

Additional quality assurance and quality control procedures include sample labels, sample seals, field logbooks, sample analysis request sheets, and laboratory notebooks.

5.5.4.5 Additional Requirements for Compliance Point Monitoring [E-5d(5)]. Compliance point monitoring could be required for some TSD units. The following sections discuss additional requirements for this compliance point monitoring.

5.5.4.5.1 Sample Frequency [E-5d(5)(a)]. In compliance with regulations, all wells (compliance and background) will be sampled at least semiannually during detection monitoring [40 CFR 264.98(d)] during the active and postclosure period of each TSD unit. During each sampling event, a sequence of four independent samples will be taken from each well [40 CFR 264.97(g)(1)]. These four samples will be taken at an interval that ensures, to the greatest extent technically feasible, that an independent sample is obtained. This requirement could be accomplished by reference to the uppermost aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient, and the fate and transport characteristics of the potential contaminants. In hydrogeologic environments where the groundwater velocity prohibits one from obtaining four independent samples on a semiannual basis, an alternate sampling procedure approved by the Ecology may be used [40 CFR 264.97(g)(2)]. Specific sampling intervals will be presented in unit-specific permit applications.

5.5.4.5.2 Compliance Point Groundwater Quality Values [E-5d(5)(b)]. The groundwater quality data obtained from the compliance point monitoring wells will be documented in a form that expresses each groundwater sampling parameter, the analytical value of the concentration in groundwater from the most recent sampling event, the analytical detection limit, and the background concentration limit for each parameter. Summary statistics to be presented include the mean and variance of the sampling sequence (based on a

minimum of four independent samples), the number of less-than-detection-limit values, the median, coefficient of variation, and minimum and maximum values.

5.5.4.6 Annual Determination [E-5d(6)]. Groundwater flow rates and flow direction within the uppermost aquifer will be determined annually for those TSD units being monitored. Average horizontal flow rates and directions will be determined from groundwater elevation contour maps constructed after each sampling event. The velocity of flow will be determined using the Darcian flow theory:

$$v_h = K_h i_h / n_e$$

where

V_h = the horizontal groundwater velocity

K_h = the horizontal hydraulic conductivity

i_h = the horizontal hydraulic gradient

n_e = the effective porosity.

The value of K_h will be determined from hydraulic property investigations performed on monitoring wells. The average value of i_h at the location of each monitoring well will be calculated from the water table contour maps. Effective porosities range between 10 percent and 30 percent (Graham 1981, p. 3-12). These data will permit the groundwater flow velocity to be determined in the vicinity of each monitoring well.

Horizontal groundwater flow directions for the uppermost aquifer beneath the TSD unit being monitored will be determined from water table contour maps constructed for those units. The data used to develop water table contour maps will be periodic water level measurements in various TSD unit groundwater monitoring wells. The flow directions will be qualitatively estimated by superimposing directional streamlines normal to the water table equipotential lines.

5.5.4.7 Statistical Determination for Detection Monitoring Program [E-5d(7)]. Indicator parameter data from downgradient compliance point wells will be compared with the background wells (area) data semiannually to determine whether there is a statistically significant increase (or decrease for the case of pH) over background concentrations. Statistical methods appropriate for a final status detection monitoring program will include analysis of variance, tolerance intervals, predication intervals, control charts, test of proportions, or other statistical methods approved by Ecology. The type of monitoring, the nature of the data, the proportions of nondetects, and temporal variation are important factors to consider when selecting appropriate statistical methods. The statistical evaluation procedures chosen will be based on the EPA guidance document, *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities - Interim Final Guidance* (EPA 1989d). Specifics will be addressed in the unit-specific permit applications.

5.5.4.8 Reporting. The results of the statistical evaluation will be reported to Ecology in the RCRA annual groundwater monitoring reports. The statistical results might include a list of groundwater parameters analyzed, detection limits and background values for each parameter, and the quantified laboratory results. For a particular TSD unit, if a statistically significant increase in one or more of the groundwater parameters is determined, the following steps will be taken.

- Ecology will be notified in writing within 7 days of the finding with a report indicating which indicator parameters and or constituents have shown statistically significant increase over the background values. Ecology will be notified in writing in 7 days if the owner/operator intends to demonstrate that increases caused from sources other than the regulated units, or from sampling errors, analyses, and/or evaluations.

- All monitoring wells will be sampled immediately and analyzed for all constituents listed in 40 CFR 264, Appendix IX, and for any other specific dangerous constituents as determined by any additional information regarding the waste disposed in that TSD unit.

- Following review and validation of the Appendix IX analytical data, the compliance wells will be resampled and reanalyzed for all of the compounds detected.

- Following review and validation of the reanalyzed data, these confirmed constituents will form the basis for compliance monitoring. Background values for each valid detected constituent identified in the Appendix IX analysis will be established unless demonstrated that the increase resulted from error in sampling, analysis, evaluation or from a source other than the regulated unit.

- Within 45 days, a plan will be submitted to Ecology to establish a compliance monitoring program meeting the requirements of WAC 173-303-645(10) or 40 CFR 264.99, or the data necessary to justify that a compliance monitoring program is not required will be submitted to Ecology.

5.6 COMPLIANCE MONITORING PROGRAM [E-6]

A compliance monitoring program will be established for a TSD unit if groundwater sampling during detection level monitoring reveals statistically significant increases (or pH decrease) over area background concentrations for groundwater. In a compliance monitoring program, the monitoring objective is to determine whether groundwater protection standards have been exceeded. This is accomplished by comparing the concentration of a constituent of concern to groundwater protection standards such as maximum concentration limit and alternate concentration limit; area or natural background; or applicable, relevant, and appropriate requirements.

5.6.1 Waste Description [E-6a]

A list of all recorded waste handled at Hanford Facility TSD units is included in the *Hanford Facility Part A Dangerous Waste Permit Application* (DOE-RL 1988b). If required, additional information will be provided on (1) the results of any direct sampling of the waste, (2) a list of expected waste constituents, and (3) an estimate of the composition and physical properties of any immiscible fluids that might be expected to have been derived from the waste.

5.6.2 Characterization of Contaminated Groundwater [E-6b]

If a compliance level monitoring program at a given TSD unit is considered necessary, a complete characterization of groundwater will be provided in which an increase in dangerous chemicals above appropriate reference levels is indicated. The characterization of groundwater will include (1) concentrations of each constituent listed in 40 CFR 264, Appendix IX, (2) concentrations of major anions and cations, and (3) concentrations of any other appropriate constituents [e.g., Table I of WAC 173-303-645(5)].

5.6.3 Dangerous Constituents to be Monitored [E-6c]

If compliance monitoring is required at any TSD unit, data quality objectives and indicator parameters will be established. Additionally, any other Appendix IX constituents detected and confirmed will be added to the constituent list. If other groundwater constituents indicative of migrating waste products are identified, the list of groundwater parameters will be revised to include such constituents.

5.6.4 Concentration Limits [E-6d]

With enactment of compliance level monitoring, maximum concentration limits will be identified for each of the groundwater monitoring parameters listed in Table 1 of WAC 173-303-645. Alternate concentration limits will be proposed after considering the observed concentrations of chemical constituents in the groundwater that might have been derived from the regulated unit in question. The area background, natural background, and other standards that are applicable, relevant, and appropriate requirements will be considered when proposing an alternate concentration limit.

If, during compliance level monitoring, the reference concentration limits for a given groundwater parameter or parameters are significantly exceeded, a corrective action program will be implemented (Section 5.7).

5.6.5 Groundwater Monitoring System [E-6f]

The compliance level groundwater monitoring system will be designed to determine whether groundwater protection standards have been exceeded. Thus, the compliance level groundwater monitoring system will comply with WAC 173-303-645(6) for compliance point monitoring.

5.6.5.1 Description of Wells [E-6f(1)]. The system design will consist of those wells installed under the detection level monitoring program and any additional wells that are determined to be required after assessing the detection efficiency of the present well network.

5.6.5.2 Representative Samples [E-6f(2)]. The compliance monitoring system will be designed to provide groundwater samples that are representative of groundwater composition at the point of compliance.

5.6.5.3 Location of Background Monitoring Wells that Are Not Upgradient [E-6f(3)]. Background groundwater composition could be based on samples from wells that are not upgradient from the TSD unit. The justification of well locations for unit background water quality is addressed in the unit-specific permit applications.

5.6.6 Background Values [E-6g]

Area and/or natural background concentration values will be proposed for each groundwater monitoring parameter identified for the compliance-level monitoring program. The exact sampling periods, frequencies, and statistical methods used to establish the area background values will be presented in the unit-specific permit applications. Natural background values will be established in conjunction with the Hanford Site-wide background study. Background will be established for additional constituents identified in the Appendix IX analysis. It is anticipated that those procedures and techniques used to establish area background conditions under the final status detection-level monitoring program will be applied.

5.6.7 Sampling, Analysis, and Statistical Procedures [E-6h]

A proposed sampling and analysis plan including procedures for sample collection, sample preservation and shipment, analytical methods, and chain-of-custody controls, will be prepared if compliance-level monitoring becomes necessary. The basic information for sample collection, sample preservation and shipment, analytical methods, and chain-of-custody procedures will not change from the proposed plans submitted under the detection-level monitoring program (Section 5.5). To comply with WAC 173-303-645(10)(d), the compliance-level monitoring wells will be sampled at least quarterly for the specified groundwater parameters and waste constituents (40 CFR 264, Appendix IX). If verified groundwater monitoring results indicate that appropriate groundwater protection standards (e.g., maximum concentration limit or alternate concentration limit; or applicable, relevant, and appropriate requirements) are exceeded at any monitoring well

along the line of compliance, written notification will be made to Ecology within 7 days of the finding. An application for a permit modification to establish a corrective action program (Section 5.7) will be submitted within 90 days [WAC 173-303-645(10)(i)(i)(ii). In the case of a false positive claim, the owner/operator will notify Ecology within 7 days in accordance with WAC 173-303-645(10)(j).

5.6.7.1 Sample Collection [E-6h(1)-(4)]. This information will not change from the proposed plans submitted under the detection level monitoring program (Section 5.5.4).

5.6.7.2 Additional Requirements for Compliance Point Monitoring [E-6h(5)]. Under compliance monitoring, additional activities will be conducted to provide a more protective monitoring program.

5.6.7.2.1 Sample Frequency [E-6h(5)(a)]. Under compliance monitoring downgradient compliance wells will be sampled quarterly.

5.6.7.2.2 Compliance Point Groundwater Quality Values [E-6h(5)(b)]. Analytical groundwater quality data will be prepared in an appropriate form for full statistical analysis. These data will exist primarily in tabular form and will consist of raw data from each independent sample obtained during each sampling event. The presentation of the statistical evaluation of the data will depend on the exact nature of the compliance limits (Section 5.6.4).

5.6.7.3 Annual Determination of Hydraulic Gradient [E-6h(6)]. Under compliance monitoring, the hydraulic gradient will be determined annually and the efficiency of the monitoring well network will be addressed. If warranted, additional monitoring wells will be installed.

5.6.7.4 Statistical Determination for Compliance Monitoring Program [E-6h(7)]. Statistical evaluation procedures under compliance monitoring program depend on the type of compliance limit. If the compliance limit is determined from the area background, the statistical method will be chosen to compare the composition of groundwater from background wells to those from compliance wells [WAC 173-303-645(10)(c)], (e.g., statistical methods presented in Section 5.5.4.7). If the compliance limit is a specified constant limit such as maximum concentration limit or alternate concentration limit, the appropriate statistical procedures will compare the compliance well concentrations estimated from sampling with the prescribed fixed limits. The recommended procedure is to compare the mean (or median) compliance well concentration against the compliance limit by constructing a confidence interval (EPA 1989d). If the permit requires that a compliance limit is not to be exceeded more than a specified fraction of the time, then the construction of tolerance limits will be the recommended procedure (EPA 1989d). Specific statistical evaluation procedures will be identified in the unit-specific permit applications.

5.7 CORRECTIVE ACTION PROGRAM [E-7]

If, at the point of compliance, dangerous constituents are measured in the groundwater at concentrations that exceed accepted water quality standards, sufficient data, supporting information, and analyses will be provided to establish a corrective action program.

The development of a corrective action program for the TSD units will include the following information:

- Characterization of the chemical nature of groundwater at each well circumscribing the affected regulated unit; characterization will provide concentrations of each constituent listed in WAC 173-303-9905, major cations and anions, and constituents listed in Table I of WAC 173-303-645(5) if not previously determined

- Proposed concentration limits for each dangerous constituent if different from the maximum concentration limits established by Ecology

- Detailed engineering report that includes (1) locations of all engineered barriers, caps, drains, and wells; (2) proposed plans for removing and treating dangerous waste and contaminated groundwater; (3) proposed concentration limits of constituents for reinjected treated groundwater; (4) operation and maintenance plans for the corrective action measures; and (5) a prediction and sensitivity analysis for estimating the effectiveness of the proposed corrective action program

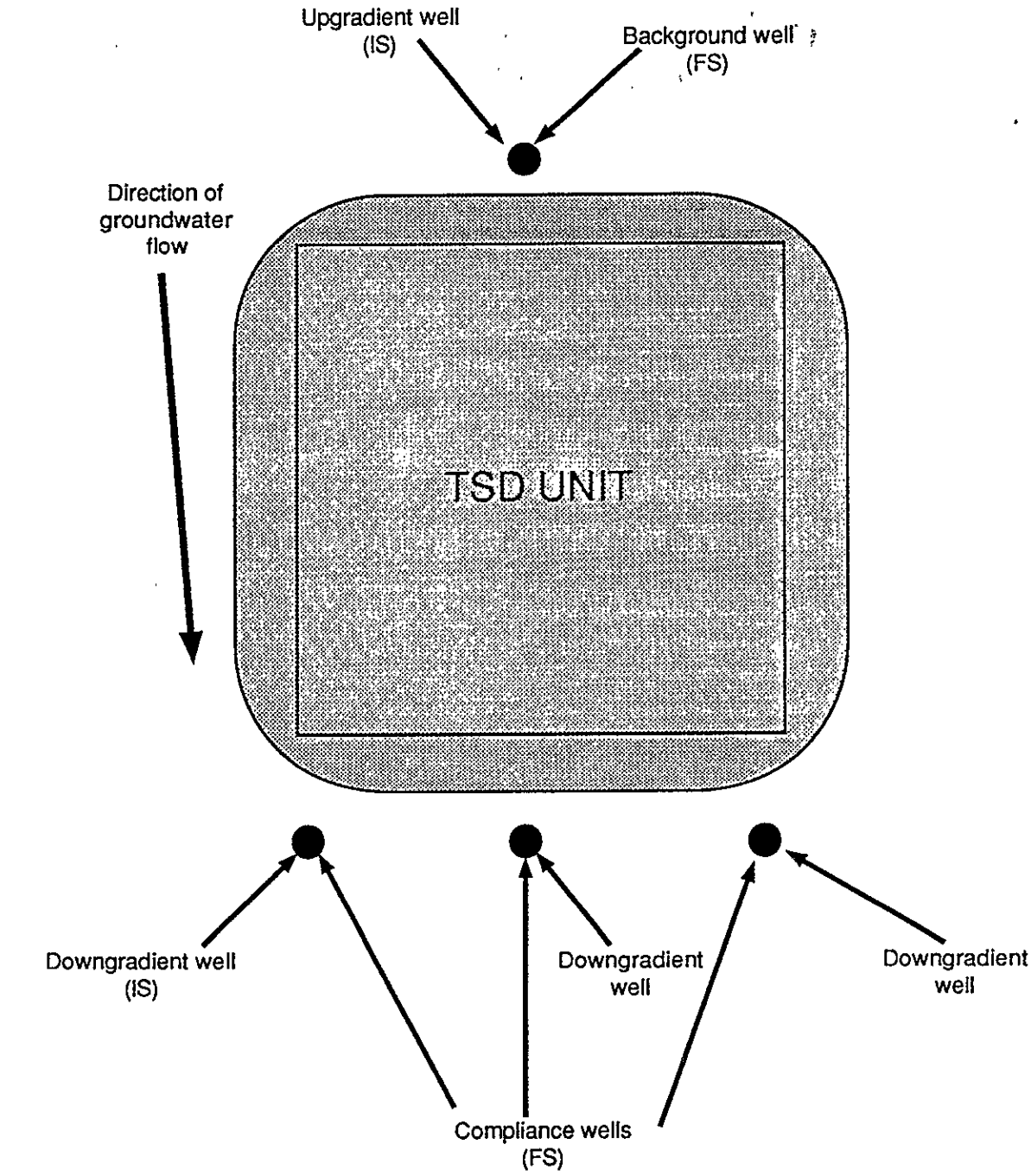
- Applicable closure and postclosure care plans for the materials used to handle the dangerous waste as part of the corrective action.

In addition to these details for the corrective action program, a description of the groundwater monitoring plan that will be used to assess the effectiveness of the corrective action measures will be submitted. This groundwater monitoring plan will be similar in scope to the detection level monitoring plan developed under Section 5.5 and will include all relevant information pertaining to the location and description of monitoring wells, groundwater sampling and analysis plans, statistical methods, and quality assurance and quality control procedures.

Background levels for groundwater currently are being determined for the entire Hanford Site to establish a base line for cleanup activities (WHC 1991a). This involves the statistical determination of representative background concentrations for inorganic elements in the aquifer, based on the natural variations measured across the Hanford Site. This method will result in a more accurate characterization of background levels by recognizing that the aquifer is a single unit, and that efficient groundwater restoration and remediation must be addressed on the scale of the aquifer, not at the scale of the individual TSD units. The basic concepts of this work are that (1) natural variations exist in the composition of groundwater within the unconfined aquifer beneath the Hanford Site, (2) the compositional

variability is due to systematic natural processes that control the distribution and range of compositions, and (3) the natural variability in groundwater composition occurs on the scale of the aquifer both laterally and vertically.

The concentrations established in conjunction with the Hanford Site-wide background program will eliminate the need to determine cleanup levels for each individual TSD unit. This will reduce the time and costs currently being expended for drilling and sampling unit-specific background wells, and will further benefit cleanup efforts by the uniform application of cleanup standards across the Hanford Site. Details of the Hanford Site-wide background program are provided in Appendix 11C.



Waste management area
[Limited projection in the horizontal plan of the area on which waste will be placed during the active life of the regulated unit (WAC 173-303-645(6)(b).]

IS = Interim status
FS = Final status

Figure 5-1. Generalized Configuration for a Detection Monitoring Groundwater Well System.

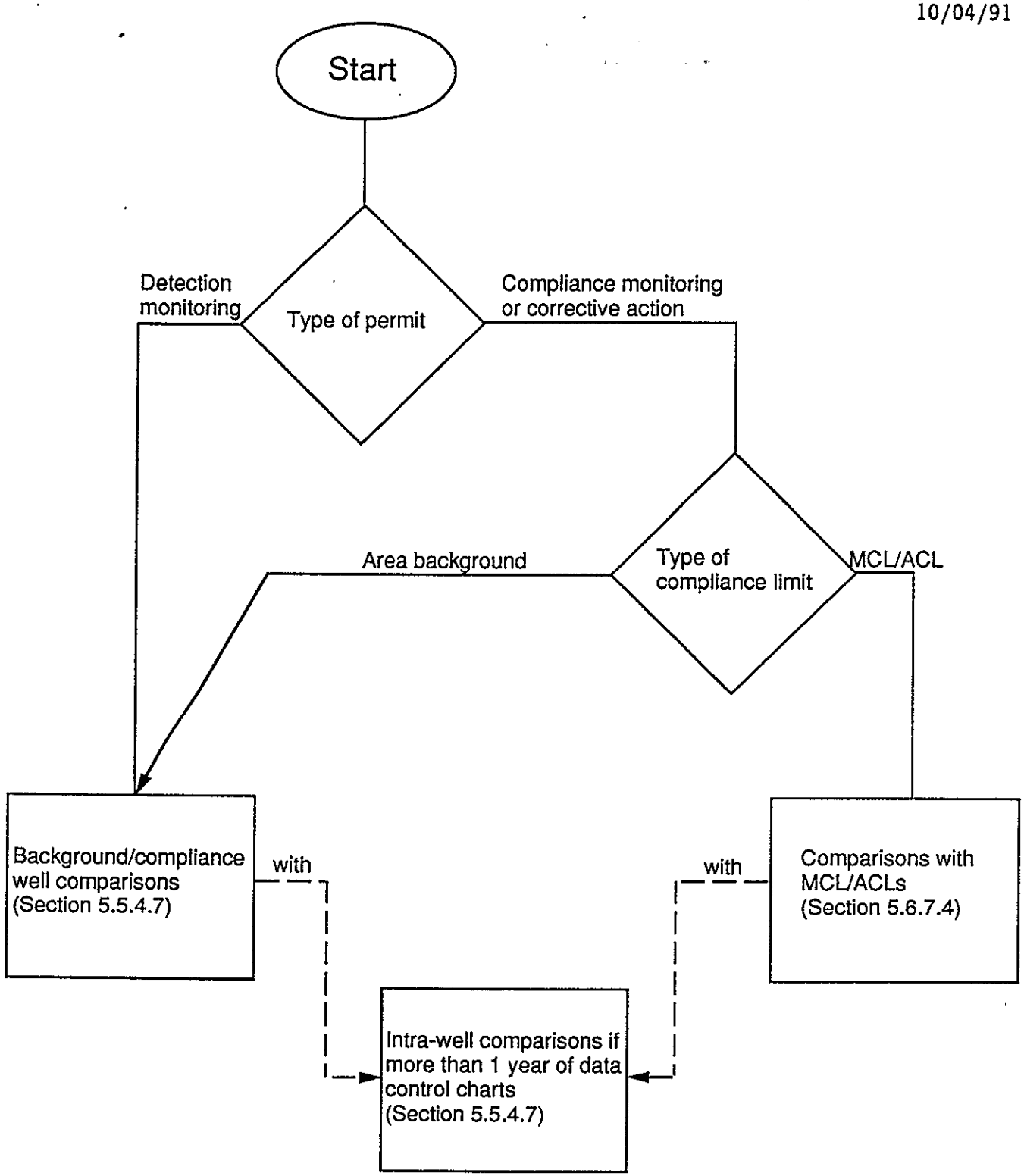


Figure 5-2. Flow Chart for Selection of Appropriate Statistical Method Used for Data Interpretation.

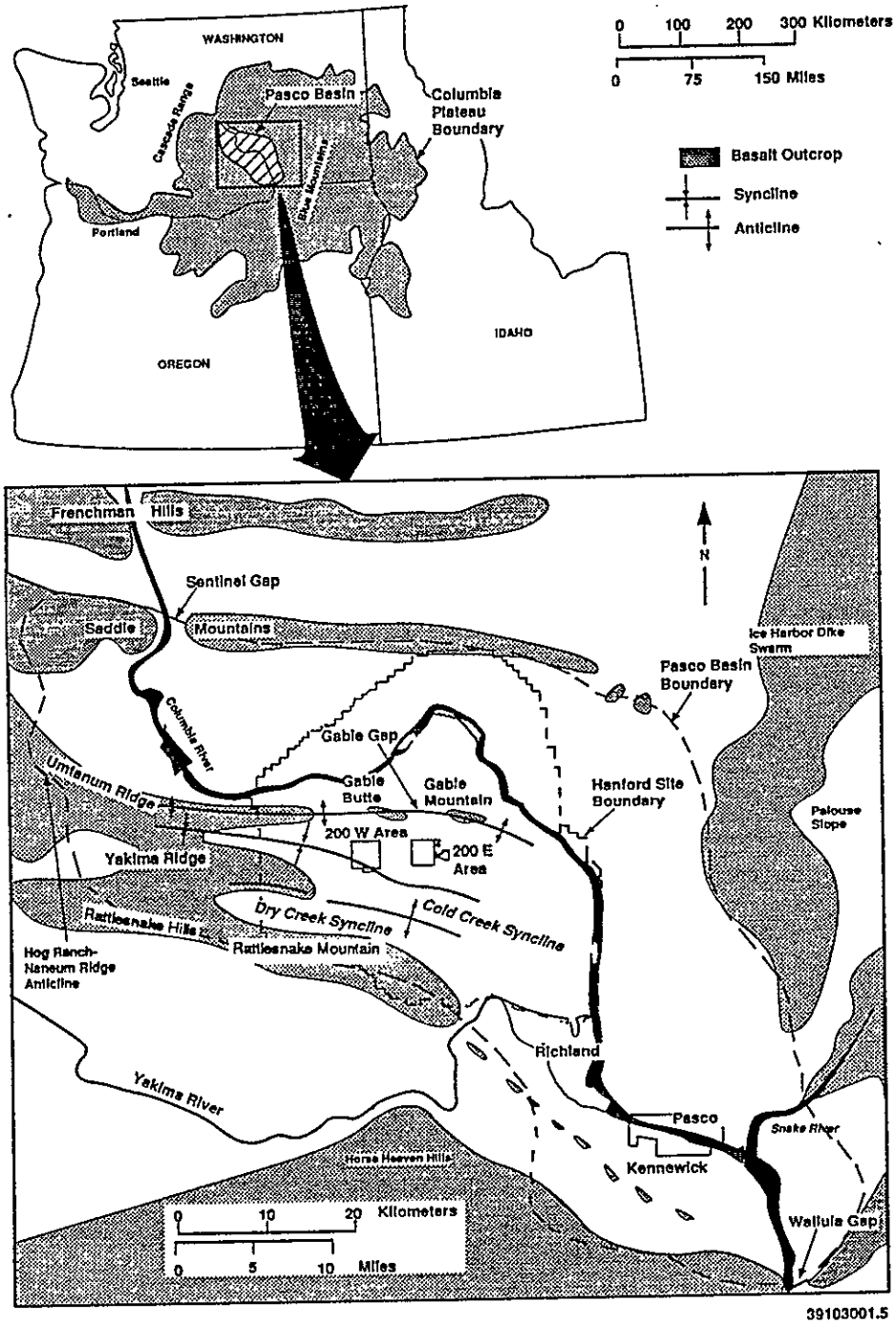


Figure 5-3. Location of Bounding Structures of the Pasco Basin.

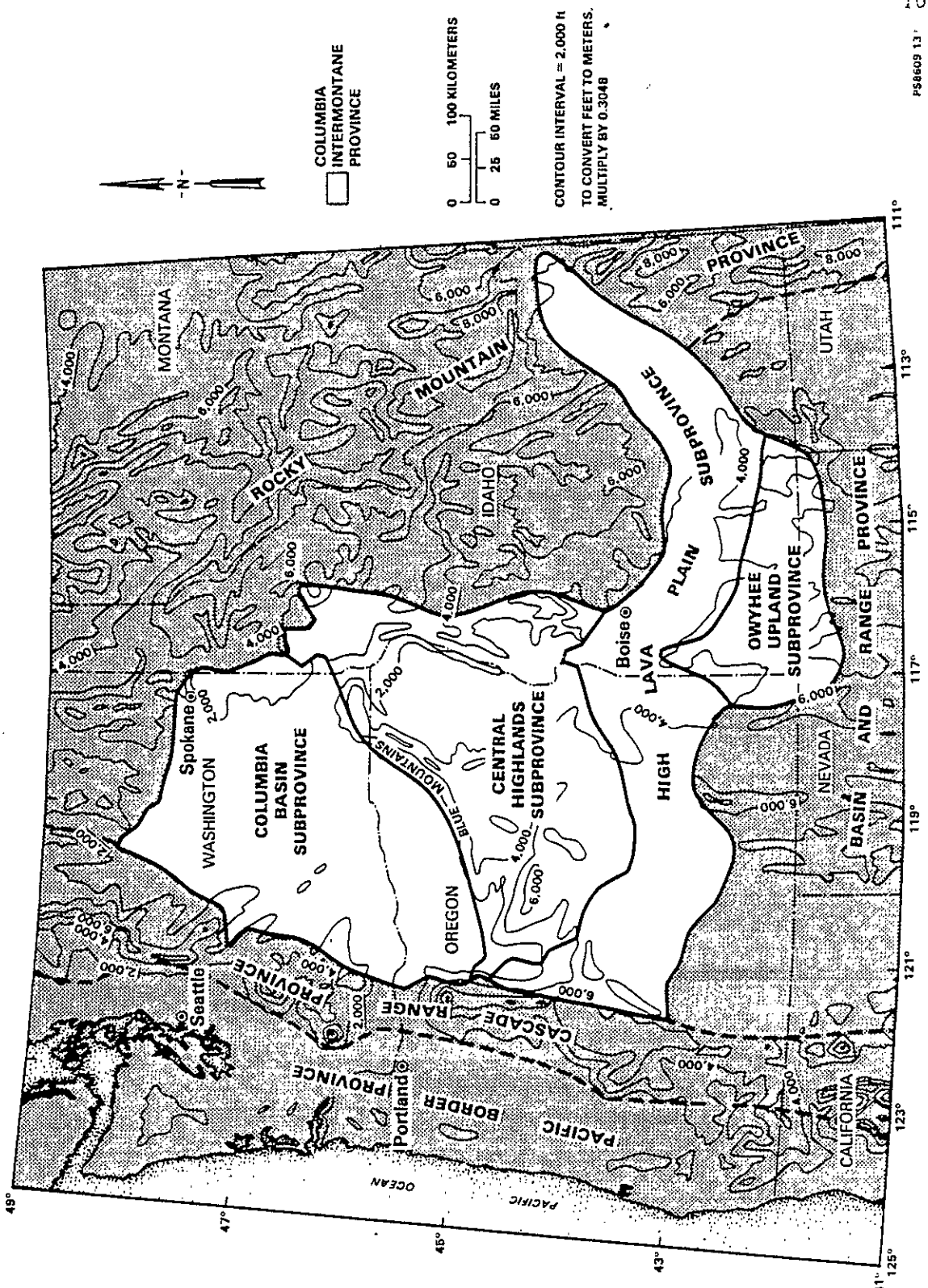


Figure 5-4. Divisions of the Columbia Intermontane Province and Adjacent Snake River Plains Province.

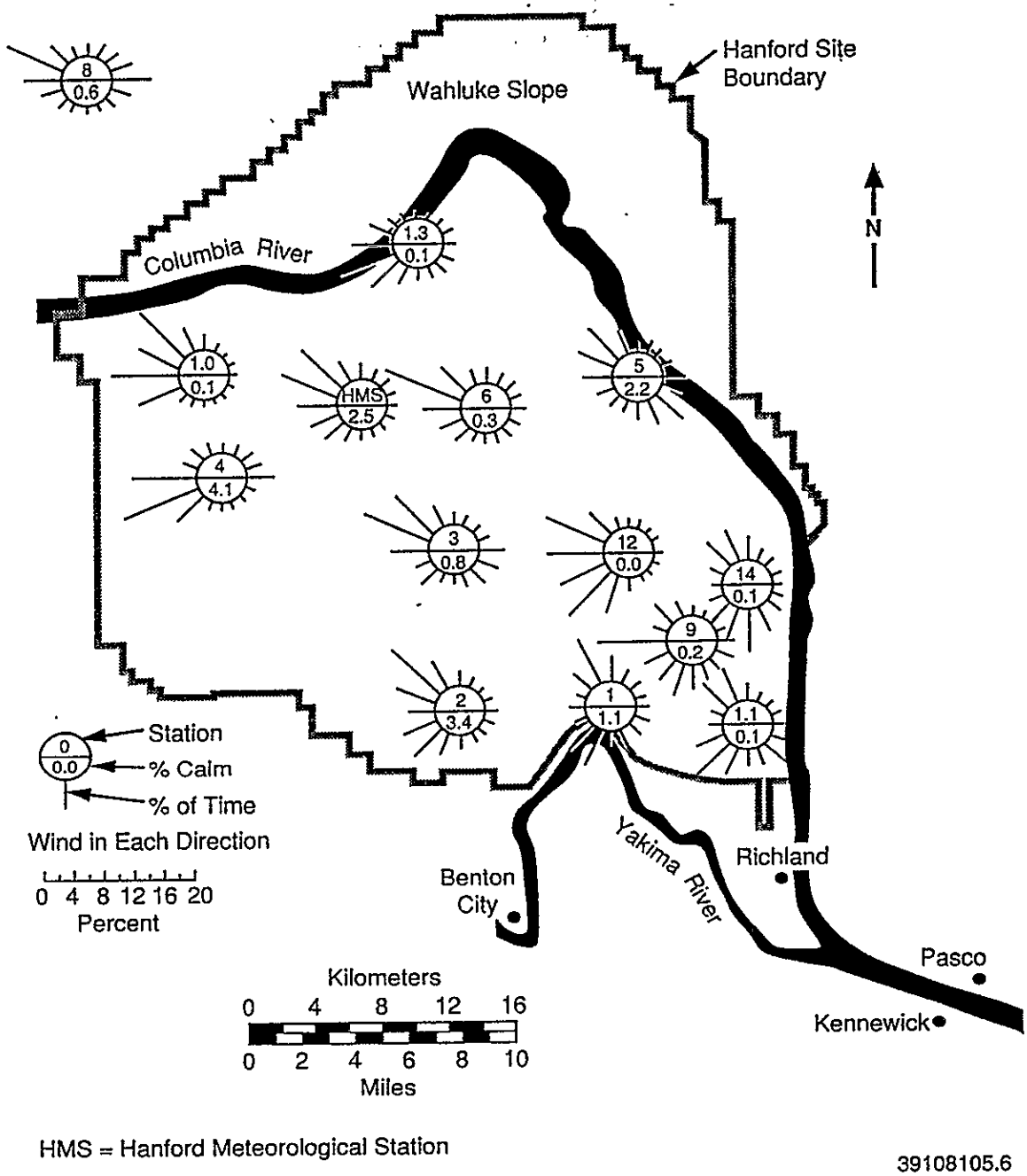


Figure 5-5. Wind Roses for the Hanford Telemetry Network (1979-1982) Showing Primary Wind Directions Throughout the Hanford Site.

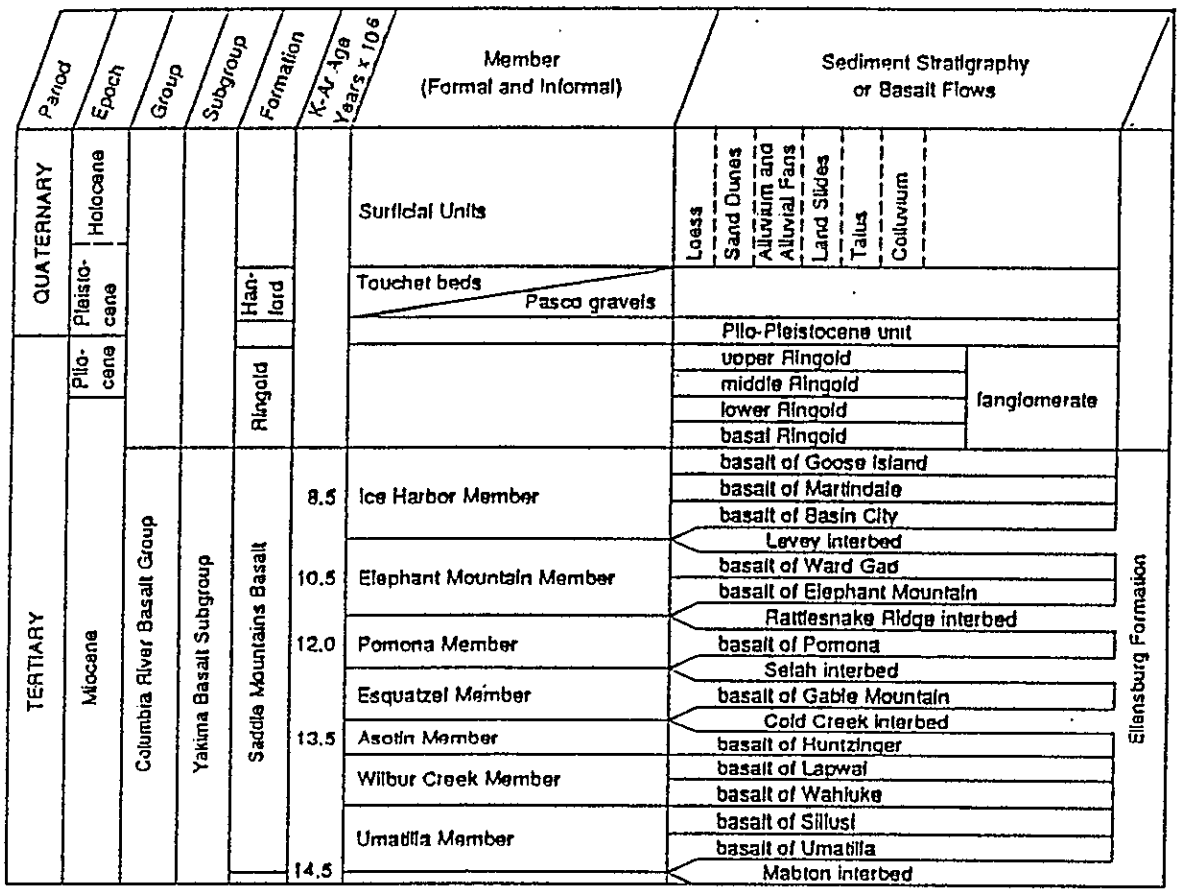
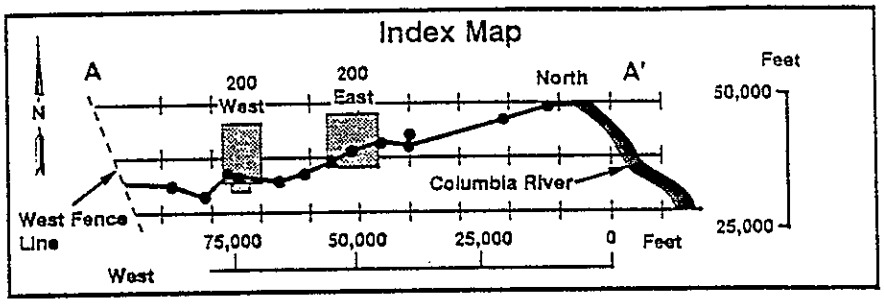


Figure 5-6. Generalized Stratigraphic Column of Formations at the Hanford Site.



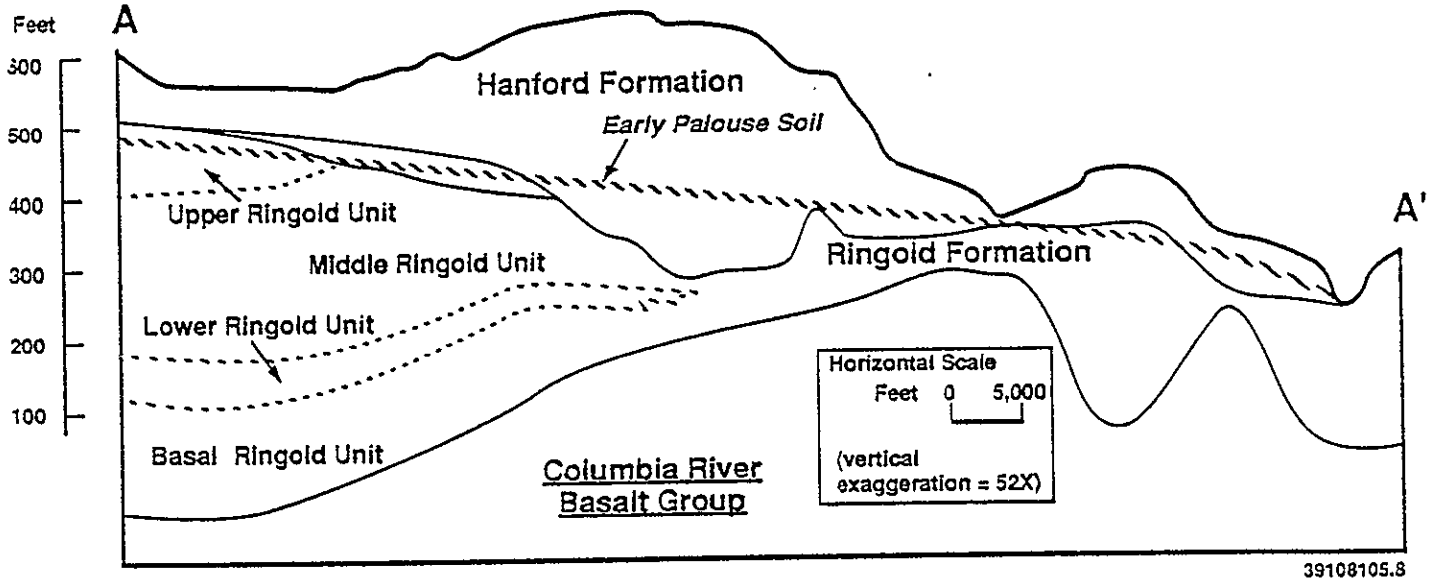


Figure 5-7. Generalized Geologic Cross Section Through the Hanford Site (after Tallman et al. 1979, p. 20).

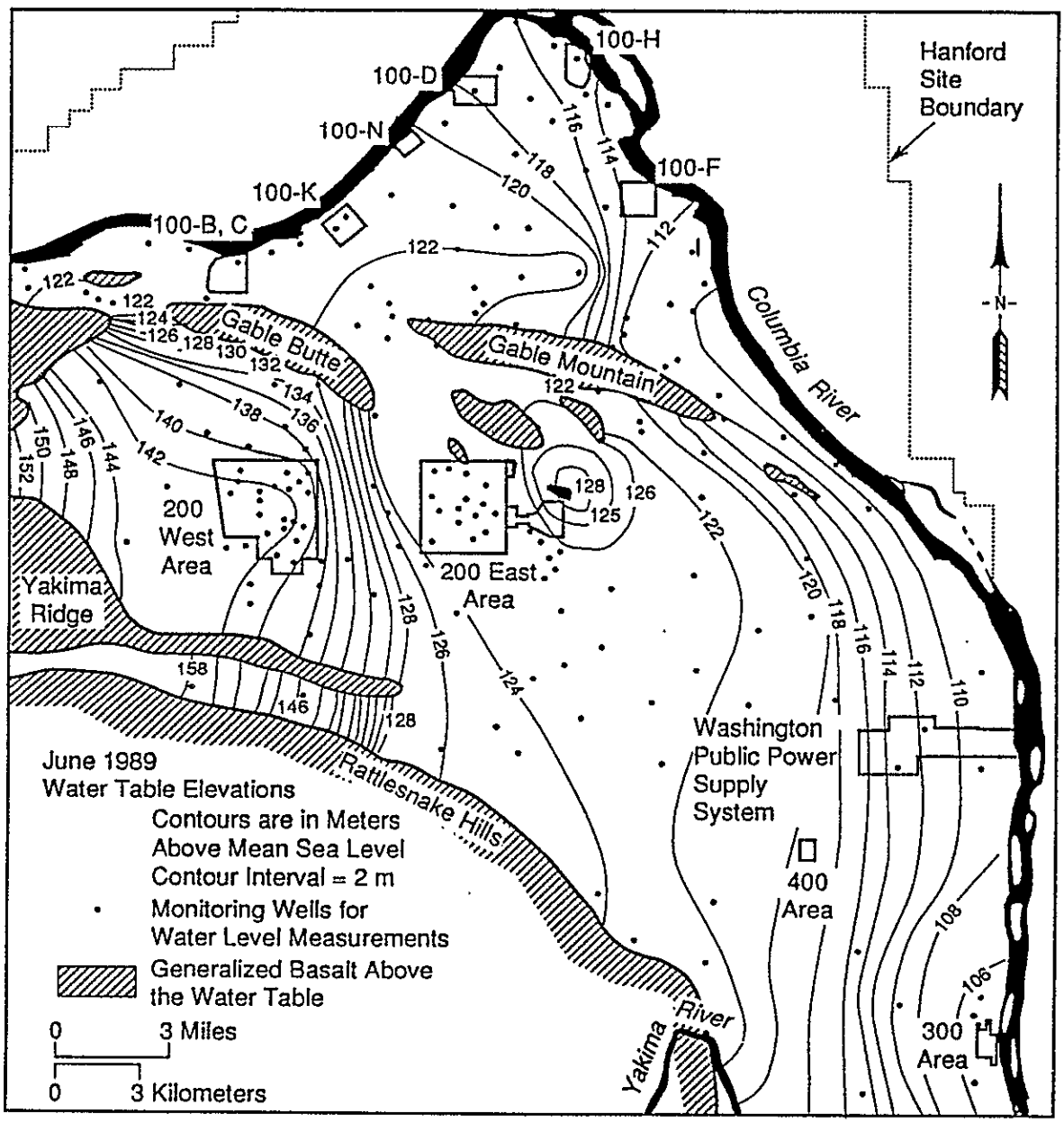
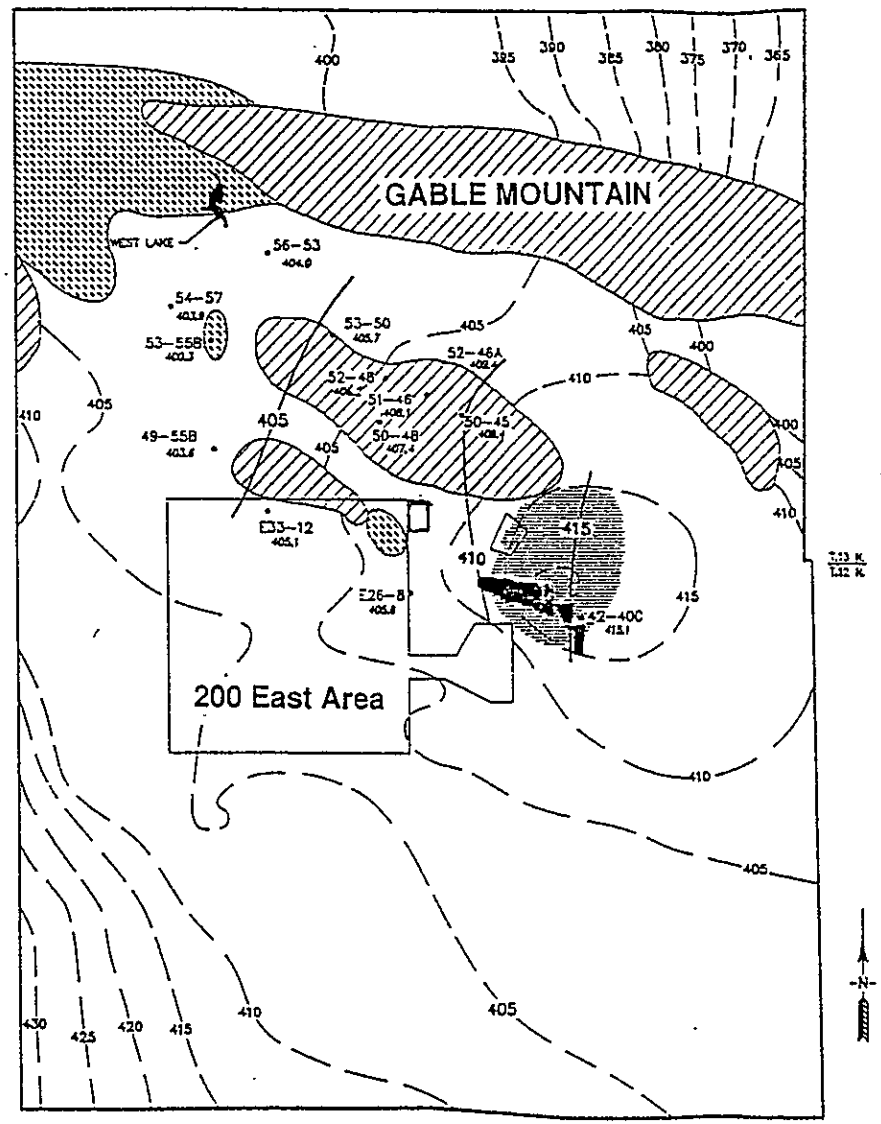


Figure 5-8. Water Table Map of the Hanford Site (June 1979) (Smith and Gorst 1990).



Comparison of Potentiometric Surface of the Rattlesnake Ridge Confined Aquifer with the Water Table of the Unconfined Aquifer

December 1989

- 400 — Potentiometric surface of the Rattlesnake Ridge confined aquifer in feet above mean sea level (ft msl)
- Water table contours in feet above mean sea level
- Areas of complete erosion of the Elephant Mountain Member (from RHO-RE-ST-12)
- Areas of downward hydraulic gradient
- 50—45 405 — Wells in confined aquifer used in preparation of maps
- Pond
- Generalized basalt above water table, as inferred 6/84

The Rattlesnake Ridge aquifer, which is confined by the Elephant Mountain Member, is monitored quarterly in the eastern portion of the separations area. The December 1989 water-level measurements in 13 wells completed in the Rattlesnake Ridge interbed were used to contour the potentiometric surface of the aquifer. Areal extent of downward hydraulic gradient from the water-table map and the contours of the potentiometric surface of the Rattlesnake Ridge. This area represents the zone in which downward flow might occur if a pathway is available due to complete erosion of the Elephant Mountain Member or sufficiently high hydraulic conductivity in the basalt.

The potentiometric surface of the Rattlesnake Ridge confined aquifer map is prepared by the Environmental Engineering Technology & Permitting Function of the Environmental Division of Westinghouse Hanford Company.

Note: To convert to metric, multiply elevation (ft) by 0.3048 to obtain elevation (m).

N

0 — 1 Mile

0 — 1 Kilometer

39103001.6

Figure 5-9. Potentiometric Surface of the Rattlesnake Ridge Aquifer Beneath the Hanford Site.

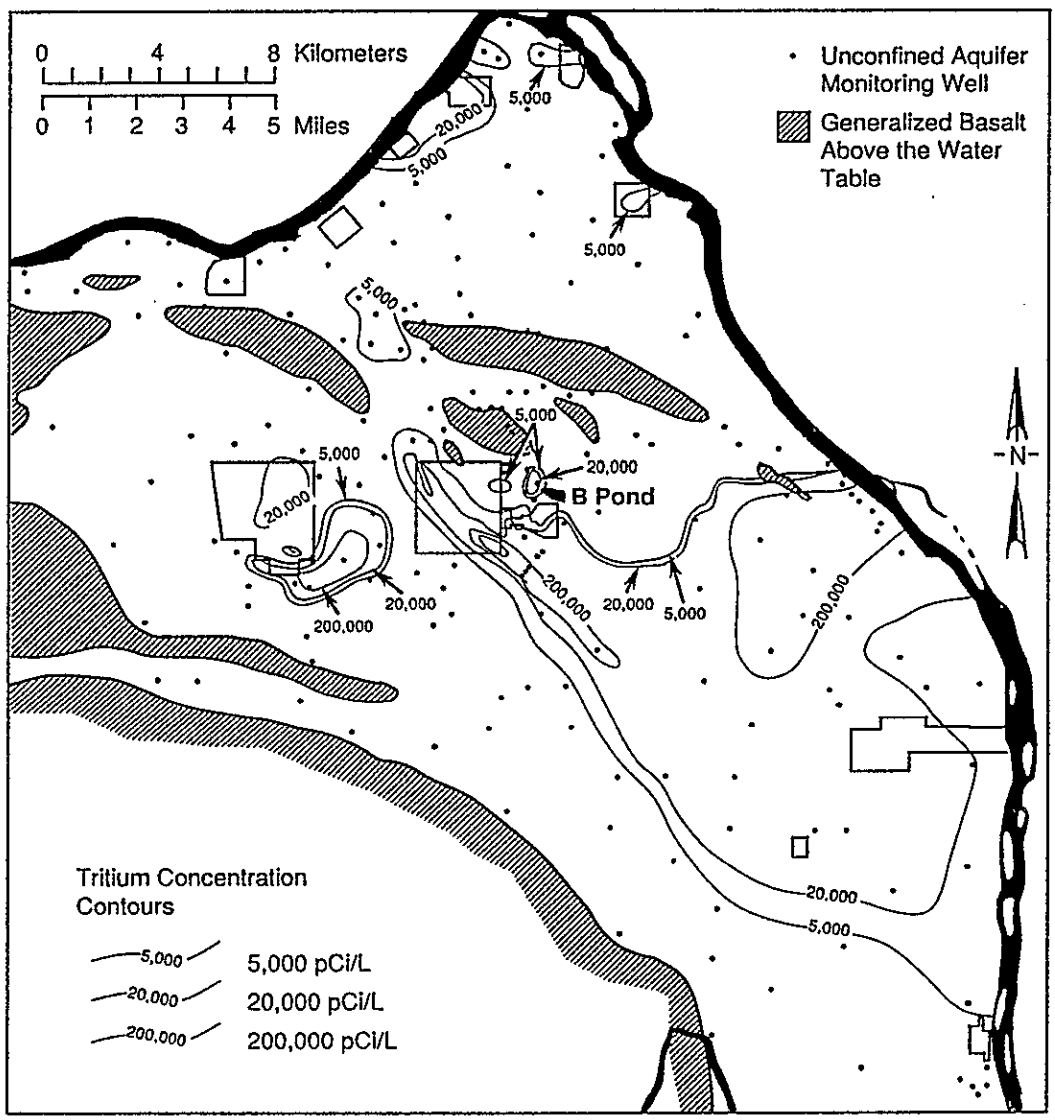


Figure 5-10. Distribution of Tritium on the Hanford Site, 1989 (Evans et al. 1990).

Table 5-1. Status of Hanford Site *Resource Conservation and Recovery Act* Interim-Status Groundwater Monitoring Projects As of December 31, 1990.[a]

Project (date initiated)	Status: Background monitoring	Status: Indicator parameter evaluation	Status: Groundwater quality assessment	Regulatory requirements
Grout Treatment Facility (8/85)		X		40 CFR 265.93(b) WAC 173-303-400
Liquid Effluent Retention Facility	X[b]			40 CFR 265.92(c) WAC 173-303-400
Low-Level Burial Grounds Waste Management Area 1 (9/88)[c]			X (12/89) Specific conductance	40 CFR 265.93(d) WAC 173-303-400
Low-Level Burial Grounds Waste Management Area 2 (9/88)		X		40 CFR 265.93(b) WAC 173-303-400
Low-Level Burial Grounds Waste Management Area 3 (10/88)			X (12/89) Total organic halogen	40 CFR 265.93(d) WAC 173-303-400
Low-Level Burial Grounds Waste Management Area 4 (10/88)		X		40 CFR 265.93(b) WAC 173-303-400
Low-Level Burial Grounds Waste Management Area 5	X[d]			40 CFR 265.91 WAC 173-303-400

[a] DOE-RL 1991a with modifications.
[b] Monitoring wells are ready for sampling.
[c] Burial grounds comprising the Low-Level Burial Grounds are not contiguous; therefore, groundwater monitoring systems have been established on a waste management area basis for each burial ground.
[d] Monitoring wells are in various stages of completion.

Table 5-2. Laboratory Analyses to be Performed as Part of Hydrogeologic Characterization.

Laboratory analysis	Parameter measured	Sample requirements/ limitations	Potential uses	Sample frequency	Method of sample collection[a]
Sieving	Particle-size distribution of sand to gravel-size particles	Individual soil particles must be disaggregated and unbroken to yield accurate results	Proxy for hydraulic parameters; groundwater modeling	All samples	SS, DB, HT
Hydrometer	Particle-size distribution of mud-size particles (i.e., silt and clay)	Fine grained; undisturbed/intact soils	Characterize aquitards; groundwater modeling	All fine-grained intervals	SS, DB
Permeameter	Saturated hydraulic conductivity	Undisturbed/intact soils	Determine rate of groundwater movement; check for aquifer tests; groundwater modeling	Selected intervals	SS
Calcium carbonate	Percent $CaCO_3$	Soils of fine sand or smaller particles	Aquitard identification; stratigraphic marker horizons	All samples	SS, DB, HT
Moisture content	Percent water	Undisturbed/intact soils	Evaluate vadose water movement; aquitard identification; groundwater modeling	All fine-grained intact intervals	SS, DB
Petrography	Mineral content/ concentration	Soils with sand and larger particles	Differentiate among hydrostratigraphic units	Selected samples where major geologic contacts are suspected	SS, DB, HT
X-ray diffraction (XRD)	Clay mineral identification	Soils with mud-size particles	Sorptive characteristics; hydrostratigraphic unit identification	Selected fine-grained intervals	SS, DB, HT
X-ray fluorescence	Major and trace element concentrations (except sodium and magnesium)	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Atomic absorption	Sodium and magnesium concentrations	Intact soils or soils uncontaminated with overlying material	Hydrostratigraphic unit identification; determine background levels of constituents in soils	Selected intervals where lithology changes	SS, DB, HT
Bulk mass density	Bulk porosity	Undisturbed/intact soils	Determine hydraulic parameters; groundwater modeling	Selected intervals	SS
Hazardous chemicals	Concentrations of hazardous constituents in groundwater	Nonturbid groundwater; soil samples	Determine presence/absence of groundwater contamination	All groundwater-bearing zones at regular intervals	Pump from completed well
Radionuclides	Concentrations of radionuclides in groundwater	Nonturbid groundwater; soil samples	Determine presence/absence of groundwater contamination	All groundwater-bearing zones at regular intervals	Pump from completed well

[a] SS=split-spoon drill method, DB=drive-barrel drill method, HT=hard-tool drill method.

Table 5-3. Sample Container, Preservative, and Holding Time Requirements for Interim Status Monitoring.

Analysis	Container[a]	Preservation	Maximum holding time
Dissolved metals	P,G	HNO_3 to pH<2	6 months
Total metals	P,G	HNO_3 to pH<2	6 months
Cyanide, total	P,G	NaOH to pH>12	14 days
Volatile organic compounds	G, Teflon[b] septum	Cool, 4 °C	14 days
Semivolatile organic compounds	G, Teflon-lined cap	Cool, 4 °C	40 days after extraction
Total organic carbon	G, teflon-lined cap	Cool, 4 °C, H to pH<2	7 days
Total organic halogens	G, teflon-lined cap	Cool, 4 °C, H_2SO_4 to pH<2	7 days
Gross alpha	P,G	HNO_3 to pH<2	6 months
Gross beta	P,G	HNO_3 to pH<2	6 months

[a] G = glass, P = polyethylene.

[b] Teflon is a trademark of E.I. DuPont de Nemours & Company.

Table 5-4. Example Travel Times for Conservative Contaminants.

Area	Travel time	Reference
100	5 Days	Chitwood and Renberger 1969
	101 Days	Eliason 1967
200 East	30 Years	Brown, et.al. 1979
	10 to 20 Years	USGS 1987
200 West	80 to 120 Years	Brown, et.al. 1979
	80 to 120 Years	Graham et al. 1981, p. 3-20

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APPENDIX

6A HANFORD FACILITY GENERAL INSPECTION PLAN . . . . . APP 6A-i

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6.0 PROCEDURES TO PREVENT HAZARDS [F]

The Hanford Facility is operated to minimize exposure of the general public and operating personnel to dangerous waste. This chapter describes the security, inspection frequencies and procedures, and emergency response equipment available to prevent, minimize, and control exposure of the general public and operating personnel to dangerous waste.

6.1 SECURITY [F-1]

The following sections describe the security measures, equipment, and warning signs used to control entry to the Hanford Facility. Security measures, equipment, and warning signs used to control entry to individual TSD units are provided in unit-specific permit applications.

6.1.1 Security Procedures and Equipment [F-1a]

The following sections describe the 24-hour surveillance system, warning signs, and barriers used to provide security and controlled access to the Hanford Facility.

6.1.1.1 24-hour Surveillance System [F-1a(1)]. The entire Hanford Facility is a controlled access area and is expected to remain so for the foreseeable future. The Hanford Facility maintains around-the-clock surveillance for protection of government property, classified information, and special nuclear materials. The Hanford Patrol maintains a continuous presence of armed guards to provide additional security.

6.1.1.2 Barrier and Means to Control Entry [F-1a(2),(2a),(2b)]. Manned barricades are maintained around the clock at checkpoints on vehicular access roads leading to the operational areas of the Hanford Facility. All personnel accessing these areas must have a U.S. Department of Energy-issued security identification badge indicating the appropriate authorization. Personnel also might be subject to a search of items carried into or out of these areas.

6.1.1.3 Warning Signs [F-1a(3)]. Warning signs stating "DANGER--UNAUTHORIZED PERSONNEL KEEP OUT" are, or will be, posted at individual TSD units within the Hanford Facility. These signs are, or will be, written in English, legible from a distance of 25 feet (7.6 meters), and visible from all angles of approach.

6.1.2 Waiver [F-1b,b(1),b(2)]

Waivers of the security procedures and equipment requirements for the Hanford Facility will not be requested. Therefore, the requirements of WAC 173-303-310 are not applicable to the Hanford Facility. If security waivers are requested for individual TSD units, the measure taken to ensure

compliance with the requirements of WAC 173-303-310 will be provided in the unit-specific permit applications.

6.2 INSPECTION SCHEDULE [F-2]

A Hanford Facility General Inspection Plan is included as Appendix 6A. This plan will complement inspection plans included in TSD unit-specific permit applications and will provide for the conduct of a general facility inspection of areas not covered by unit-specific plans. Inspections will be conducted on a frequency that allows for all areas subject to the plan to be inspected once every 2 years. The need for more detailed and frequent inspections of the Hanford Facility is considered to be limited, as Hanford Site-wide cleanup efforts have been, and will continue to be, performed on a regular basis. In addition, training programs currently in place at the Hanford Site (Chapter 8.0) are designed to develop and maintain a heightened employee awareness of the responsibility to identify and report situations that could result in environmental problems. The Hanford Facility Inspection Plan will be implemented 6 months after approval of the initial Hanford Facility Permit.

6.3 WAIVER OR DOCUMENTATION OF PREPAREDNESS AND PREVENTION REQUIREMENTS [F-3]

The emergency preparedness and prevention measures taken for the Hanford Facility are described in the unit-specific permit applications. Most of the Hanford Facility TSD units are equipped with internal communication systems to relay emergency or other information to unit personnel. The internal communication systems include telephones, various alarm systems, and hand-held or vehicle two-way radios. Alarm systems exist at various locations throughout the Hanford Facility to allow personnel to respond appropriately to various emergency situations, including the following: building evacuations, take-cover events, and fire and/or explosion. Telephones are located throughout the Hanford Facility and provide both internal and external communication. In addition, the following external communication systems are available for notifying persons assigned to emergency response organizations:

- Fire alarm pull boxes and fire sprinkler flow monitoring devices--connected to a system monitored around the clock by the Hanford Fire Department

- Telephone number 811--contact point for the Hanford Site; on notification, the Hanford Patrol Operations Center notifies and/or dispatches required emergency responders

- Telephone number 373-3800--single point of contact for the operations and engineering contractor emergency duty officer; this number can be dialed from any Hanford Facility telephone

- Crash alarm telephone system--consists of selected telephones that are disassociated from the regular system and are connected automatically to control stations

- Two-way radio system--consists of hand-held or vehicle radios; the system accesses the Hanford Facility emergency network and can summon the Hanford Fire Department, Hanford Patrol, and/or any other assistance needed to deal with emergencies.

6.4 PREVENTIVE PROCEDURES, STRUCTURES, AND EQUIPMENT [F-4]

The preventive procedures, structures, and equipment used on the Hanford Facility are described in the unit-specific permit applications. Preventive procedures are in place to ensure that unloading activities are conducted in a safe manner and that run-off of liquid spilled during waste unloading operations are contained and disposed of properly. In those areas of the Hanford Facility where significant risk of exposure to dangerous, radioactive, or mixed waste exists, personnel are required to wear protective suits and/or respiratory devices, depending on the specific hazard that could exist. Procedures are in place at specific TSD units to provide backup power to equipment critical to unit operation.

A plan also is in place to address response measures to control and mitigate effects to health and the environment for any spill or release between TSD unit boundaries (e.g., onsite transportation) (Chapter 7.0).

6.5 PREVENTION OF REACTION OF IGNITABLE, REACTIVE, AND INCOMPATIBLE WASTES [F-5]

Unit-specific permit applications for TSD units that store or treat ignitable or reactive waste will describe procedures and precautions to prevent the reaction of ignitable, reactive, and incompatible waste. A plan also is in place to address preventive measures to be taken when handling waste in areas between specific TSD unit boundaries (e.g., onsite transportation) (Chapter 7.0).

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7.0 CONTINGENCY PLAN [G] 7-1

APPENDIX

7A HAZARDOUS MATERIALS RESPONSE PLAN . . . . . APP 7A-i

7.0 CONTINGENCY PLAN [G]

The WAC 173-303 requirements for a Hanford Facility contingency plan are addressed in the following documents: the DOE-RL emergency plan and procedures manual, the *Emergency Plan* (WHC 1989e), and *Emergency Preparedness* (PNL 1991). The permit applications for individual TSD units will provide unit-specific emergency plans where necessary. Guidance to all Hanford Facility contractors for response to a nonradiological hazardous materials spill or release at Hanford Facility locations not covered by TSD unit-specific contingency plans or building emergency plans is provided in Appendix 7A, the Hazardous Materials Response Plan. This appendix includes response for spills or releases as a result of transportation activities, movement of materials, packaging, and storage of hazardous materials. Current copies of all contingency plan documents cited in Chapter 7.0 can be accessed by contacting the Regulatory File Custodian (Chapter 12.0).

The cited contingency plan documents also serve to satisfy a broad range of other requirements (e.g., Occupational Safety and Health Administration and U.S. Department of Energy Orders). Therefore, revisions made to portions of the contingency plan documents that are not governed by the requirements of WAC 173-303 will not be considered as modifications subject to review or approval by Ecology. The DOE-RL emergency plan will take precedence over any inconsistencies noted in the previously cited emergency plans.

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8.0 PERSONNEL TRAINING [H]

This chapter outlines the training program approved and implemented by the DOE-RL for employees whose duties are identified as being related to dangerous waste management. This training program contributes to the assurance that TSD units are, and will be, operated and maintained in accordance with requirements of the EPA, Ecology, Occupational Safety and Health Administration, and the U.S. Department of Energy.

8.1 OUTLINE OF THE TRAINING PROGRAM [H-1]

This program meets the requirements of WAC 173-303-330 for the development of a written dangerous waste training program.

The training program is overseen by the DOE-RL and prepares employees to maintain and operate Hanford Facility TSD units in a safe, efficient, and environmentally sound manner. In addition to preparing employees to operate and maintain the TSD units under normal conditions, the program ensures that employees are prepared to respond in a prompt and effective manner should abnormal or emergency conditions occur. Emergency response training is consistent with emergency responses outlined in TSD unit-specific contingency plans.

According to this training program, all employees receive a level of dangerous waste training commensurate with their position. This training program includes the following:

- A description of the four dangerous waste worker categories in which all employees could be classified
- A written description of the type and amount of both initial and continuing training required by employees, based on their worker category classification
- A description of the system used to document the training received and completed by employees.

The Hanford Site contractors are responsible for developing and administering the courses required by this training program. The TSD unit management is responsible for identifying TSD unit- and job-specific training requirements for TSD unit employees and for ensuring that employees complete the appropriate training.

8.1.1 Job Positions and Descriptions [H-1a]

On the Hanford Facility, each employee is assigned a job position. The specific job titles, job descriptions, and names of the employees filling each job position are maintained by contractor line management. The TSD unit-specific training information is located in unit-specific permit applications.

8.1.2 Worker Category Classification

While there are numerous job positions on the Hanford Facility, all employees can be classified into one of four categories with respect to their work responsibilities and their involvement with dangerous waste. This classification is made by an employee's manager using the Decision Flow Diagram presented in Figure 8-1. The Decision Flow Diagram was developed based on requirements regulating the training of individuals working with dangerous waste. The jobs listed for each category are not all inclusive, but are examples of the type of work that meets the criteria of that particular category.

If employees fit into two different categories of work (e.g., Category No. 2 and Category No. 4) according to the Decision Flow Diagram, the employees require the higher level of training. In the case mentioned, employees would be placed into the Category 4 classification.

8.1.3 Training Content, Frequency, and Techniques [H-1b]

This section provides an overview of the training provided for employees in each of the four employee categories identified in Figure 8-1.

8.1.3.1 Overview of Training for Specific Employee Categories. The training program includes general to specific dangerous waste training courses. The training requirements depend on the category in which the employee is classified by his manager. The four categories of workers are as follows:

- All employees
- General worker
- General supervisor/manager
- General nonradiological shipper.

In addition to the dangerous waste training required for all employees who are placed in each of these categories, TSD unit-specific certifications or qualifications must be maintained according to union contract and/or management direction.

All dangerous waste training must be completed by the employee within 6 months of being assigned to a position requiring training.

8.1.3.2 Worker Category Initial and Continuing Training. Table 8-1 and Table 8-2 relate the required training courses to the job category under which an employee is classified. The training program requirements for employees in each category are presented in the following sections.

8.1.3.2.1 Category 1 - All Employees. All new employees receive general training that provides an overview of hazard communication programs

and dangerous waste disposal requirements. The required course for new employees is "New Hire Orientation".

8.1.3.2.2 Categories 2 and 3 - General Worker and General Supervisor/Manager. According to the Decision Flow Diagram, employees who are classified as Category 2 or Category 3, have job responsibilities related to dangerous waste management. In addition to the "New Hire Orientation", the following courses are required for these employees:

- "Dangerous Waste Management"
- "Dangerous Waste Management" - TSD unit-specific information.

These courses are required as both initial and continuing training.

8.1.3.2.3 Category 4 - General Nonradiological Shipper. Employees who are classified as Category 4, according to the Decision Flow Diagram, have job responsibilities related to dangerous waste management. These individuals also are responsible for signing a Uniform Hazardous Waste Manifest. In addition to the "New Hire Orientation", the following courses are required for these employees:

- "Dangerous Waste Management"
- "Dangerous Waste Management" - TSD unit-specific information
- "Dangerous Waste Shipment Training" (for shippers of nonradioactive dangerous waste).

These courses are required as both initial and continuing training.

8.1.3.2.4 Additional Training. Employees responsible for the collection of representative samples for waste characterization and laboratory analysis also will receive training as outlined in Appendix 2B, Section 5.3.1.2, "Waste Characterization and Laboratory Analysis".

8.1.3.3 Visitor Training. All visitors who have the potential for exposure to dangerous waste while on the Hanford Facility must be trained to the levels commensurate with their anticipated job assignments.

8.1.3.3.1 Pre-job Safety Briefing. Before a visitor can enter a dangerous waste area, a pre-job safety briefing could be conducted. This briefing could include a discussion of the hazards of the work site, mitigation of those hazards, work procedures for that site, and emergency procedures.

8.1.3.3.2 Treatment, Storage, and/or Disposal Unit Management Responsibilities. Pre-job planning, training, and medical surveillance requirements must be identified and verified for all visitors requesting access to areas where there is a potential for exposure to dangerous waste. The TSD unit management has the responsibility to ensure that before the

visitors are allowed access to work sites, the visitors must have met all the requirements.

8.1.3.4 Subcontractor Training. Personnel who are subcontracted by any of the Hanford Site contractors to work at TSD units must complete the appropriate level of training required by Hanford Site contractors before commencement of work assignments.

Subcontractors who have completed training offsite are required to provide a certificate or other suitable evidence of the completion of a training course that meets the WAC 173-303 requirements.

8.1.3.5 Training Course Descriptions. Table 8-3 contains a brief outline of selected courses, including descriptions of the target audience, instructional technique, evaluation method, and frequency of retraining.

8.1.4 Training Director [H-1c]

The position of Training Director is a shared responsibility among Hanford Site contractor training, support organizations, and the TSD unit management organizations. Their responsibility is to ensure the development and implementation of the dangerous waste training program to comply with Ecology *Dangerous Waste Regulations*.

8.1.5 Relevance of Training to Job Position [H-1d]

The training program for the Hanford Facility was developed after completing a review of the federal and state dangerous waste regulations. The resulting plan ensures that employees are adequately trained to safely perform their jobs as their positions pertain to the handling, storage, treatment and/or disposal of dangerous waste. Training needs in relation to current federal and state regulations are evaluated on a continual basis. These evaluations could result in modifying or adding new material to the current training program.

In addition to dangerous waste training, employees are certified or qualified for their specific job responsibilities. These certifications and qualifications vary according to the job location and assignments of the employees and are designated by TSD unit management.

Employees also can receive additional training in accordance with other regulations such as 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" and 29 CFR 1910.1200, "Hazard Communication Program".

The TSD unit-specific training information is located in the unit-specific permit application.

8.1.6 Training to Emergency Response [H-1e]

Effective response to emergencies and familiarity with emergency equipment and emergency systems are covered under the classroom and on-the-job training. The TSD unit management must ensure that the following specific topics are addressed where applicable:

- Procedures for using, inspecting, repairing, and replacing TSD unit emergency and monitoring equipment
- Key parameters for automatic waste feed cut-off systems
- Communications or alarm systems
- Response to fires or explosions
- Response to groundwater contamination incidents
- Shutdown of operations.

Additional emergency response information and training requirements can be located in TSD unit-specific permits.

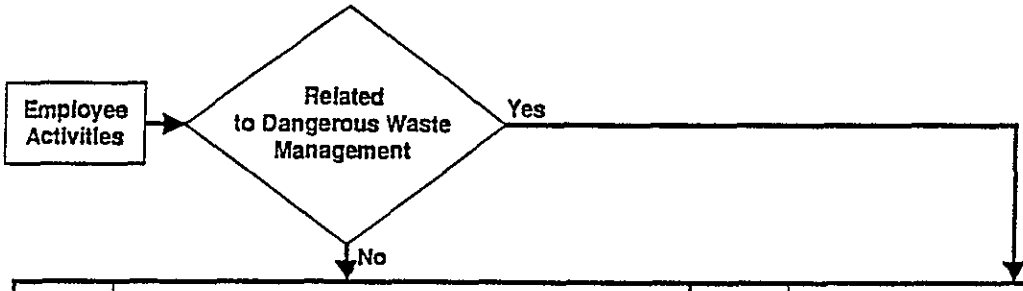
8.2 IMPLEMENTATION OF THE TRAINING PROGRAM [H-2]

The training program is in place and has been fully implemented. Training content is reviewed and updated as appropriate to ensure compliance with WAC 173-303.

Training of employees is to be completed within the first 6 months of their date of hire or transfer to a new position. After the initial training, employees are required to attend annual retraining. Employees are not permitted to work in a TSD unit without the appropriate level of training. The TSD unit management is responsible for ensuring new employees are trained and qualifications are maintained.

Each Hanford Site contractor maintains official training files in a centralized location. These files include employee training records, course attendance rosters, and course outlines.

Specific employee training records are available, at reasonable times, to the regulators on a demonstrated need-to-know basis. Copies of these records will be marked *Sensitive Information* and are expected to be handled in accordance with the *Privacy Act of 1974*. Training record access can be arranged by contacting the Regulatory File Custodian (Chapter 12.0). Training records on current and former employees will be maintained in accordance with Chapter 12.0, Section 12.4.2.3.1.



Category	Definition/*Examples*	Category	Definition/*Examples*
1.	**All Employees** All Employees and unescorted contract personnel. *(e.g., administrative, clerical)*	2.	**General Worker** Any employee who handles, generates, packages, stores or ships hazardous materials/waste or directly affects the management of dangerous waste. *(e.g., maintenance shops, fabrication shops, warehouse, paint shops)*
		3.	**General Supervisor/Manager** Supervisor/Manager who has employees that qualify as general workers. (Category #2)
		4.	**General Nonradiological Shipper** Employees who qualify under Category #2 general worker and/or prepare and sign a Uniform Hazardous Waste Manifest. *(e.g., lab waste shipper, garage waste shipper)*

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Figure 8-1. Decision Flow Diagram.

Table 8-1. Dangerous Waste Initial Training Requirements Matrix.

Employee category	Course title			
	New Hire Orientation	Dangerous Waste Management Training	Dangerous Waste Management TSD-Specific Training	Dangerous Waste Shipment Certification
1. All employees	x			
2. General worker		x	x	
3. General supervisor/ manager		x	x	
4. General nonradiological shipper		x	x	x

TSD = treatment, storage, and/or disposal.

Table 8-2. Dangerous Waste Continuing Training Requirements Matrix.

Employee category	Course title		
	Dangerous Waste Management Training (2 years)	Dangerous Waste Management TSD-Specific Training (1 year)	Dangerous Waste Shipment Certification (1 year)
1. All employees (none required)			
2. General worker	x	x	
3. General supervisor/manager	x	x	
4. General nonradiological shipper	x	x	x

TSD = treatment, storage, and/or disposal.

Table 8-3. Training Course Descriptions. (sheet 1 of 4)

New Hire Orientation	
Prerequisites	None
Description	New employee orientation to management responsibilities and to employee safety responsibilities and programs
Target audience	All employees
Technique	Classroom
Assessment	None
Frequency	One time only

I. INTRODUCTION

II. EMPLOYEE RESPONSIBILITIES
- A. Being responsible for your own safety
- B. Reporting emergencies
- C. Following procedures
- D. Observing signs and postings

III. MANAGEMENT RESPONSIBILITIES
- A. Providing a safe and healthful work place
  - 1. Implementation of the "Worker-Right-To-Know" legislation
  - 2. Implementation of Dangerous Waste Laws developed by state of Washington as the laws apply to the Hanford Facility
- B. Ensuring procedures are developed and are adequate

IV. SAFETY RELATED PROGRAM OVERVIEW
- A. Training for specific job
- B. Protective equipment
- C. Training
  - 1. Right-to-Know
  - 2. Dangerous waste training
- D. Work planning
- E. Housekeeping inspections
- F. Waste disposal

Table 8-3. Training Course Descriptions. (sheet 2 of 4)

Dangerous Waste Management Training	
Prerequisites	None
Description	Provides the target personnel with the fundamentals for safe use and disposal of dangerous waste
Target audience	Any employee with job responsibilities related to dangerous waste management.
Technique	Classroom
Evaluation	Written test
Frequency	24 months

I. DANGEROUS WASTE MANAGEMENT POLICY AND RESPONSIBILITIES
- A. Management of waste in an environmentally sound manner
- B. Management of waste in compliance with WAC 173-303 and U.S. Department of Energy Orders
- C. Responsibilities of generating organization for waste from 'cradle to grave'

II. II. WASTE IDENTIFICATION AND STORAGE
- A. Identification of dangerous waste
- B. Definition of radioactive dangerous waste (mixed waste)
- C. Definition of satellite accumulation areas and associated requirements
- D. Definition of temporary accumulation areas and associated requirements
- E. Use of a Disposal Request form

III. WASTE MINIMIZATION
- A. Definition of waste minimization
- B. Explanation of purpose for waste minimization
- C. Techniques for waste minimization

Table 8-3. Training Course Descriptions. (sheet 3 of 4)

Dangerous Waste Management-TSD Unit-Specific Information	
Prerequisites	None
Description	Provides job-specific dangerous waste information to the employee
Target audience	Any employee with job responsibilities related to dangerous waste management
Technique	On-the-job training
Evaluation	None
Frequency	12 months

Unit-specific training is provided to any employee with job responsibilities related to dangerous waste management. The specific training provided depends on the unit and its associated hazards. This information is located in the unit-specific permit applications.

Table 8-3. Training Course Descriptions. (sheet 4 of 4)

Hazardous Waste Shipment Certification	
Prerequisites	Hazardous Waste Management Training
Description	This course provides an in-depth look at specific federal, state, and contractor requirements for nonradioactive dangerous waste management and shipments.
Target audience	Nonradioactive dangerous waste shippers
Technique	Classroom
Evaluation	Written examination
Frequency	12 months

I. COURSE INTRODUCTION

II. NONRADIOACTIVE DANGEROUS WASTE MANAGEMENT
- A. Introduction to applicable regulations
- B. Waste identification and designation
- C. Generating unit management
- D. Waste packaging and shipment
- E. Exercise

III. POLYCHLORINATED BIPHENYLS MANAGEMENT
- A. Introduction to polychlorinated biphenyls
- B. Polychlorinated biphenyls management
- C. Compliance with 40 CFR 761 requirements
- D. Overview of unit polychlorinated biphenyls management systems
- E. Polychlorinated biphenyls management system responsibilities
- F. Summary of inspections, records, and reporting

IV. WASTE MINIMIZATION
- A. Introduction to regulations
- B. Waste minimization techniques
- C. Unit requirements

V. MIXED WASTE MANAGEMENT
- A. Introduction to mixed waste
- B. Scope of DOE-RL mixed waste management directive
- C. Action planning for the segregation of mixed waste from high-level waste, transuranic, and low-level waste
- D. Management of mixed waste consistent with nonradioactive hazardous waste management
- E. Summary

VI. PREPARATION AND SHIPMENT OF HAZARDOUS WASTE
- A. Introduction to applicable regulations
- B. Instructions for using 49 CFR 171-173 and 178
- C. Sample cases
- D. Summary

VII. SUMMARY AND PREPARATION FOR TEST

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APPENDIX

9A ZONING AND LAND USE FOR BENTON COUNTY . . . . . APP 9A-i

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9.0 EXPOSURE INFORMATION REPORT

Owners or operators of hazardous waste surface impoundments or landfills are required under RCRA, Section 3019, to submit an exposure information report in conjunction with a Part B permit application. The purpose of the exposure information report is to identify and characterize the magnitude of human exposure resulting from contaminant releases or potential releases from the units under evaluation, and to determine if there is a "significant potential risk" to public health (EPA 1986a).

The EPA has identified three criteria that must be considered in evaluating the potential for human exposure (EPA 1986a).

- A release of hazardous waste or hazardous constituents must have occurred.
- The release must have moved offsite via an environmental pathway (groundwater, surface water, or air).
- A nearby population must be affected by such a release.

These criteria form the basis for the evaluation conducted in the exposure information report.

This chapter is intended to provide an overview of available information regarding the potential for exposure to chemical toxicants and hazardous materials present at, or released from, surface impoundment or landfill units within the Hanford Facility that will receive final status permits. These units currently include the Grout Treatment Facility, the Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. The Double-Shell Tank System might be added to this chapter at a later time if it is determined that portions of the Double-Shell Tank System will undergo landfill closure. The Purgewater Storage Unit might also be added, if the Part A permit application for this unit is not withdrawn. All these units are located within or near the 200 Areas of the Hanford Site.

The EPA guidance manual (EPA 1986a, p. 1-5) states that the "EPA does not expect applicants to develop major, expensive new pieces of information..." to prepare the Exposure Information Report. Therefore, this chapter has been developed primarily around available information already evaluated to prepare exposure information reports in Part B permit applications submitted for the three noted TSD units (DOE-RL 1988a, 1989d, 1991c). This information addresses reasonably foreseeable potential releases from both normal operations and accidents. This information includes releases associated with potential environmental transport pathways and routes of human exposure to dangerous waste or constituents.

9.1 GENERAL INFORMATION

The Grout Treatment Facility consists of equipment to grout waste and to place grouted waste in vaults. The vaults are managed as surface impoundments when the grout slurry is fluid, and as landfills after the grout slurry has solidified. The Grout Treatment Facility is located in the 200 East Area.

The Low-Level Burial Grounds are classified as a landfill and cover a total area of approximately 518 acres. The Low-Level Burial Grounds are divided into eight burial grounds located in the 200 East and 200 West Areas.

The Liquid Effluent Retention Facility consists of four surface impoundments located on a 39-acre site. The Liquid Effluent Retention Facility is located east of the 200 East Area.

Detailed information concerning these TSD units is provided in the unit-specific permit applications submitted for these TSD units.

9.1.1 Risk Assessment Reports and Information

Health and risk assessment reports have been prepared for the Grout Treatment Facility. These reports include the following:

- *Environmental Assessment for the Grouting and Near-Surface Disposal of Low-Level Radioactive Phosphate/Sulfate Wastes from N Reactor Operations* (DOE 1986)
- *Final Environmental Impact Statement, Disposal of Hanford Waste High-Level, Transuranic and Tank Wastes* (DOE 1987)
- *Long-Term Performance Assessment of Grouted Phosphate/Sulfate Waste from N Reactor Operations* (Stewart et al. 1987)
- *Prevention of Significant Deterioration Application for Approval of Modification* (DOE-RL 1990).

No risk assessment reports have been prepared specifically for disposal of dangerous waste in the Low-Level Burial Grounds or for storage of effluent in the Liquid Effluent Retention Facility. A comprehensive discussion of risk from disposal of high-level, transuranic, and tank waste is provided in the final environmental impact statement (DOE 1987). Although this document does not specifically address the Low-Level Burial Grounds, Liquid Effluent Retention Facility, or dangerous waste, the document does provide general information about risks from waste disposal at the Hanford Site.

Risk assessments are, and will continue to be, developed as part of environmental impact statements, environmental surveillances, and safety analyses reports for the Hanford Site. If these risk assessments provide additional information relevant to the noted TSD units, this chapter and the applicable unit-specific permit applications will be modified if required.

9.1.2 Land Use and Zoning Maps

The Hanford Site is federally owned and covers approximately 560 square miles (1,450 square kilometers). A Benton County zoning and land use map is provided in Appendix 9A. Figure 9-1 shows the current land zoning status of lands surrounding the Hanford Site. Lands surrounding the Hanford Site are zoned primarily for agriculture. Figure 9-2 depicts the current land uses in and adjacent to the Hanford Site.

The Hanford Site is dedicated to U.S. Department of Energy-controlled operations, with limited exceptions. Located within the boundaries of the Hanford Site are the Washington Public Power Supply System reactor and generating complex and the US Ecology Company, Incorporated waste disposal facility located southwest of the 200 East Area. Seimens Nuclear Power is located just north of Richland, Washington, adjacent to the Hanford Site boundary. The eastern boundary of the nearest military installation, the Yakima Firing Center, is 25 miles (40 kilometers) west-northwest of the Hanford Site.

The portion of the Hanford Site south and west of the Columbia River is where reactor, fuel reprocessing, and TSD units are located. The portion of the Hanford Site that is located on the north and east sides of the Columbia River is designated as a buffer zone and currently is used for wildlife refuge or wildlife recreation land. The southwest portion of the Hanford Site is the Arid Lands Ecology Reserve. Additional information concerning activities on the Hanford Site can be found in Chapter 2.0.

Outside the Hanford Site are privately owned farms and the urban and suburban areas of Richland and West Richland.

9.1.3 Summary of Waste Analysis Data

The *Hanford Facility Dangerous Waste Part A Permit Application* (DOE-RL 1988b) provides waste characteristics information for the noted TSD units. Process knowledge documentation and results of analyses have been, and will be, maintained with other TSD unit records (Chapter 12.0) and will be provided to Ecology and the EPA as required by applicable regulations.

9.1.4 Amount of Waste

Current waste information for the noted TSD units is available in the Waste Information Data System (WIDS). The WIDS database is accessible to regulatory agency personnel (Appendix 1A).

9.1.5 Records Produced by Environmental or Health Agencies

The EPA inspected the Hanford Facility in 1986, 1987, and 1988. Copies of the inspection reports have been provided to Ecology.

9.2 PATHWAY-SPECIFIC INFORMATION

This section provides information on potential contaminant release pathways. Potential pathways discussed include the following:

- Groundwater pathway
- Surface water pathway
- Air pathway
- Subsurface gas pathway
- Contaminated soil pathway.

9.2.1 Groundwater Pathway

General information concerning the hydrogeology of the Hanford Facility, and the groundwater monitoring program at the Hanford Facility, is provided in Chapter 5.0. Information concerning the groundwater monitoring program specific to the Low-Level Burial Grounds, Grout Treatment Facility, or the Liquid Effluent Retention Facility can be found in the unit-specific permit applications.

9.2.1.1 Known Release Information. The following sections provide a brief discussion of known release information for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. Detailed information can be found in the unit-specific permit applications.

9.2.1.1.1 Grout Treatment Facility. Although the Grout Treatment Facility is an existing operational unit, this unit has not processed any dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.1.1.2 Low-level Burial Grounds. Based on the information search conducted for developing the unit-specific permit application, no known releases of waste have been reported at the Low-Level Burial Grounds since 1984. As stated in Chapter 5.0, two assessment groundwater monitoring plans have been prepared for the Low-Level Burial Grounds. Sufficient data are not yet available for the source or extent of detected contamination to be determined. It is possible that the source of contamination is nearby liquid disposal sites.

9.2.1.1.3 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility has not yet stored dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.1.2 Potential for Human Exposure via the Groundwater Pathway. The following sections discuss the potential for contaminant-release through the groundwater pathway.

9.2.1.2.1 Groundwater Uses. Several drinking water supply wells are located on the Hanford Site. Water supply wells are the Yakima Barricade well about 3.2 miles (5.2 kilometers) west of the 200 West Area, two wells in the 400 Area (one supply and one back-up), and the Rattlesnake Springs well located about 4 miles (6.4 kilometers) southwest of the 200 West Area. No agricultural irrigation or commercial food preparation occurs on the Hanford Site.

9.2.1.2.2 Potential for Human Exposure via the Groundwater Pathway. The general discussion of the groundwater pathway is divided into the following segments:

- Release of waste from TSD unit
- Migration through the vadose zone
- Groundwater transport to the Columbia River without detection
- Human exposure via the Columbia River.

A more detailed discussion of the groundwater pathway as it relates to the specific TSD units can be found in the unit-specific permit applications.

Release of Waste from TSD Unit--For human exposure via the groundwater pathway to occur, waste must first move beyond the TSD unit. Systems in place, or planned, for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility are designed to prevent movement of waste from the TSD unit. The controls in place, or planned, for these TSD units are described in detail in the unit-specific permit applications.

Migration Through the Vadose Zone--The low precipitation amounts and high evapotranspiration rates on the Hanford Site reduce the possibility that chemical constituents from the waste could reach the water table. For chemical constituents from the waste to reach the groundwater, these constituents must be transported through the vadose zone sediments. This column of sediments is approximately 185 to 285 feet (56.4 to 86.9 meters) thick beneath the noted TSD units.

Groundwater Transport to the Columbia River Without Detection--Assuming that waste had breached a containment system and migrated through the soil to the water table, the contamination would have to move beyond the source areas without first being detected by personnel or existing monitoring well systems. All three TSD units have groundwater monitoring systems in place (Chapter 5.0).

Human Exposure via the Columbia River--Several factors reduce the possibility of human exposure via the Columbia River and include (1) containment systems, (2) warning systems, (3) low infiltration rates from the various TSD units, and (4) generally thick sequences of vadose zone sediments. If contaminants from the waste do reach the groundwater, the detection-level monitoring systems should detect the release, and a compliance and/or corrective action program would be initiated. The distance between the

TSD units and drinking water supply wells provides additional protection. Finally, if contamination should reach the Columbia River, dilution would reduce concentrations by at least several orders of magnitude compared to groundwater concentrations.

In summary, it is unlikely that handling dangerous or mixed waste at the noted TSD units would result in unacceptable exposure to humans via the groundwater pathway. For human exposure to occur, contaminants from the waste must first breach containment systems without detection, migrate to the water table, and migrate to the Columbia River.

9.2.2 Surface Water Pathway

The only natural surface water bodies on the Hanford Site are the Columbia and Yakima Rivers, Cold Creek drainage, and West Lake (Appendix 2A). The locations of these water bodies are shown in Chapter 2.0, Figures 2-5, 2-6, 2-7, and Appendix 2A. The Cold Creek drainage is an ephemeral and discontinuous stream (Chapter 2.0, Section 2.3.2).

9.2.2.1 Known Release Information. The following sections provide a brief discussion of known release information for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. More detailed information can be found in the unit-specific permit applications.

9.2.2.1.1 Grout Treatment Facility. Although the Grout Treatment Facility is an existing operational unit, this unit has not processed any dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.2.1.2 Low-level Burial Grounds. Based on the information search conducted for developing the unit-specific permit application, no known releases of waste have been reported at the Low-Level Burial Grounds since 1984.

9.2.2.1.3 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility has not yet stored dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.2.2 Potential for Human Exposure via the Surface Water Pathway. There is very limited potential for humans to be exposed to contaminants originating from the noted TSD units via the surface water pathway. For there to be even a possibility of this occurring, a large scale release of dangerous waste would need to occur simultaneously with a major precipitation or flooding event.

Two principal scenarios have been considered in assessing the potential for human exposure via surface water pathways. The first is surface run-off of precipitation that is contaminated with waste. The second is flooding of a surface water body into one of the noted TSD units.

The first scenario requires a large enough precipitation event to result in significant overland flow. Large precipitation events are infrequent in the Pasco Basin. Days with greater than 0.5 inch (1.3 centimeters) of precipitation occur less than 1 percent of the year, and rainfall intensity of 1.0 inch (2.5 centimeters) in 1 hour are estimated to have a recurrence interval of 500 years (DOE 1987). Furthermore, given the flat topography and gravelly/sandy soils at the Hanford Site, significant overland flow rarely occurs (Chapter 2.0, Section 2.5.1).

The second scenario involves flooding of a surface body of water into the noted TSD units. The TSD units are located on a plateau and are above the maximum flood levels of either the Columbia or Yakima Rivers and the Cold Creek drainage (Chapter 2.0, Section 2.3.2). Thus, this scenario is considered unlikely.

Given the elevated but flat topography of the 200 Areas, the low precipitation, and the lack of nearby surface water bodies, the potential for human exposure to surface water that has been contaminated with dangerous waste is very low.

9.2.3 Air Pathway

The noted TSD units are remotely located approximately 20 miles (32 kilometers) from Richland, Washington, the nearest population center. Protection of Hanford Site personnel and the general public is afforded by limited access to the noted TSD units.

Climatological data have been collected since 1945 at the Hanford Meteorological Station, located between the 200 Areas. The prevailing wind direction in the 200 Areas is from the northwest in all months of the year; a secondary maximum occurs from the southwest. High winds that cause dust storms are usually from the southwest. High winds also are associated with afternoon drainage winds from the northwest, frequently reaching velocities of 31 miles per hour (50 kilometers per hour). Wind roses for several locations within the Hanford Site are shown in Figure 9-3.

High winds from the northwest are associated with thunderstorms. The average occurrence of thunderstorms is 10 per year, typically occurring in the summer months, though the thunderstorms have occurred in all months.

The final environmental impact statement (DOE 1987) lists no violent tornadoes for the region surrounding the Hanford Site. Predictions presented in the Hanford Site *National Environmental Policy Act* (NEPA) *Characterization* (Cushing 1988) estimate the probability of a tornado striking a point on the Hanford Site as 9.6×10^{-6} per year.

9.2.3.1 Known Release Information. The following sections provide a brief discussion of known release information for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. More detailed information can be found in the unit-specific permit applications.

9.2.3.1.1 Grout Treatment Facility. Although the Grout Treatment Facility is an existing operational unit, this unit has not processed any dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.3.1.2 Low-level Burial Grounds. Based on the information search conducted for developing the unit-specific permit application, no known releases of waste have been reported at the Low-Level Burial Grounds since 1984.

9.2.3.1.3 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility has not yet stored dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.3.2 Potential for Human Exposure via the Air Pathway. An important factor that reduces the risk of human exposure via the air pathway is the large uninhabited buffer zone that separates the noted TSD units from surrounding areas. The nearest major population center is Richland, Washington, located approximately 20 miles (32 kilometers) southeast of the 200 Areas (Figure 9-4). Because of the remote location and the management practices implemented at the noted TSD units, the potential for human exposure via the air pathway is considered very low. Detailed information concerning management practices, engineered barriers, and other measures to reduce the potential for human exposure can be found in the unit-specific permit applications.

9.2.4 Subsurface Gas Pathway

Gas generation from the decomposition of municipal waste is a major concern in subsurface gas pathway assessment. No municipal waste disposal is proposed for the Low-Level Burial Grounds, Grout Treatment Facility, or the Liquid Effluent Retention Facility; therefore, no gas generation from biologic degradation is anticipated. Minor amounts of gas potentially could result from the vaporization of volatile constituents or from chemical reaction. However, the design of the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility allows for the venting of such gases.

9.2.4.1 Known Release Information. The following sections provide a brief discussion of known release information for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. More detailed information can be found in the unit-specific permit applications.

9.2.4.1.1 Grout Treatment Facility. Although the Grout Treatment Facility is an existing operational unit, this unit has not processed any dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.4.1.2 Low-level Burial Grounds. Based on the information search conducted for developing the unit-specific permit application, no known releases of waste have been reported at the Low-Level Burial Grounds since 1984.

9.2.4.1.3 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility has not yet stored dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.4.2 Potential for Human Exposure from Subsurface Gas Pathway. Unit design and the absence of municipal waste minimize the potential for human exposure from the subsurface gas pathway.

9.2.5 Contaminated Soil Pathway

At the Grout Treatment Facility, chemical constituents could enter the soil through escape from the vaults, spills on the soil surface, or leaks from underground pipelines. The vault cover is designed to minimize contact of infiltrating water with the grouted waste, thus limiting the liquid available for transport by diffusion/advection. Such diffusion/advection could occur through the small amount of soil water in the unsaturated zone. Most of the underground pipelines in the Grout Treatment Facility are encased and leak detectors are placed in the annulus between the pipes. A leak in the annulus causes a shutdown of the process. Procedures and structures in place at the Grout Treatment Facility are designed to minimize impacts on humans from constituents that could be released to the soil. Additional discussions regarding the operation of the Grout Treatment Facility are contained in the unit-specific permit application.

Soil sampling programs for hazardous chemicals have not been performed at the Low-Level Burial Grounds. However, an information search conducted for Chapter 9.0, "Exposure Information," of *The Low-Level Burial Grounds Dangerous Waste Permit Application* indicates that no known releases of waste have been reported since 1984.

The Liquid Effluent Retention Facility is designed, in accordance with WAC 173-303-650, to minimize the potential for releases of hazardous chemicals to the soil. Double liners, with leachate detection, collection, and removal system, are used in each of the surface impoundments. Therefore the potential for contaminant migration via the soil pathway is low.

9.2.5.1 Known Release Information. The following sections provide a brief discussion of known release information for the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility. More detailed information can be found in the unit-specific permit applications.

9.2.5.1.1 Grout Treatment Facility. Although the Grout Treatment Facility is an existing operational unit, this unit has not processed any dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.5.1.2 Low-level Burial Grounds. Based on the information search conducted for developing the unit-specific permit application, no known releases of waste have been reported at the Low-Level Burial Grounds since 1984.

9.2.5.1.3 Liquid Effluent Retention Facility. The Liquid Effluent Retention Facility has not yet stored dangerous waste. Consequently, there has been no release of dangerous waste to the environment.

9.2.5.2 Potential for Human Exposure from Releases to Soil. Chemical constituents might enter the soil column through escape from the Grout Treatment Facility vaults, spills to the soil surface, or leaks from underground pipes. This potential, however, is considered to be low because of design measures and operational practices.

The potential for human exposure from releases to the soil at the Liquid Effluent Retention Facility and the Low-Level Burial Grounds is minimized by operational controls. For example, waste received at the Low-Level Burial Grounds is double packaged by the generator before shipment to help minimize the potential for release of dangerous waste to the soil column. In addition, no food-chain crops currently are raised on the Hanford Site. Administrative control of the Hanford Site by the DOE-RL will preclude contact through food chain crops as long as that control is maintained.

9.2.6 Management Practices Information

Management practices such as inspections, monitors, alarms, double-containment systems, and operating procedures are designed to limit the effects on human health and the environment from operation of the Grout Treatment Facility, Low-Level Burial Grounds, and Liquid Effluent Retention Facility. Measures to minimize exposure (Chapter 6.0), and contingency plans (Chapter 7.0) are designed to ensure that exposure of both workers and offsite individuals is minimized.

9.3 CONCLUSIONS ON EXPOSURE POTENTIAL

The potential for exposure to dangerous waste is minimized by (1) the relative isolation of the Grout Treatment Facility, Low-Level Burial Grounds, and the Liquid Effluent Retention Facility from population centers, (2) the large distance through the soil column that a contaminant would have to travel to the groundwater should a release occur and, (3) the highly unlikely event of overland flow. Therefore, potential exposure via the air pathways, soil, and surface water, is extremely low. Present and proposed management practices appear to be effective and are not a cause for concern.

Potential exposure to releases from the groundwater pathway also is low; however, this appears to be the most likely pathway for human exposure should a release from a TSD unit occur. For human exposure to waste to occur from the groundwater, waste has to first breach containment systems and be of sufficient volume to overcome soil depth and retention factors to reach the

groundwater. On reaching the groundwater, the contaminants must then migrate to the Columbia River. In addition, the contaminants would have to overcome the dilution factor of the Columbia River. The conclusion is that the potential for human exposure via the groundwater pathway is low.

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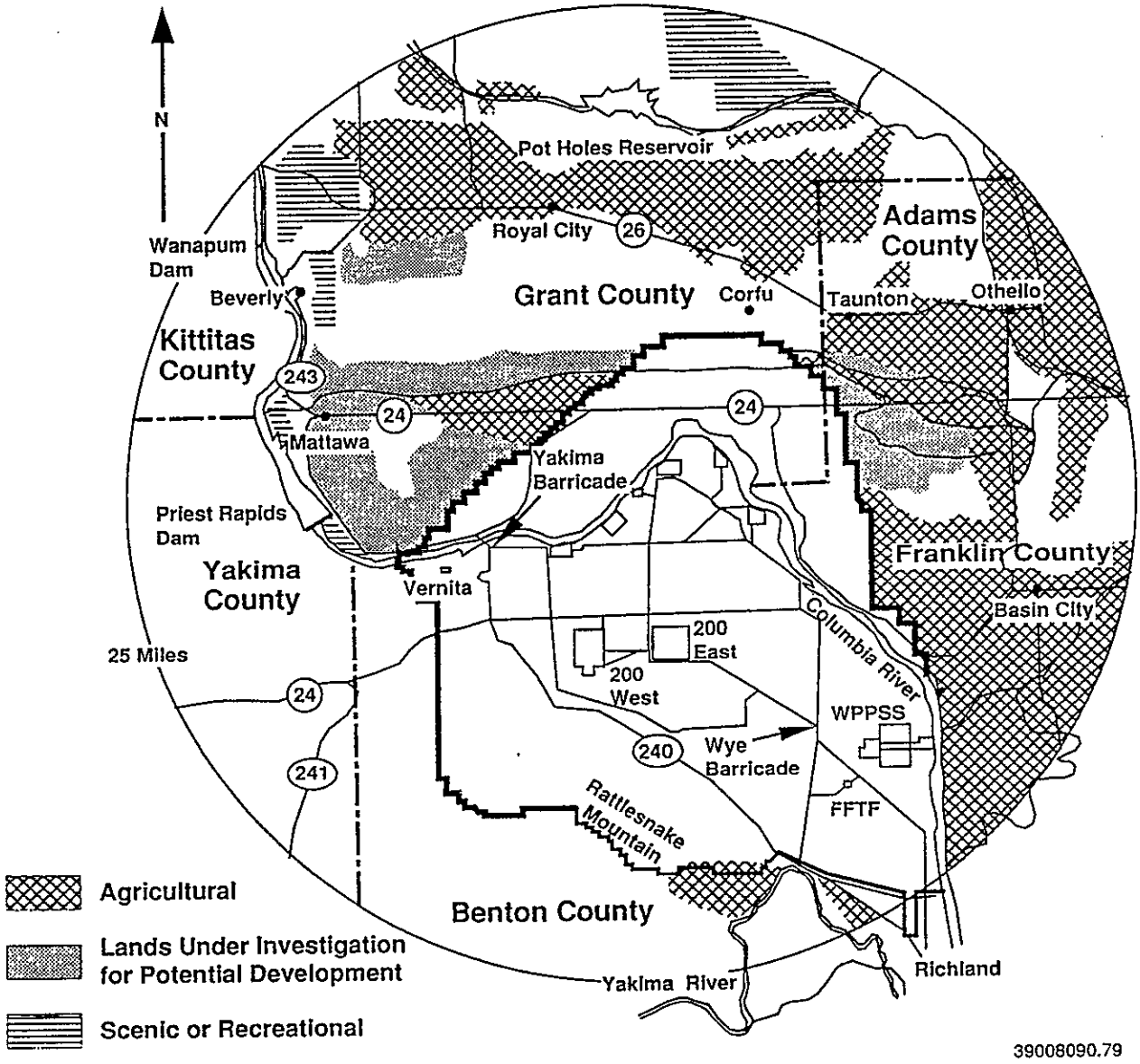
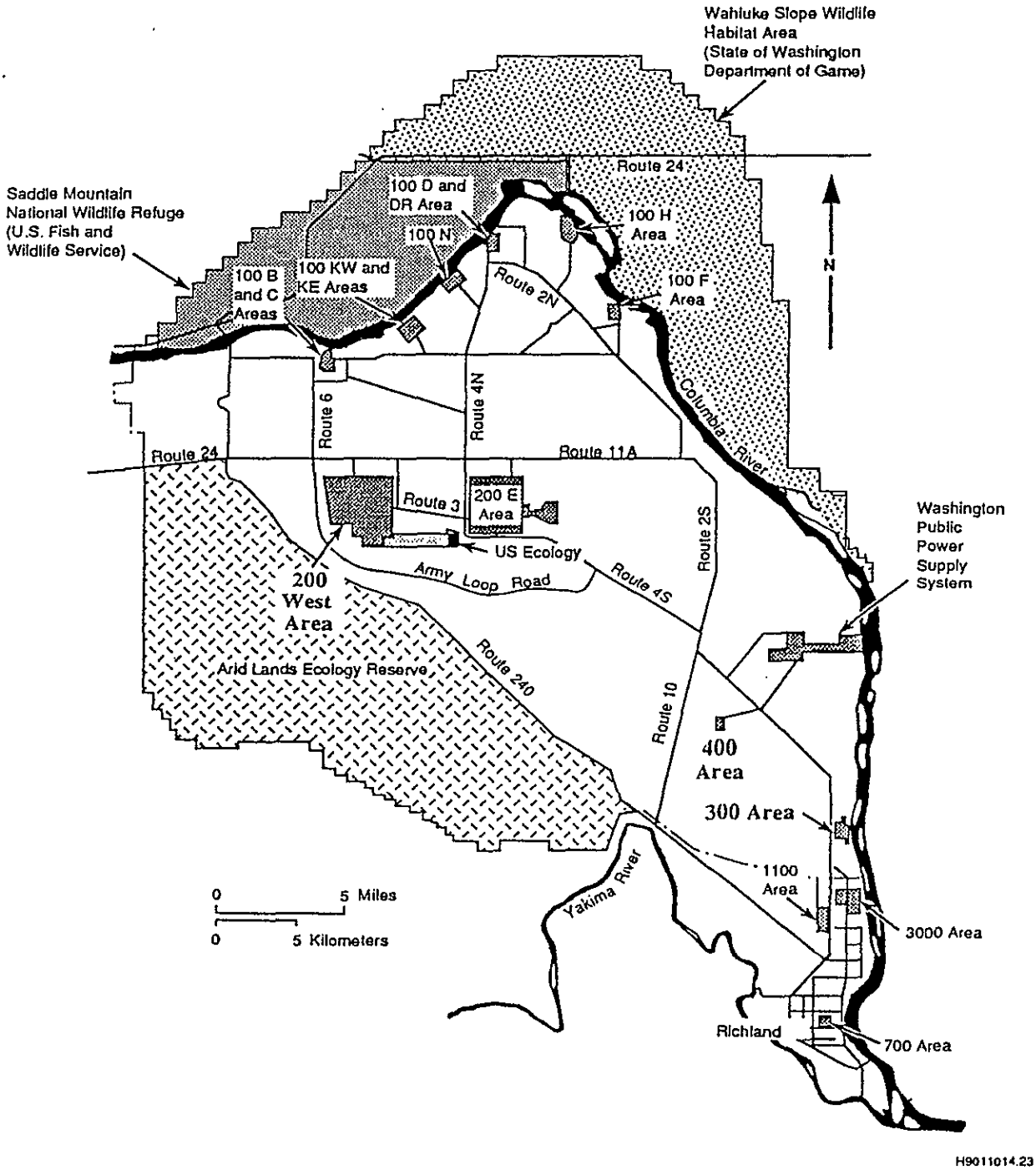


Figure 9-1. Land Zoning Status in the Vicinity of the Hanford Site.



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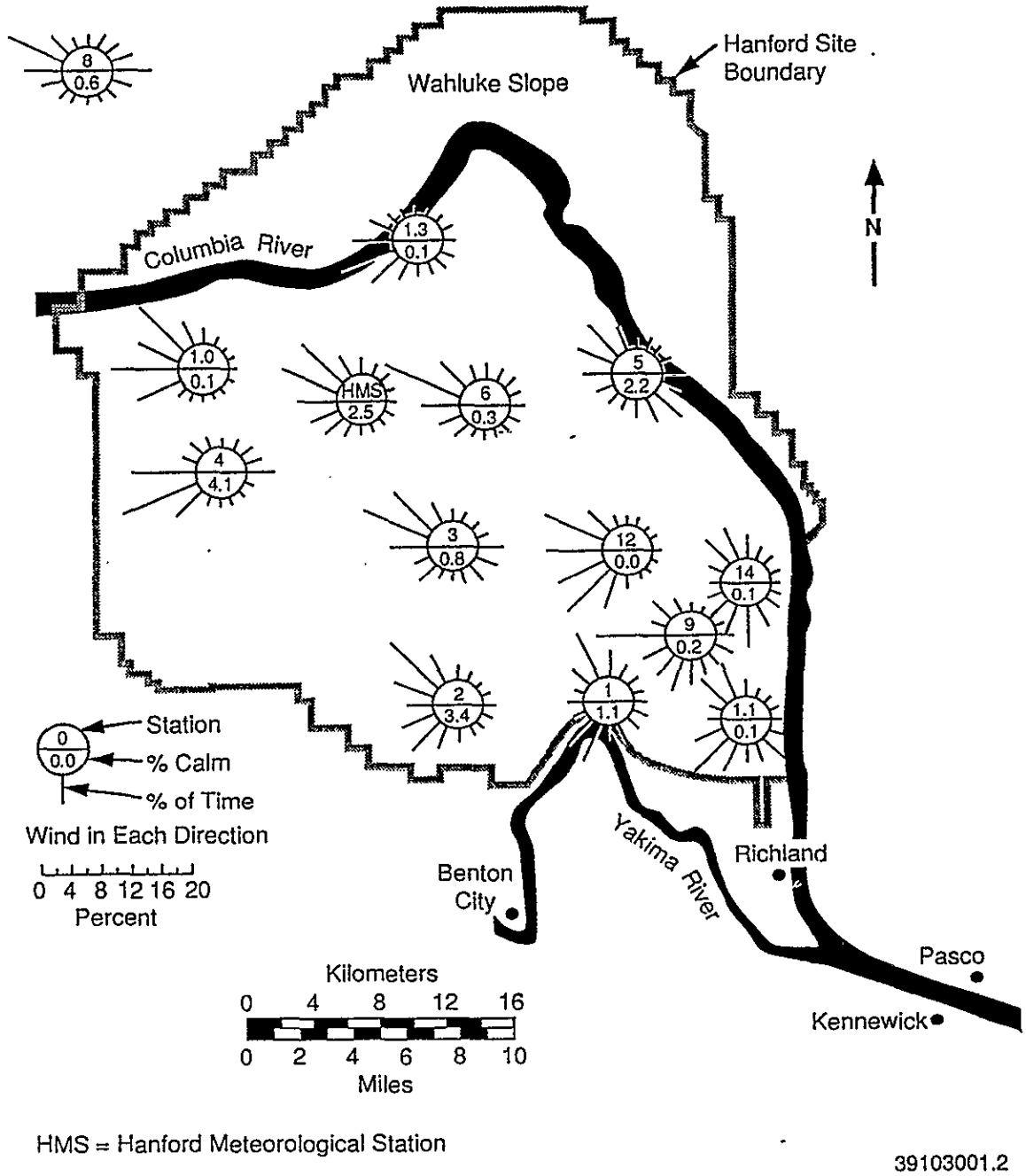
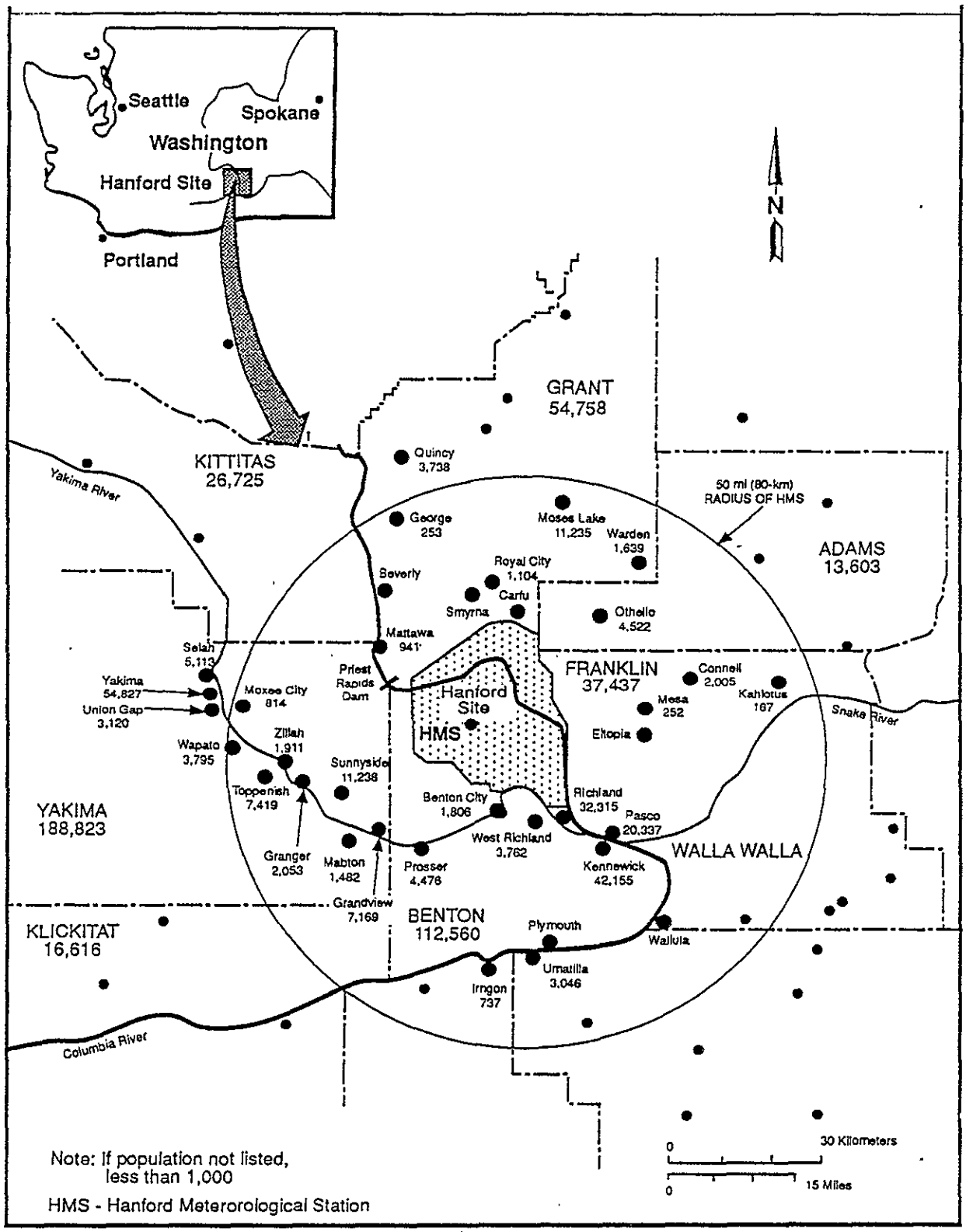


Figure 9-3. Wind Roses on the Hanford Site.



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10.0 WASTE MINIMIZATION

This chapter outlines the Hanford Facility Waste Minimization Program. The program specifies activities and methods that are, and will be, employed to reduce the quantity and toxicity of waste generated on the Hanford Facility.

10.1 SCOPE

A waste minimization program is an organized, comprehensive, and continual effort to systematically reduce waste generation. The Hanford Facility Waste Minimization Program is designed to eliminate or minimize pollutant releases to all environmental media from all aspects of operations, and offers increased protection of public health and the environment. These efforts also yield the following additional benefits:

- Reduce waste management and compliance costs
- Reduce resource use
- Improve product yields
- Reduce or eliminate inventories and releases of hazardous chemicals reportable under the *Emergency Planning and Community Right-to-Know Act of 1986*.

The program reflects the policies for waste minimization and represents an ongoing effort to make waste minimization part of the operating philosophy of the Hanford Facility. In accordance with U.S. Department of Energy policy, a hierarchical approach to waste management has been adopted and is applied to all types of waste.

The U.S. Department of Energy recognizes a hierarchy of waste management practices that places the priority on source reduction, followed by recycling, treatment, storage, and disposal in that order (Figure 10-1). The waste minimization program emphasizes the elimination or minimization of waste through source reduction. Potential waste materials that cannot be eliminated or minimized will be evaluated for recycling (i.e., used, reused, or reclaimed).

This chapter describes the policy, objectives, strategy, and support activities for the Hanford Facility Waste Minimization Program. Primary elements of the program are: (1) the establishment of waste minimization goals, (2) the development of waste generation baseline information through waste assessments, and (3) the implementation of a process for continual evaluation of the program. Various waste minimization techniques are, and will be, implemented with the support of employee training and awareness programs to reduce waste and still meet the requirements for quality, productivity, safety, and environmental compliance.

10.2 REGULATORY BASIS

In accordance with the RCRA, the Hanford Facility, as a dangerous waste generator with a single EPA/State Identification Number, has established a program to reduce the volume or toxicity of waste to the degree determined by the generator to be 'economically practicable'. Individual dangerous waste generating units within the Hanford Facility must certify in their waste manifest (for offsite shipments) that this requirement has been fulfilled. The generator also must identify in the EPA-required biennial waste minimization report the efforts undertaken during the year by the generating units to reduce the volume and toxicity of waste generated, and the changes in volume and toxicity actually achieved. For the Hanford Facility, this requirement is met by an annual dangerous waste report submitted to Ecology (Chapter 12.0, Sections 12.2 and 12.4.1.2).

10.3 STATEMENT OF MANAGEMENT SUPPORT/COMMITMENT

The DOE-RL management is committed to minimizing the generation of waste by giving preference to source reduction, material substitution, and environmentally sound recycling over treatment, storage, and disposal of such waste. Management takes appropriate action to provide adequate personnel, budget, training, and resources on a continuing basis to ensure that the objectives of the Hanford Facility Waste Minimization Program are met.

10.4 PROGRAM OBJECTIVES

The objectives of the Hanford Facility Waste Minimization Program are as follows:

- Foster a philosophy to conserve resources and minimize waste and pollution while achieving strategic objectives
- Promote the use of nonhazardous materials in operations to minimize the potential risks to human health and the environment
- Reduce or eliminate the generation of waste through input substitution, process modification, improved housekeeping, and closed-loop recycling to achieve minimal adverse effects to the air, water, and land
- Comply with applicable federal and state regulations and U.S. Department of Energy requirements for waste minimization, waste reduction, and pollution prevention
- Characterize waste streams and develop a baseline of waste generation data
- Identify and implement methods and technologies for waste minimization

- Target policies, procedures, or practices that might be barriers to waste minimization

- Enhance communication of waste minimization objectives, goals, and ideas

- Promote integration and coordination on waste minimization matters between managers of waste generating and TSD units

- Develop specific goals and schedules for waste minimization activities

- Create incentives for waste minimization

- Collect and exchange waste minimization information through technology transfer, outreach, and educational networks

- Develop mechanisms for fully disseminating current technical information to Hanford Facility users.

10.5 GOALS

Goals for the minimization of the types of waste generated are established yearly. Goals represent a percent reduction of the baseline value adjusted for changes in production rates, new processes, and stabilization and remediation actions. Each contractor develops their own waste minimization goals consistent with achieving the overall Hanford Facility goals.

10.6 ORGANIZATION AND STAFF RESPONSIBILITIES

The overall management responsibility for the Hanford Facility resides with the DOE-RL. The DOE-RL management is responsible for ensuring the implementation of the Hanford Facility Waste Minimization Program as shown in Figure 10-2.

Each contractor has been directed by the DOE-RL to develop an appropriate organization to define an effective waste minimization program and to implement the Hanford Facility Waste Minimization Program. The primary functions of the Hanford Facility Waste Minimization Program include the following:

- Ensure program requirements are incorporated into procedures and policy statements

- Communicate program objectives to employees

- Sponsor ongoing employee awareness and training

- Establish waste minimization goals and objectives for the Hanford Facility

- Facilitate integration and interaction on waste minimization matters between managers of waste generating units and TSD units

- Monitor and report progress of the waste minimization program

- Facilitate technology transfer and waste minimization awareness.

10.7 WASTE MINIMIZATION TECHNIQUES

Waste minimization encompasses activities that minimize or eliminate the generation of waste and recycling processes that use, reuse, or reclaim a material from a waste stream. This section discusses the following waste minimization techniques employed to minimize the generation of waste:

- Inventory management

- Operational changes

- Maintenance program

- Material changes

- Process equipment modification

- Recycling and reuse.

Some activities commonly thought to be waste minimization are actually waste treatment. The following activities are not considered waste minimization:

- Transferring hazardous constituents from one environmental medium to another

- Concentration conducted solely for reducing volume

- Dilution as a means of toxicity reduction, unless later recycling steps are involved.

10.7.1 Inventory Management

Methods to control the types and quantities of materials in inventory are reviewed periodically. Where necessary, inventory control techniques are revised or expanded to reduce inventory size and hazardous chemical use while increasing inventory turnover. In particular, inventory control techniques are used to reduce waste resulting from excess raw materials that are out of date and no longer used. Similarly, material controls are revised or expanded to reduce raw material and finished product loss and damage during handling, production, and storage. The inventory management techniques are applied to waste material as well as to raw materials and finished products.

The review of inventory management techniques includes an evaluation of (1) how existing inventory management procedures can be applied more effectively, (2) whether new techniques should be added to or substituted for current procedures, (3) the need for review and evaluation approval procedures for the purchase of materials, and (4) the need for additional employee training.

10.7.2 Operational Changes

Processes are examined to determine whether significant reduction of waste at the source can be achieved by improvements in process efficiency. Operating procedures are examined to determine whether the elimination or revision of operating procedures can contribute to the reduction of waste. The revision and review of operating procedures are fully documented and incorporated as part of the employee training program. Techniques such as segregation to separate dangerous waste and recoverable waste from the total waste stream are explored.

10.7.3 Maintenance Program

Equipment maintenance programs are reviewed to determine whether improvements in corrective and preventive maintenance can reduce waste generation caused by equipment failure. The methods for maintenance cost tracking and preventive maintenance scheduling and monitoring are examined.

10.7.4 Material Changes

The replacement, reformulation, reduction, or elimination of hazardous materials in production, maintenance, and cleaning processes are examined.

10.7.5 Process Equipment Modification

The effect of waste minimization by the installation of new equipment or the modification of existing equipment is considered.

10.7.6 Recycling and Reuse

The recovery of waste is used as an option in the Hanford Facility Waste Minimization Program after first considering reducing the amount of waste generated at the source. Opportunities for reclamation and reuse of waste materials are explored whenever feasible. Decontamination of tools, equipment, and materials for reuse or recycle is used to the extent practicable to minimize the amount of waste for disposal.

If the activity makes the material more amenable to disposal (e.g., reduces volume or toxicity before storage or disposal), the waste is treated, not minimized.

Another aspect of recycling is material and waste exchange. Programmatic, job scope, and other changes often result in excess materials and chemicals that could become a waste if a specific need for the excess materials and chemicals cannot be identified. Methods to facilitate both onsite and offsite exchanges have been developed at the Hanford Facility and new methods will be pursued.

10.8 TRAINING

An important element of the Hanford Facility Waste Minimization Program is training. The training program includes all levels of employees on the Hanford Facility. The goal of the training program is to make each employee aware of waste generation, its impact on the Hanford Facility and the environment, and ways waste can be reduced and pollution prevented.

10.8.1 Specialized Training Program

Specialized training sessions on waste minimization policy and procedures and waste minimization techniques are tailored for management and staff positions. These sessions are incorporated into the regularly scheduled training program. The adequacy of training procedures is evaluated annually. Any special equipment needed to perform waste minimization functions also is evaluated annually.

10.8.2 Procedures Qualification

As part of quality assurance, certain employees are required to be trained and examined on their knowledge of operating procedures before performing work. Waste minimization is incorporated into operating, administrative, and waste handling procedures requiring documentation using data sheets or forms. Training on waste minimization, therefore, is conducted as part of the quality assurance procedures qualification process.

10.9 QUALITY ASSURANCE PROGRAM PLAN

Waste minimization activities retain an appropriate level of documentation and accountability to ensure an adequate level of confidence that the requirements for reduction of waste are being met.

10.10 PROGRAM EVALUATION

The Hanford Facility Waste Minimization Program is evaluated semiannually by the DOE-RL. All major activities are reviewed. The following evaluation criteria are available to aid in the demonstration of effective waste minimization efforts:

- Reduced amount of hazardous waste
- Reduced amount of all waste
- Reduced waste management costs
- Improved regulatory compliance
- Reduced health risks
- Increased production efficiency
- Reduced accident risk
- Improved public relations.

The evaluation documents program achievements and identifies potential areas for improvement.

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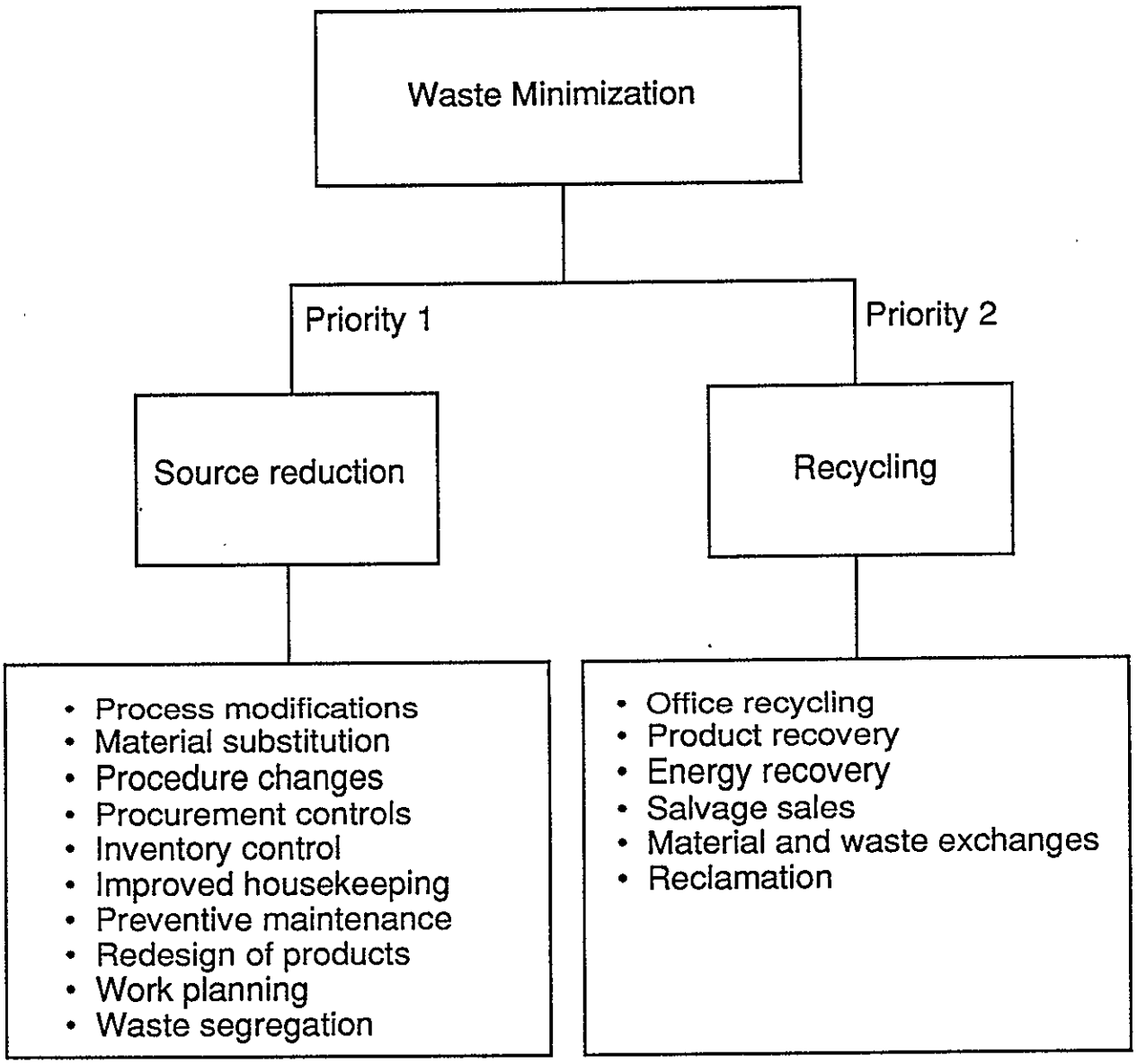

Figure 10-1. Waste Reduction Techniques.

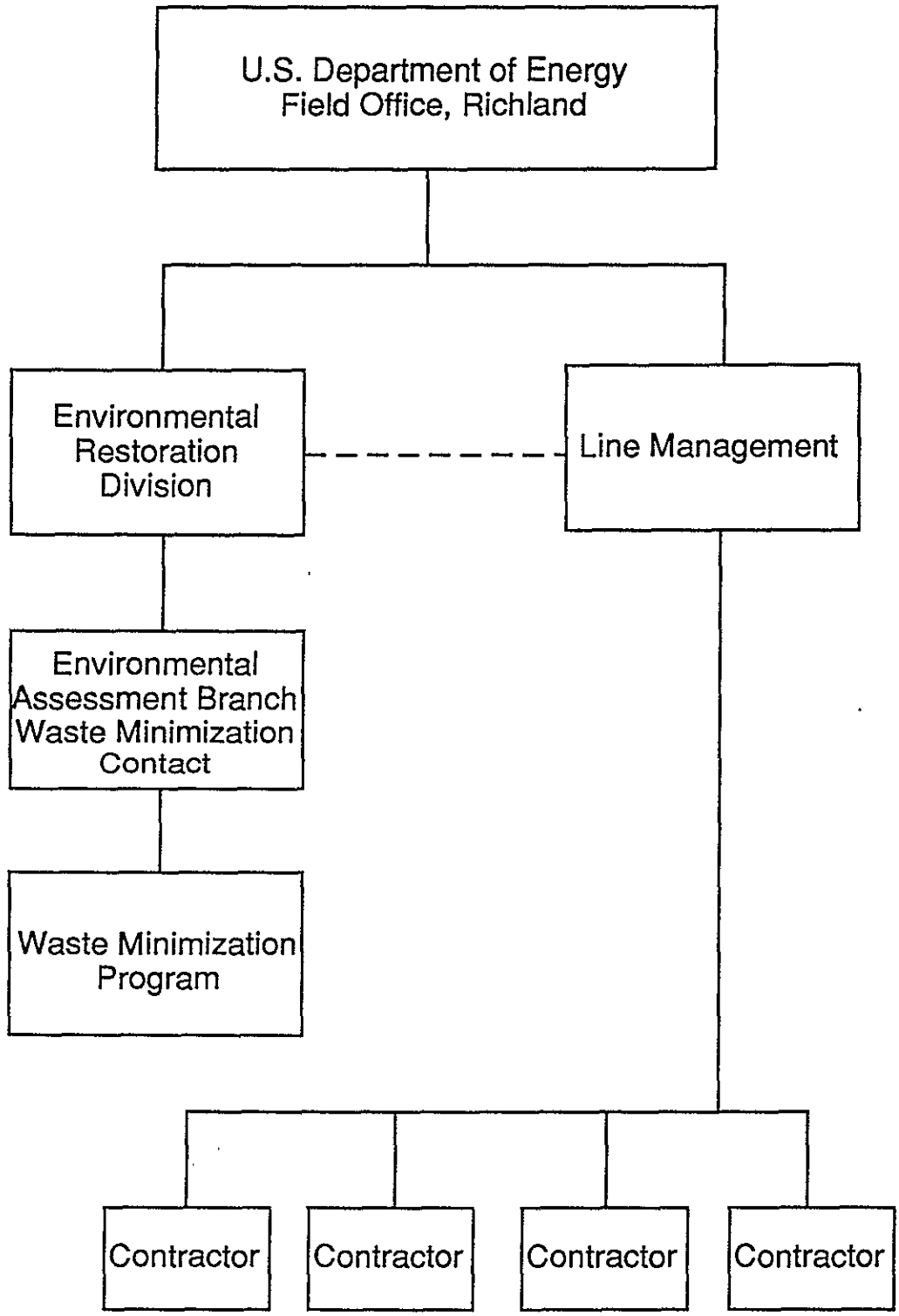

Figure 10-2. Hanford Facility Waste Minimization Program Organizational Chart.

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FIGURE

11-1. General Closure Logic Flow Chart F11-1

11.0 CLOSURE AND POSTCLOSURE REQUIREMENT

This chapter describes the general activities and objectives common to closures of Hanford Facility TSD units for which a final status permit has been, or will be, sought. If closure of such TSD units will leave waste in place, then, postclosure permit applications also will be submitted. This chapter is divided into six sections that address closure options, closure performance standards, closure activities, closure and postclosure plans (within Part B permit applications), postclosure permit applications, and Facility-wide closure. Appendices 11A and 11B provide the general outlines for closure information contained in Part B permit applications and in postclosure permit applications, respectively. As stated in Chapter 1.0, Section 1.1.1, interim status closure and postclosure plans are not part of this permit application.

When a TSD unit is no longer used to treat, store, and/or dispose of dangerous waste, the TSD unit is closed. Closure is required to be accomplished in a manner that is protective of human health and the environment. Closure of the TSD units on the Hanford Facility is conducted in accordance with the current regulations contained in 40 CFR 264 through 268 and 40 CFR 270, WAC 173-303, and the requirements of the Tri-Party Agreement.

In addition, closure of a TSD unit on the Hanford Facility must be integrated with remediation of any surrounding past-practice units. This integration is addressed in the Tri-Party Agreement, in Article III, Article IV, Article XXIV, Article XXXII, and in Section 5.5 of the Tri-Party Agreement Action Plan.

On the Hanford Site, there are over 1,100 past-practice units. These past-practice units are organized into areas called operable units that contain all of the individual TSD units (Appendix 2A). The past-practice units will be remediated either under the CERCLA regulations or the RCRA corrective action regulations. These regulations, although based on protection of human health and the environment, might not require the same performance standard as for a RCRA TSD closure. Integration of the remediation of past-practice operable units with TSD closures will require RCRA TSD units located within past-practice operable units to have the same cleanup standards. This integration will eliminate the possibility of having different cleanup standards for coincident or adjacent parcels of land. Ongoing discussions are taking place with the EPA and Ecology to address RCRA and CERCLA integration needs. This plan will be updated through the permit modification process to incorporate the results of these discussions.

11.1 CLOSURE OPTIONS

Basically, there are three RCRA closure options: clean closure, a health-based closure, and closure as a landfill. All of the TSD units are within the Hanford Site past-practice (RCRA and CERCLA) operable units. Because of this, activities and cleanup standards for remediation of the past-

practice operable units should take precedence when integrated with the closure of RCRA TSD units.

Specific closure activities and objectives for any one TSD unit can be found in the unit-specific Part B permit applications. Figure 11-1 shows a general closure logic flow chart.

The following sections address the three closure options: clean closure, health-based closure, and landfill closure.

11.1.1 Clean Closure

Clean closure requires that all dangerous waste constituents and contamination be removed and disposed of in accordance with applicable regulations. Clean closure is accomplished by verifying that the potentially dangerous constituents treated, stored, or disposed of at the TSD unit being closed are not present above the Hanford Site background values for those potential contaminants. Verification will be accomplished by comparing the chemical concentration of a potentially dangerous constituent in samples obtained at the TSD unit to the Hanford Site background values for that constituent. The report, *Characterization and Use of Soil and Groundwater Background for the Hanford Site* (WHC 1991a) (Appendix 11C) presents the justification for, use of, and method for obtaining the Hanford Site background.

In some instances, samples obtained at a TSD unit for closure will be compared to local background instead of the Hanford Site background. Local background refers to the concentrations of constituents from analyses of samples obtained in the local vicinity of a unit. If the concentrations of potentially dangerous constituents are not above the local background threshold, the TSD unit would be considered closed. Any necessary remediation beyond the TSD unit closure would be accomplished during cleanup of the past-practice operable unit in which the TSD unit is located.

11.1.2 Health-Based Closure

Health-based closures are closures of TSD units accomplished by treating or removing contamination to concentrations based on protection of human health and the environment. This situation occurs at the Hanford Site because of the past-practice operable units (CERCLA and RCRA) that surround the operating TSD units. The remediation of past-practice waste management units is based on human health and environmental protection standards. Remediation of a TSD unit to a more stringent standard, i.e., background, than the surrounding area would accomplish little and would not be cost effective. Integrating the remediation activities and cleanup standards of an operating TSD unit with the surrounding past-practice operable unit would allow the cleanup of the TSD unit and the past-practice operable unit to the same standards. The health-based closure would be used when the health-based closure facilitates uniformity in the overall cleanup process.

Protection of human health and the environment will be accomplished by removing or treating contamination to concentrations at a TSD unit to levels that are not a threat to human health or the environment. Health based risk standards will be established using guidance such as the *Model Toxics Control Act Cleanup Regulation* (WAC 173-340), the EPA *Integrated Risk Information System (IRIS)* database (EPA 1989a), the EPA *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual* (EPA 1989c), and other appropriate information.

11.1.3 Landfill Closure

A landfill closure occurs when waste or contamination is left at the TSD unit in concentrations that are above the health-based standards. When waste or contamination is left in place, a postclosure permit application is required. The postclosure permit application would contain a RCRA-compliant landfill cover design and a postclosure monitoring plan. The postclosure monitoring plan would describe how the covered TSD unit would be monitored and maintained to ensure protection of human health and the environment. Regulations require monitoring and maintenance for 30 years unless a shorter time is approved by Ecology (the shorter time must be shown to be sufficient to protect human health and the environment).

Information specific to any one TSD unit can be found in the unit-specific postclosure permit application.

11.2 CLOSURE PERFORMANCE STANDARDS

The following sections address closure performance standards and waste removal and decontamination standards.

All plans will be developed to close TSD units in a manner that meets the following closure performance standards of WAC 173-303-610(2):

"(a)(i) Minimizes the need for further maintenance;

(ii) Controls, minimizes or eliminates to the extent necessary to protect human health and the environment, postclosure escape of dangerous waste, dangerous constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, ground water, or the atmosphere; and

(iii) Returns the land to the appearance and use of surrounding land areas to the degree possible given the nature of the previous dangerous waste activity."

11.2.1 Minimizing the Need for Future Maintenance

Minimizing the need for future maintenance will be accomplished by clean closing the specific TSD units whenever possible. Clean closure will

eliminate the need for future maintenance. In cases where clean closure cannot be achieved, future maintenance needs will be addressed in the unit-specific postclosure permit application.

11.2.2 Protection of Human Health and the Environment

Protection of human health and the environment will be accomplished by removing or treating all contamination at a TSD unit to levels that are not a threat to human health or the environment. If contamination cannot be removed or treated to levels that are protective of human health and the environment and must be left in place, a RCRA-compliant landfill cover will be installed. Regulations require monitoring and maintenance for 30 years unless a shorter time is approved by Ecology (the shorter time must be shown to be sufficient to protect human health and the environment).

Health-based risk standards will be established using guidance such as WAC 173-340, the EPA *Integrated Risk Information System (IRIS)* database (EPA 1989a), the EPA *Risk Assessment Guidance for Superfund: Human Health Evaluation Manual* (EPA 1989b), and other appropriate information.

11.2.3 Return Land to the Appearance and Use of Surrounding Land

Closure plans will include, to the extent practicable, consideration of returning the TSD units to an appearance compatible with surrounding structures and/or the semi-desert terrain of the area.

11.3 CLOSURE ACTIVITIES

The activities undertaken to perform closure for an individual TSD unit receiving a final status permit will be identified in the unit-specific closure and postclosure plans. General closure activities should address the following four waste management activities during the cleanup of the Hanford Site.

- Waste investigation
- Investigative derived waste management
- Remediation process
- Sampling methods.

The sampling methods and sample data reduction and inventory database control also are outlined in the following sections.

11.3.1 Waste Investigation

During the waste investigations, the TSD unit-specific closure plans will ensure that the waste is characterized properly in terms of presence, location, concentration, and volume of each contaminant. Research of process records, drawings, and photographs will shape the initial sampling strategy. As field information and laboratory results become available, the sampling strategy will specify more sampling until the waste contaminants can be reliably located and quantified. Information specific to any one TSD unit can be found in the unit-specific Part B permit application or postclosure permit application.

11.3.2 Investigative Derived Waste Management

Because of the large number of samples that will be required in the course of the waste investigations, investigative derived waste will be generated. Field instruments will be used to make field determinations for the control of investigative derived waste. Investigative derived waste can be generated when moving materials to gather samples and/or during decontamination of sampling equipment. Based on the contaminants properties and field-designated concentrations, handling requirements will be defined according to applicable regulations. The management of the investigative derived waste will be specified as part of the unit-specific Part B permit application or postclosure permit application.

11.3.3 Remediation Process

During the remediation of the TSD unit through negotiations with the appropriate regulatory agency, an appropriate closure option (clean, health-base closure, or landfill) will be selected (Section 11.1.1, 11.1.2, and 11.1.3, respectively). The approved closure option will include sampling to determine if clean closure is achievable unless landfill closure is selected. If some remediation is undertaken, the sampling results will be used to determine when the remediation effort has been completed. Information specific to any one TSD unit can be found in the unit-specific Part B permit application or postclosure permit application.

11.3.4 Sampling Methods

Sampling will be accomplished according to information contained in established environmental regulations and guidelines. This information has been used in developing protocols set forth in contractor procedures and in SW-846. These protocols will be followed in obtaining and handling all samples. Field duplicate, equipment blank, and trip blank samples will be taken as appropriate and analyzed as a check on field sampling procedures, cross-contamination of samples, contamination from sample handling, and laboratory contamination. Samples usually will be taken on intervals down to 3 feet (0.91 meter) for non-land disposal units. For land disposal units, some vadose zone characterization will be required. Details on the number of

samples, samples depths, and number of vadose zone wells needed will be included in the unit-specific Part B permit application or postclosure permit application.

The analytical data obtained from the sampling of each TSD unit will be evaluated by SW-846 methods and analyzed by a cognizant person in the media involved (i.e., soil, water, concrete, or air). The resulting concentration levels of the identified constituents will be compared with the corresponding background level or health- and environmental-based standards. If this comparison supports the conclusion that the area does not contain greater contaminant concentrations than the background or health and environmental based levels, the area will be considered decontaminated and can be cleaned closed. If sample results from a particular TSD unit do not meet the closure criteria, the particular constituents that exceed the action levels will be identified, and further evaluations of the potential success of additional decontamination efforts will be limited to these constituents.

Sampling and analysis of materials that are not covered by SW-846 will be achieved using protocols, procedures, and methods approved by the appropriate regulatory agencies before conducting the sampling or analytical work. Descriptions of procedures currently used to support closure activities are contained in Appendix 2D. The specific sampling plan for the TSD unit will be provided in the unit-specific Part B permit application or postclosure permit application.

11.4 CLOSURE PLANS

The unit-specific permit application closure and postclosure plans will follow the outline provided in Appendix 11A. The unit-specific permit application closure and postclosure plan is designed for closure of a TSD unit where closure will be implemented in the future once operations are discontinued. These closure and postclosure plans will be implemented when approval is received from Ecology and the EPA and after the final waste receipt by the TSD unit.

The closure and postclosure plan contained in Chapter 11.0 of the unit-specific permit applications contains information on closure performance standards, decontamination, waste inventory removal, sampling and analysis, schedule, closure certification, and postclosure information (if applicable). Where possible, the closure plan will be prepared using clean closure as the basis for closing the TSD unit.

Appendix 11B is the outline for a final status postclosure permit application. Basically, the final status postclosure permit application contains information on the long-term monitoring, care, and maintenance required because of waste being left in place. The postclosure permit application contains a description of the TSD unit, closure activities, groundwater monitoring, landfill cover design, maintenance, and corrective actions.

11.4.1 Schedule for Closure

In accordance with regulations, closure activities will commence with the final receipt of waste. The TSD unit specific schedules for closure will be provided in the closure plans. The activities to complete closure will be scheduled within 180 days unless a modified schedule is presented and agreed upon in the closure plan.

11.4.2 Extension of Closure Time

If closure activities will exceed the approved closure plan schedule, closure time extensions will be requested. All extension requests will include the justification for the extension and details for the remaining activities to achieve closure.

11.4.3 Amendments to Closure Plans

Should changes be required to the approved closure plan, an amended plan will be prepared and submitted to the proper regulatory agency for approval in accordance with 40 CFR 264.112(c) and WAC 173-303-610(3)(b).

11.4.4 Certification of Closure

Within 60 days of final closure of any TSD unit, the DOE-RL will submit a certification of closure to the proper regulatory agency in accordance with 40 CFR 264.115 and/or WAC 173-303-610(6). This certification will be signed by both the DOE-RL and by an independent professional engineer registered in the state of Washington, and will state that the TSD unit has been closed in accordance with the approved closure plan. The certification will be submitted by registered mail or an equivalent delivery service. Documentation supporting the closure certification will be retained and will be furnished upon request to the proper regulatory agency. This documentation will be maintained by the DOE-RL contact (or the successor) identified in Section 11.4.7.

11.4.5 Notice to Local Land Authorities

To the extent that residual contamination (waste left-in-place) exceeds limits for protection of public health and the environment, the local land authority (county-specific land zoning board and engineer) will be provided a certified legal description of the contaminant location and contaminant inventory.

11.4.6 Closure Cost Estimates

Federal facilities are not required to comply with WAC 173-303-620 as is stated in the regulations. However, the DOE-RL has agreed to provide

projections of anticipated costs for closure of final status TSD units (i.e., those units for which final status permit chapters have been incorporated into the Hanford Facility Permit) on an annual basis in a separate report (Chapter 12.0, Section 12.4.2.3.3). Submittal of this report will take place on or before October 30 commencing in 1992.

11.4.7 Closure Contacts

The following office (or its successor) is the official contact for the TSD units:

Environmental Restoration Division
U.S. Department of Energy
Field Office, Richland
P.O. Box 550
Richland, Washington 99352
(509) 376-7277.

11.5 POSTCLOSURE PLANS

Postclosure plans will be submitted with the closure plan for the TSD units where closure as a landfill is likely. For landfill closure, a final status postclosure permit application (Appendix 11B) will be submitted separately. Typically, the final status postclosure permit application will be submitted formally following some amount of closure area sampling. When data indicate that some level of residual contamination above human health and the environmental standards will remain after cleanup, a postclosure permit application will be submitted. In addition, temporary or limited monitoring will occur when contamination is left in place after closure for remediation during the operable unit cleanup.

11.5.1 Notice in Deed

For those TSD units that cannot be clean closed, the following action will be taken in accordance with 40 CFR 264.119 and WAC 173-303-610(1)(b). Within 60 days of the certification of closure, the DOE-RL will sign, notarize, and file for recording the notice indicated below. The notice will be sent to the Auditor of Benton County, P.O. Box 470, Prosser, Washington, with instructions to record this notice in the deed book.

TO WHOM IT MAY CONCERN

The United States Department of Energy Field Office, Richland, an operations office of the United States Department of Energy, which is a department of the United States government, the undersigned, whose local address is the Federal Building, 825 Jadwin Avenue, Richland, Washington, hereby gives the following notice as required by 40 CFR 264.119 and WAC 173-303-610(10) (whichever is applicable):

(a) The United States of America is, and since April 1943, has been in possession in fee simple of the following described lands: (legal description of the TSD unit).

(b) The United States Department of Energy Field Office, Richland, by operation of the (name of TSD unit), has disposed of hazardous and/or dangerous waste under the terms of regulations promulgated by the United States Environmental Protection Agency and the Washington State Department of Ecology (whichever is applicable) at the above described land.

(c) The future use of the above described land is restricted under terms of 40 CFR 264.117(c) and WAC 173-303-610(7)(d) (whichever is applicable).

(d) Any and all future purchasers of this land should inform themselves of the requirements of the regulations and ascertain the amount and nature of wastes disposed on the above described property.

(e) The United States Department of Energy Field Office, Richland, has filed a survey plat with the Benton County Planning Department and with the United States Environmental Protection Agency, Region 10, and the Washington State Department of Ecology (whichever are applicable) showing the location and dimensions of the (name of the TSD unit) and a record of the type, location, and quantity of waste treated.

11.5.2 Inspection Plan

The inspection plan will describe inspections to be conducted during the postclosure period, the frequency of inspections, the inspection procedures, and the logs to be kept. The inspection plan will contain information on the following items, as applicable: security control devices; erosion damage; cover settlement, subsidence, and displacement; vegetative cover condition; integrity of run-on and run-off control measures; cover drainage system; gas venting system; well condition; and benchmark integrity.

11.5.3 Groundwater Monitoring Plan

The groundwater monitoring plan will describe activities associated with groundwater monitoring during the postclosure period. The groundwater monitoring plan will contain the following information, as applicable: interim status period groundwater monitoring data, aquifer identification, contaminant plume description, detection monitoring program, compliance monitoring program, and corrective action program.

11.5.4 Maintenance Plan

The maintenance plan will describe the preventative and corrective maintenance procedures, equipment, and material needs. The plan will contain the following information, as applicable: repair of security control devices; erosion damage repair; correction of settlement, subsidence, and displacement; mowing, fertilization, and other vegetative cover maintenance; repair of run-on and run-off control structures; and well replacement.

11.5.5 Personnel Training

This section will contain information on the training programs that prepare personnel to maintain the TSD unit in a safe manner.

11.5.6 Postclosure Contact

The following office (or its successor) is the contact for TSD units:

Environmental Restoration Division
U.S. Department of Energy
Field Office, Richland
P.O. Box 550
Richland, Washington 99352
(509) 376-7277.

11.5.7 Provisions to Amend the Postclosure Plan

Should changes be required to the approved postclosure plan, an amended plan will be prepared and submitted to the proper regulatory agency for approval in accordance with 40 CFR 264.112(c) and WAC 173-303-610(3)(b).

11.5.8 Provisions to Certify the Postclosure Plan

The certification statement will be the same certification statement that is used for the unit-specific permit application.

11.5.9 Postclosure Cost Estimates

Federal facilities are not required to comply with WAC 173-303-620 as is stated in the regulations. However, the DOE-RL has agreed to provide projections of anticipated costs for postclosure for final status TSD units (i.e., those units for which final status permit chapters have been incorporated into the Hanford Facility Permit) on an annual basis in a separate report (Chapter 12.0, Section 12.4.2.3.3). Submittal of this report will take place on or before October 30 commencing in 1992.

11.6 FACILITY-WIDE CLOSURE PLAN

The Hanford Facility will be considered closed when the last TSD unit-specific closure or postclosure plan (for which a final status permit was issued) has been implemented.

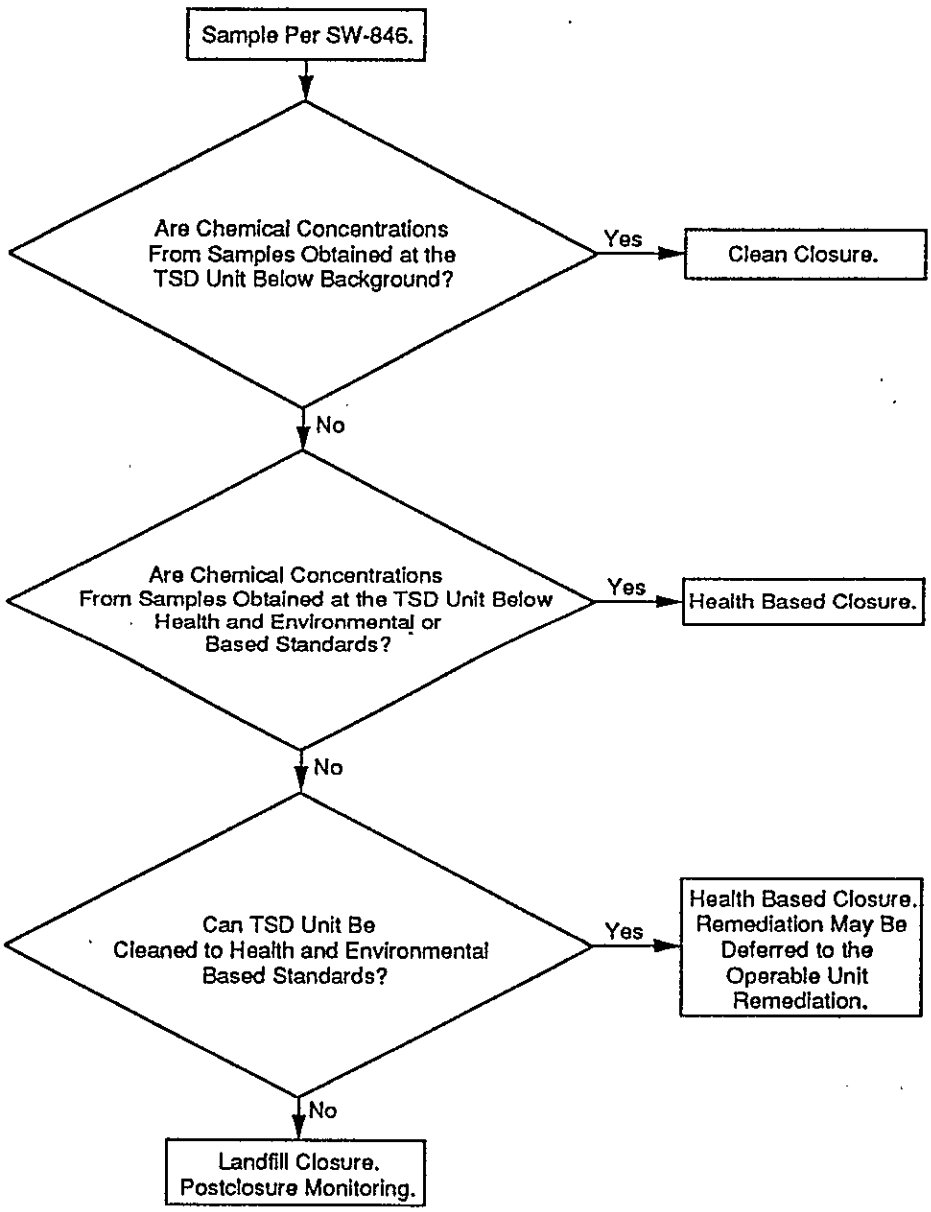

Figure 11-1. General Closure Logic Flow Chart.

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12.0 REPORTING AND RECORDKEEPING

This chapter summarizes the Hanford Facility reporting and recordkeeping requirements. A general reporting requirement applicable to all TSD units (e.g., notification) is described, as well as the reporting and recordkeeping requirements for generators, transporters, and TSD facilities. Required reports and records are accessible through a centralized Hanford Facility Regulatory File index, currently under development. This index, once fully developed, can be used to provide regulatory agency access to all Hanford Facility TSD unit regulatory compliance records required by WAC 173-303, including those maintained at the TSD units. Reports and records applicable to the Hanford Facility are summarized in Table 12-1.

The Regulatory File is maintained by the Environmental Data Management Center (Figure 12-1). Each TSD unit will undergo a periodic review by an Environmental Data Management Center Regulatory File Custodian (Regulatory File Custodian) to ensure standardized collection and maintenance of unit-specific reports and records (operating records). The anticipated completion date for the systematic review of all Hanford Facility TSD units is January 1993. Subsequent periodic assessments of each TSD unit will ensure the continuation of effective records management practices.

Regulatory requests for operating records from active and closed TSD units are directed to the Regulatory File Custodian on 509-376-2530. Operating records accessible through the Regulatory File Custodian include the following, as required by RCRA and Ecology *Dangerous Waste Regulations*:

- Waste manifests
- Waste designation and/or characterization data
- Personnel training plans/records
- Contingency and/or emergency plans
- Inspection plans/procedures
- Waste analysis plans
- Spill reports
- Waste minimization plans and reports
- Annual dangerous and mixed waste reports
- Tank integrity plans and reports
- Groundwater monitoring plans and reports
- Records, plans, specifications, reports, etc. to demonstrate compliance with interim status standards.

12.1 NOTIFICATION OF DANGEROUS WASTE ACTIVITIES

Regulations require that facilities involved in the generation or transportation of dangerous waste or the owner or operator of a TSD facility have a current EPA/State identification number. The Hanford Facility is a single RCRA facility operating under EPA/State Identification Number WA7890008967.

12.2 GENERATOR REQUIREMENTS

The Hanford Facility complies with the generator reporting and recordkeeping regulations. Hanford Facility waste generation records and required reports (e.g., annual reports) are compiled and issued as single records or reports for the entire Hanford Facility. The regulations governing generator recordkeeping and reporting are discussed in the following sections.

12.2.1 Recordkeeping

Generator records maintained by the Hanford Facility include the following:

- Records of waste generated onsite
- Waste shipment records
- A copy of each annual report
- Land disposal restriction records.

Waste generation records are retained as required by 40 CFR 262.40 and WAC 173-303-210.

A discussion of the waste tracking and manifest system used by the Hanford Facility is contained in Chapter 2.0, Section 2.8. Records of onsite waste movements and offsite shipments, as well as receipt of offsite waste, are accessible through the Regulatory File Custodian.

12.2.2 Reporting

Generator reports required by 40 CFR 262, Subpart D, and WAC 173-303-220 submitted by the Hanford Facility include the annual report, exception reports, and any required additional reports.

The Hanford Facility submits an annual report to Ecology of waste generation activities. The annual report is submitted on the "Generator Annual Dangerous Waste Report--Form 4." All dangerous waste generated at the Hanford Facility is included in the annual report.

Copies of waste analysis reports or other documentation relating to the composition of dangerous or mixed waste generated at the Hanford Facility is retained and is available by contacting the Regulatory File Custodian. Documents relating to land disposal restrictions are discussed in Section 12.4.2.2.7.

12.3 TRANSPORTER REQUIREMENTS

The Hanford Facility does not transport dangerous waste offsite. Transporters having their own EPA/State identification numbers are used to transport dangerous waste generated by the Hanford Facility (nonradioactive dangerous waste) to a permitted offsite TSD facility. Waste transfers onsite are recorded and tracked in accordance with Hanford Facility procedures. Therefore, transporter records required by 40 CFR 263.22 and WAC 173-303-260 are not maintained by either the TSD unit or the Hanford Facility, and reports such as discharge reports required by 40 CFR 263.30 and WAC 173-303-270 are not applicable.

12.4 TREATMENT, STORAGE, AND/OR DISPOSAL REQUIREMENTS

The Hanford Facility reporting and recordkeeping methods are discussed in this section. The TSD records are described, the operating record and miscellaneous support record contents are detailed, and plans submitted with this permit application are described. The records and reports described in this section are available by contacting the Regulatory File Custodian.

12.4.1 Reports

This section discusses the reporting requirements of WAC 173-303 and several parts of Title 40, Code of Federal Regulations relating to aspects of dangerous waste management. The following are included in the reporting requirements:

- Waste manifest reports
- Annual dangerous waste reports
- Biennial dangerous waste reports
- Groundwater monitoring reports
- Contingency plan incident notifications
- Spills, discharges, and leaks reports
- Closure reports
- Postclosure reports.

Additional details of these reports are provided in the following sections. Copies of these reports are accessible by contacting the Regulatory File Custodian.

12.4.1.1 Waste Manifest Reports. The Hanford Facility has methods in place for tracking onsite and offsite waste shipments. The waste manifest and waste manifest reports are for offsite waste shipments. The waste manifest is the source of two possible reports, the manifest discrepancy report and the unmanifested waste report. Methods of dealing with manifesting discrepancies are described in Chapter 2.0, Section 2.8. Records documenting both onsite and offsite waste shipments are retained and are accessible through the Regulatory File Custodian.

12.4.1.2 Annual Reports. The state of Washington, pursuant to WAC 173-303-390, requires an overall annual report for each facility that holds an active EPA/State identification number. The report is due to Ecology on March 1 of each year. The report contents for the Hanford Facility include the following:

- The EPA/State identification number
- Name and address of the Hanford Facility
- Calendar year covered by the report
- Sources of the waste stored on the Hanford Facility
- Description and quantity of the waste stored on the Hanford Facility
- TSD methods
- Certification statement signed by an authorized representative.

The report form and instructions in the "Waste Management Facility Annual Dangerous Waste Report-Form 5" are used for this report.

12.4.1.3 Biennial Reports. The EPA requires, pursuant to 40 CFR 264.75, that an overall report describing each dangerous waste facility activity be submitted on March 1 of each even-numbered year. Ecology has been extended administrative responsibilities for biennial reporting as required by 40 CFR 264.75. A specific biennial report is not prepared and submitted as reporting requirements are satisfied by submittal of the annual report to Ecology.

12.4.1.4 Groundwater Monitoring Reports. Groundwater monitoring reports and plans are discussed in unit-specific permit applications. Reports are accessible by contacting the Regulatory File Custodian.

12.4.1.5 Contingency Plan Incident Notifications. The building emergency director or coordinator, TSD unit line management, and the contractor's environmental protection organization are responsible for making notifications as per unit-specific building emergency plans and Chapter 7.0 of this permit

application. Notifications of all emergency situations requiring contingency plan implementation are made as required by 40 CFR 264.56, WAC 173-303-360, and the U.S. Department of Energy Order 5000.3A.

In the event of a fire or an explosion, the building emergency director or coordinator or TSD unit line management immediately must notify the Patrol Operations Center by telephone at 811. All emergency incident calls to the emergency number (811) are reported by the Patrol Operations Center to the Hanford Fire Department and the Occurrence Notification Center. In the event of an unplanned release of hazardous or dangerous waste or materials, the building emergency director or coordinator immediately notifies the contractor's environmental protection organization who notifies the DOE-RL and the Occurrence Notification Center. The DOE-RL must be notified by telephone as soon as possible on the day of the incident. The building emergency director or coordinator or TSD unit line management must document the incident on an occurrence report to the DOE-RL within 24 hours of categorization of the incident. A copy of occurrence reports is accessible by contacting the Regulatory File Custodian.

If a Hanford Facility TSD unit stops operations in response to a fire, an explosion, or a release that could present a hazard to human health or the environment, the building emergency director or coordinator notifies the DOE-RL, via TSD unit line management, that the unit is operational and the emergency cleanup is complete.

The DOE-RL is responsible for three types of notifications: an immediate notification, the incident assessment report, and the TSD unit restart notification. Details of these notifications are provided in the following sections.

12.4.1.5.1 Immediate Notification. The Occurrence Notification Center (509-376-2900) immediately will notify affected county emergency management, Ecology, and the individual designated as the on-scene coordinator for the southeastern Washington area of the National Response Center (800-424-8802) if a fire, an explosion, or a release on the Hanford Facility could threaten human health or the environment outside the Hanford Facility.

The report will contain the following information:

- Name and telephone number of reporter
- Name and address of the TSD unit
- Time and type of incident
- Name and quantity of material(s) involved to the extent known
- Extent of injuries if any

- Possible hazards to human health or the environment outside the Hanford Facility

- Actions already taken to mitigate the situation.

12.4.1.5.2 Incident Assessment Report. The DOE-RL will provide a written report to Ecology within 15 days of any incident that requires implementation of the contingency plan. This report will include the following information:

- Name, address, and telephone number of the owner or operator

- Name, address, and telephone number of the TSD unit

- Date, time, and type of incident

- Name and quantity of material(s) involved

- Extent of injuries if any

- Assessment of actual or potential hazards to human health or the environment where this is applicable

- Estimated quantity and disposition of recovered material that resulted from the incident

- Cause of incident

- Description of corrective action taken to prevent recurrence of the incident.

12.4.1.5.3 Treatment, Storage, and/or Disposal Unit Restart Notification. If a TSD unit stops operations in response to a fire, an explosion, or a release that could present a hazard to human health or the environment, the DOE-RL will notify Ecology and the appropriate local authorities before operations are resumed in the affected area(s) of the TSD unit. The notification will indicate that cleanup procedures are complete and that emergency equipment is cleaned and fit for its intended use.

12.4.1.6 Spills, Discharges, and Leaks Reports. This section discusses the reports prepared as a result of unpermitted spills and discharges to the environment of dangerous waste or hazardous substance.

In the event of any nonemergency unplanned release of dangerous waste or hazardous substance, the building emergency director or coordinator immediately notifies the contractor's environmental protection organization and the Occurrence Notification Center. The Occurrence Notification Center immediately will notify the Hanford Fire Department for appropriate action. The building emergency director or coordinator documents the incident on an occurrence report (Chapter 2.0, Figure 2-8). A copy of the occurrence report can be obtained from the Regulatory File Custodian upon request. If an unpermitted spill or discharge exceeds the thresholds or reportable

quantities, the contractor's environmental protection organization performs the reporting necessary to comply with EPA and Ecology regulations. The following information is transmitted to the Occurrence Notification Center:

- Name and telephone number of reporter
- Name and address of the TSD unit
- Time and type of incident
- Name and quantities of material(s) involved to the extent known
- Extent of injuries if any
- Possible hazards to human health or the environment outside the TSD unit.

The Occurrence Notification Center will notify Ecology of all reportable spills to the environment or atmosphere in accordance with the requirements of WAC 173-303-145.

12.4.1.7 Closure Reports. Reports regarding the closure of the Hanford Facility TSD unit(s) will be made in accordance with the requirements of 40 CFR 264.115 and .116 and WAC 173-303-610(6) and (9).

12.4.1.7.1 Certification of Closure. Within 60 days of completion of closure of a TSD unit, a certification signed by the DOE-RL and an independent registered professional engineer will be submitted to the regulatory authority. The certification will be sent by registered mail or an equivalent delivery service. The certification will state that the TSD unit was closed in accordance with the approved closure plan. Documentation supporting the independent registered engineer's certification will be supplied upon request of the regulatory authority.

12.4.1.7.2 Survey Plat. For units that are not disposal units, a survey plat is not required. On submission of the closure certification for a disposal unit, a survey plat indicating the location and dimensions of the unit will be submitted to the following:

- Benton County Land Planning Department
- The EPA and Ecology.

The survey plat will be prepared and certified by a professional land surveyor. The plat will contain a note that states the DOE-RL's obligation to restrict disturbance of the TSD unit.

12.4.1.8 Postclosure Reports. Postclosure reports required by 40 CFR 264.119 and .120 and WAC 173-303-610(9), (10), and (11) for disposal units include location records, notice in deed, and postclosure care completion certification. These documents are discussed in the following sections.

12.4.1.8.1 Location Records. Not later than 60 days after the submission of the closure certification described in Section 12.4.1.7.1, the DOE-RL will submit to the local zoning authority a record of the type, location, and quantity of dangerous waste disposed of at the disposal unit. This submission will satisfy the requirements of 40 CFR 264.119(a) and WAC 173-303-610(9).

12.4.1.8.2 Notice in Deed. Within 60 days of the certification of closure of the disposal unit, the DOE-RL will, in accordance with the state regulations, sign, notarize, and file for recording, the notice in deed discussed in Chapter 11, Section 11.5.1. The notice will be sent to the Auditor of Benton County, P.O. Box 470, Prosser, Washington, with instructions to record this notice in the General Index. This document normally is reviewed in property title searches.

12.4.2 Recordkeeping Requirements

Records retained by the Hanford Facility include plans described in other portions of this permit application, operating records, miscellaneous support records, and records of reports made to the regulatory authority. These records are described in the following sections. Copies of these items are accessible by contacting the Regulatory File Custodian.

Records will be maintained in accordance with Table 12-1. Due to the limitation of space, records may be archived, as appropriate, at the Federal Records Center, 6125 Sand Point Way, Seattle, WA 98115, or other federal government archive centers in the state of Washington. Records archived at the Federal Records Center also are accessible by contacting the Regulatory File Custodian.

12.4.2.1 Permit Application Plans. The Hanford Facility and unit-specific plans described in other portions of this permit application, which are accessible through the Regulatory File Custodian, include the following:

- Waste analysis plan
- Contingency plan and amendments
- Training plan
- Closure/postclosure plans
- Inspection plan.

Unit-specific plans will be maintained at the TSD unit throughout the active life of the unit. Modifications or amendments required as a result of changing regulations, operational modifications, or data gathered with monitoring and sampling programs will be submitted to the regulatory authority and factored into the plans maintained at the respective TSD unit as required.

12.4.2.2 Operating Records. Operating records maintained at the TSD unit, and accessible by contacting the Regulatory File Custodian, include the following:

- Description and the quantity of each dangerous waste received and the method(s) and date(s) of treatment at the TSD unit in accordance with 40 CFR 264 Appendix I and WAC 173-303-380
- Location of each dangerous waste stored within a TSD unit and the quantity at each location
- Waste analyses results
- Contingency plan incident reports
- Inspection records
- Waste minimization certification
- Land disposal restriction records.

12.4.2.2.1 Waste Description and Quantity. A description and the quantity of each dangerous waste handled by the TSD unit are maintained in TSD unit records. Waste manifests and onsite waste transfer records, describing the types and quantities of waste, are maintained as part of the operating record.

12.4.2.2.2 Waste Location. The location of each dangerous or mixed waste and the quantity stored within the unit are documented and maintained. Transfers are documented on onsite waste transfer records and provided to other Hanford Facility TSD units receiving the waste. Copies of these onsite waste transfer records are maintained and are accessible by contacting the Regulatory File Custodian.

12.4.2.2.3 Waste Designation. Waste designation records maintained at the TSD units are generated, as appropriate, for the following:

- Feed candidates during tank sampling before initiating an evaporator campaign
- Waste resulting from a spill or leak that cannot be identified
- Waste generated at the unit during decontamination or maintenance activities if required.

As required, results of these analyses are provided to other TSD units subsequently receiving the waste for further treatment, storage, and/or disposal.

12.4.2.2.4 Contingency Plan Incident Records. Records documenting the details of any incidents requiring the implementation of the contingency plan (Chapter 7.0) are maintained as part of the Regulatory File as required by

40 CFR 264.73 and WAC 173-303-380. In addition to these records, occurrence reports are generated to document incidents. The occurrence report describes all incidents, including those that are judged too minor to require the implementation of the contingency plan but are identified as offnormal events, unusual occurrences, or emergencies.

12.4.2.2.5 Inspection Records. Records of unit-specific inspections are maintained at the TSD unit or accessible through the Regulatory File for a period of at least 5 years from the inspection date. The records include the following:

- The date and time of inspection
- The inspector's printed name and handwritten signature
- Notations of observations
- The date and nature of any repairs or other remedial actions.

12.4.2.2.6 Waste Minimization Certification. Annually a certification by the DOE-RL that the Hanford Facility is in compliance with waste minimization requirements is entered into the Regulatory File as required by 40 CFR 264.73(b)(9).

12.4.2.2.7 Land Disposal Restrictions Records. Records related to treatment and disposal of waste subject to land disposal prohibitions are maintained by the Hanford Facility as required by 40 CFR 264.73(b)(10) and (12). Possible records include:

- Waste placed in land disposal units under an extension to the effective date of any land disposal restriction granted pursuant to 40 CFR 268.5
- Waste placed in land disposal units under a petition granted pursuant to 40 CFR 268.6
- The applicable notice and certification required by 40 CFR 268.7(a) or 40 CFR 268.7(b)
- The demonstration and certification required by 40 CFR 268.8, if applicable, for waste subject to land disposal prohibitions or restriction.

An onsite waste tracking system is in place to document the transfer of waste subject to land disposal restrictions. Land disposal restriction documentation is accessible by contacting the Regulatory File Custodian.

12.4.2.3 Miscellaneous Support Records. Miscellaneous support records include the following:

- Training records
- Closure/postclosure cost estimates
- Certification records
- Report records.

12.4.2.3.1 Training Documentation. The name of each employee and the waste management position held are maintained by the TSD unit. Training records document that employees have received the training or have the job experience required for that position. Training records on current employees are kept until closure of the unit. Training records on former employees are kept for 3 years from the date the employee last worked at a TSD unit. Auditable copies of these records are maintained by the contractors' training organizations. Specific employee training records are available on a demonstrated need-to-know basis. Copies of these records will be marked *Sensitive Information* and are expected to be handled in accordance with the *Privacy Act* (Chapter 8.0, Section 8.2).

12.4.2.3.2 Liability Coverage Documentation. In accordance with 40 CFR 264.140(c) and WAC 173-303, this documentation is not required for federal facilities. The Hanford Facility is a federally owned facility for which the federal government is an operator and this documentation is therefore not applicable.

12.4.2.3.3 Closure and Postclosure Cost Estimates. In accordance with 40 CFR 264.140(c) and WAC 173-303, these estimates are not required for federal facilities. The Hanford Facility is a federally owned facility for which the federal government is an operator and these estimates are not applicable.

An annual report updating projections of anticipated closure and postclosure costs for final status TSD units (i.e., those units for which final status permit chapters have been incorporated into the Hanford Facility Permit) will be submitted to Ecology by October 30 (beginning in 1992).

12.4.2.3.4 Certification Records. Reports, data, and information requested or required in direct support of the Hanford Facility Permit will be certified as required in accordance with WAC-173-303-810(12) and (13) or 40 CFR Part 2 and 40 CFR 270.11 for *Hazardous and Solid Waste Amendment* provisions. Records of certification will be maintained as part of the Regulatory File.

12.4.2.3.5 Report Records. The reports described in Section 12.1 and 12.4.1 are accessible by contacting the Regulatory File Custodian.

12.5 IMMEDIATE REPORTING

The DOE-RL verbally will report to Ecology and the EPA any noncompliance with the Permit that might endanger human health or the environment. Any such

information will be reported to Ecology and EPA within 24 hours after the DOE-RL becomes aware of the circumstances of the noncompliance. The immediate verbal report will contain all the information needed to determine the nature and extent of any potential threat to human health and the environment, including information concerning the release of any dangerous waste required by WAC 173-303-145.

Regulatory File Management

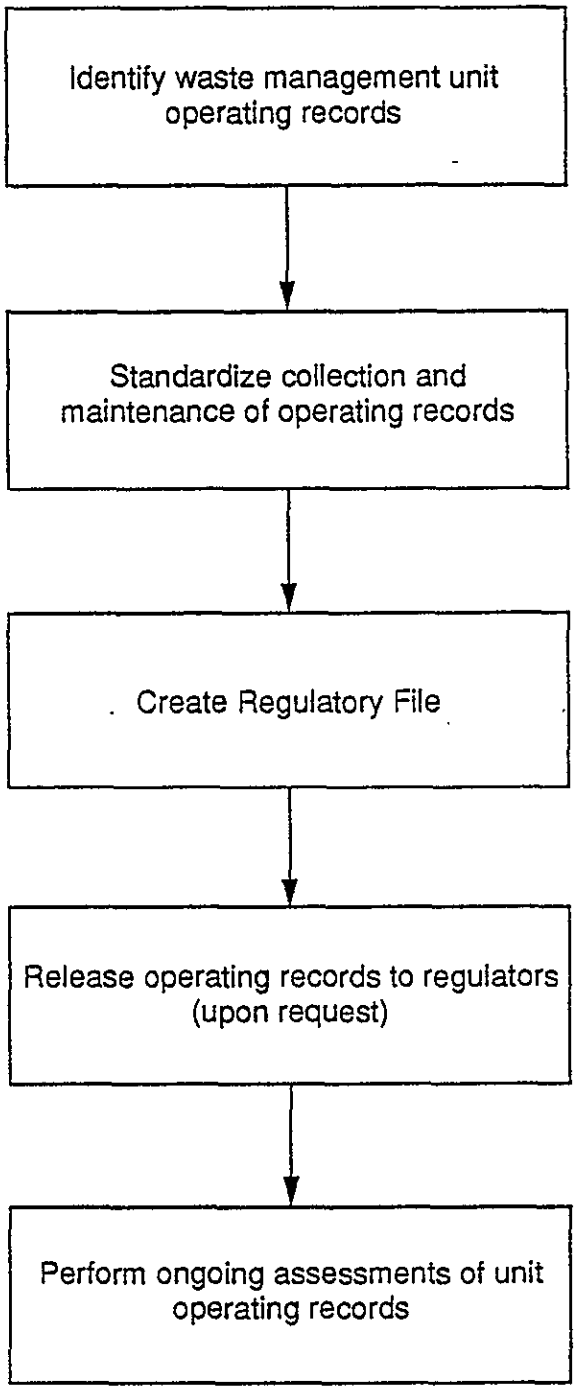

Figure 12-1. Regulatory File Management Flowchart.

Table 12-1. Reports and Records. (sheet 1 of 5)

Item	Storage	
	Retention time	Location
Notification of dangerous waste activities	Life of TSD unit	Hanford Facility
GENERATOR REPORTS AND RECORDS:		
Annual report	Life of TSD unit	Hanford Facility
Exception report	Life of TSD unit	Hanford Facility
Additional reports and records as required (e.g., inspection logs)	Life of TSD unit	Hanford Facility
Test and Waste Analysis Results:		
Waste generated onsite	Life of TSD unit	Hanford Facility
Waste Manifest Reports and Records:		
Manifests	Life of TSD unit	At TSD unit[a]
Manifest discrepancy	Life of TSD unit	At TSD unit
Unmanifested waste	Life of TSD unit	Hanford Facility
Land Disposal Restriction Records:		
Extension to an effective date	Life of TSD unit	At TSD unit
Petition for a variance	Life of TSD unit	At TSD unit
Notice and certification of treatment standards	Life of TSD unit	At TSD unit
Demonstration and certification for a temporary extension to the effective date	Life of TSD unit	At TSD unit

Table 12-1. Reports and Records. (sheet 2 of 5)

	Item	Storage	
		Retention time	Location
1	**TRANSPORTER REPORTS AND RECORDS:**		
2	None required	NA[b]	NA
3			
4	**TREATMENT, STORAGE, OR DISPOSAL REPORTS AND RECORDS:**		
5	Permit Application Plans:		
6	Waste analysis plan	Life of TSD unit	At TSD unit
7 8	Contingency plan and amendments	Life of TSD unit	At TSD unit
9	Training plan	Life of TSD unit	At TSD unit
10	Closure plan	Life of TSD unit	At TSD unit
11	Postclosure plan		NA
12	Inspection plans	Life of TSD unit	At TSD unit
13 14	Operating Reports and Records:		
15 16	Waste description and quantity	Life of TSD unit	At TSD unit
17	Waste location	Until closure	At TSD unit
18	Waste analysis data	Life of TSD unit	Hanford Facility
19	Inspection records	Varies from 5 years from inspection date to life of TSD unit	At TSD unit
20 21	Certification of waste minimization efforts	Life of TSD unit	At TSD unit
22 23	Land Disposal Restriction Records:		
24 25	Extension to an effective date	Life of TSD unit	At TSD unit
26	Petition for a variance	Life of TSD unit	At TSD unit

Table 12-1. Reports and Records. (sheet 3 of 5)

	Item	Storage	
		Retention time	Location
1 2	Notice and certification of treatment standards	Life of TSD unit	At TSD unit
3 4 5 6	Demonstration and certification for a temporary extension to the effective date	Life of TSD unit	At TSD unit
7 8	<u>Waste Manifest Reports and Records</u>:		
9	Transfer data sheets	Until closure	At TSD unit
10 11	Transfer data sheet discrepancy	Until closure	At TSD unit
12	Manifests	Until closure	Hanford Facility
13	Manifest discrepancy	Until closure	Hanford Facility
14	Unmanifested waste	Until closure	Hanford Facility
15 16	<u>Groundwater Monitoring Reports and Records</u>:		
17	Detection monitoring	Life of TSD unit	At TSD unit
18	Statistically significant	Life of TSD unit	At TSD unit
19	Permit modification	Life of TSD unit	At TSD unit
20 21 22	Variance justification or engineering feasibility plan	Life of TSD unit	At TSD unit
23	Alternate demonstration	Life of TSD unit	At TSD unit
24	Compliance monitoring	As required	As required
25	Corrective action	As required	As required
26 27	<u>Contingency Plan Incident Reports and Records</u>:		
28 29	Immediate notification--Occurrence Reports	Life of TSD unit	Hanford Facility
30	Assessment report	Life of TSD unit	At TSD unit

Table 12-1. Reports and Records. (sheet 4 of 5)

	Item	Storage	
		Retention time	Location
1 2	TSD Unit restart notification	Life of TSD unit	At TSD unit
3 4	Spills, Discharges, and Leaks Reports:		
5 6	Immediate notification--Occurrence Reports	Life of TSD unit	Hanford Facility
7	Closure Reports and Records:		
8	Certification of closure	Life of TSD unit	At TSD unit
9	Survey plat	Life of TSD unit	NA
10	Closure cost estimates	Life of TSD unit	NA
11	Postclosure Reports and Records:		
12	None required	Life of TSD unit	NA
13 14	Miscellaneous Support Reports and Records:		
15	Annual report	Life of TSD unit	Hanford Facility
16	Training documentation	Life of TSD unit	At TSD unit
17 18	Liability coverage documentation		NA
19 20	Hanford Facility inspection records	Varies from 5 years from inspection date to life of Hanford Facility	Hanford Facility
21 22	Environmental investigation instructions	Life of Hanford Facility	Hanford Facility
23 24	Listing of engineering change notices	Life of TSD unit	Hanford Facility
25 26	Listing of equivalency reports	Life of TSD unit	Hanford Facility
27	Certification records	Life of Hanford Facility	Hanford Facility

Table 12-1. Reports and Records. (sheet 5 of 5)

Item	Storage	
	Retention time	Location
Anticipated closure and postclosure costs	Life of Hanford Facility	Hanford Facility
Hanford solid waste management units reports	Life of Hanford Facility	Hanford Facility

[a] Located with organization responsible for the day-to-day operation of the TSD unit for 5 years from the date of origination, then transferred to the Hanford Facility for remainder of the retention period.

[b] NA = not applicable.

Note: At the time of closure, all TSD unit environmental records will be transferred to the Hanford Facility Regulatory File. For purposes of maintaining TSD records designated for the "Hanford Facility", the 700 Area of the Hanford Site is considered to meet the intent of WAC 173-303 even though it is not located within the Hanford Facility boundary.

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13.0 OTHER RELEVANT LAWS

The Hanford Facility TSD units are, or will be, constructed and operated in compliance with all applicable laws and regulations. This chapter provides a summary of the regulatory review performed to determine that TSD units of the Hanford Facility have met, or will meet, their obligations with respect to other federal and state laws. The environmental laws evaluated include the following, all as amended:

- *Atomic Energy Act of 1954*
- *Clean Air Act of 1977*
- *Clean Water Act of 1977*
- *Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
- *Emergency Planning and Community Right to Know Act of 1986*
- *Endangered Species Act of 1973*
- *Federal Insecticide, Fungicide, and Rodenticide Act of 1975*
- *Fish and Wildlife Coordination Act of 1934*
- *Hanford Reach Study Act*
- *National Environmental Policy Act of 1969*
- *National Historic Preservation Act of 1966*
- *Safe Drinking Water Act of 1974*
- *Toxic Substances Control Act of 1976*
- *Wild and Scenic Rivers Act of 1968.*

When other relevant laws apply to TSD units, best efforts will be made to obtain all other necessary permits and/or approvals in a timely fashion. For the purposes of this permit application, 'best efforts' means submittal of an application for the permit(s) and/or approval(s) in accordance with schedules specified in applicable regulations or as determined through negotiations with the applicable regulatory agency. All non-RCRA permits will be enforceable by the regulatory authority through which the permits are issued.

13.1 THE ATOMIC ENERGY ACT OF 1954

The *Atomic Energy Act* provides that the U.S. Atomic Energy Commission (succeeded by the U.S. Department of Energy for conducting nuclear defense and

research and development activities at the Hanford Site) is authorized to develop and implement regulations to govern activities related to the design, location, and operation of U.S. Department of Energy sites, to protect health, and to minimize danger to life or property. The radioactive component of mixed waste is interpreted by the U.S. Department of Energy to be regulated under the *Atomic Energy Act*; the nonradioactive dangerous component of mixed waste is interpreted to be regulated under the RCRA and WAC 173-303.

The U.S. Department of Energy has issued several orders to govern the activities of its sites and to manage the health protection aspects of mixed waste. These orders provide for a consistent approach to managing waste that results from U.S. Department of Energy activities. The orders set radiation exposure limits and concentration guidelines to minimize exposure to radiation and detail the standards and procedures for managing mixed waste. All Hanford Facility operations are, and will be, carried out in accordance with these orders.

13.2 CLEAN AIR ACT OF 1977

The *Clean Air Act* establishes national ambient air quality standards and sets standards for abating air pollution and preventing further deterioration of air quality. Air standards are implemented and enforced primarily by state and local authorities. The Hanford Facility will comply with the letter and spirit of all applicable federal, state, and local requirements to control and abate air pollution, including the following:

- *National Emission Standards for Hazardous Air Pollutants* (40 CFR 61) and *National Emission Standard for Radionuclide Emissions* from U.S. Department of Energy Facilities (40 CFR 61, Subpart H)

- Air pollution control regulations (WAC 173-400 through 495) issued under the authority of the *Washington Clean Air Act of 1967*

- *Radiation Protection - Air Emissions* (WAC 246-247), which promulgates the policies set forth in Chapter 70.98 of the *Revised Code of Washington, Nuclear Energy and Radiation*, issued under the authority of the *Washington Clean Air Act*

- Benton-Franklin-Walla Walla Counties Air Pollution Control Authority, General Regulation 80-7 (1980).

13.3 CLEAN WATER ACT OF 1977

The *Clean Water Act* establishes national ambient water quality standards and sets standards for abating water pollution and preventing further deterioration of the water quality. These standards are implemented and enforced primarily by state and local authorities. The Hanford Facility will comply with the letter and spirit of applicable federal, state, and local requirements to control and abate water pollution. Potentially applicable or relevant regulations include the following:

- *National Pollutant Discharge Elimination System*, 40 CFR 121 to 125
- *Water Quality Standards for Surface Waters of the State of Washington*, WAC 173-201
- *On-Site Sewage System*, WAC 246-272.

13.4 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980

The CERCLA, as amended in 1986 by the *Superfund Amendments and Reauthorization Act* (SARA), establishes a process for undertaking remedial action at inactive waste sites that contain hazardous substances, and establishes reporting requirements for releases of hazardous substances. The CERCLA remedial process has been initiated at the Hanford Site in response to identification on the National Priorities List. The Tri-Party Agreement addresses how RCRA corrective actions and CERCLA remedial actions are to be integrated on the Hanford Facility.

13.5 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT OF 1986

The *Emergency Planning and Community Right-to-Know Act* is a freestanding provision of the SARA. This act establishes the framework for state and local emergency planning and provides a mechanism for community awareness of hazardous chemicals present in a locality.

13.6 ENDANGERED SPECIES ACT OF 1973

The *Endangered Species Act* establishes a program for conserving endangered species and their ecosystems. Most activities on the Hanford Facility take place in areas that have been extensively developed during past construction. It is not expected that any listed or proposed endangered or threatened species or their habitats will be affected by the Hanford Facility or TSD unit activities. However, activities outside extensively developed areas will be reviewed for applicability and compliance. In the event that such species or habitats must be disturbed as a part of Hanford Facility operating or clean-up activities, mitigative measures will be taken in accordance with applicable requirements.

13.7 FEDERAL INSECTICIDE, FUNGICIDE, AND RODENTICIDE ACT OF 1975

The *Federal Insecticide, Fungicide, and Rodenticide Act* establishes a program to regulate the manufacture and use of pesticides. One class of pesticide commonly used on the Hanford Site consists of herbicides used to control vegetation. The application of all pesticides used on the Hanford Facility is done in compliance with the *Federal Insecticide, Fungicide, and Rodenticide Act*.

13.8 FISH AND WILDLIFE COORDINATION ACT OF 1934

The *Fish and Wildlife Coordination Act* authorizes the U.S. Secretary of the Interior to assist and cooperate with public and private organizations to protect fish and wildlife. Activities at the Hanford Facility impacted by the *Fish and Wildlife Coordination Act* such as the building or demolition of an outfall, will be handled in accordance with the agreement between the U.S. Department of Energy and the Washington State Department of Fisheries.

13.9 HANFORD REACH STUDY ACT

The *Hanford Reach Study Act* directs the Secretary of the Interior to prepare a study on the Hanford Reach of the Columbia River to consider the addition of the Hanford Reach to the National Wild and Scenic Rivers System. During the 8-year study period ending in 1996, activities undertaken from river miles 396 to 345 and within a quarter-mile of the Columbia River mean high-level mark must be conducted in consultation and coordination with the National Parks Service, acting for the Secretary of the Interior. Hanford Site activities undertaken within the Hanford Reach are conducted in compliance with the *Hanford Reach Study Act*.

13.10 NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The *National Environmental Policy Act* (NEPA) establishes a broad national policy for protection of environmental quality and provides the means for implementing that policy. All major construction and cleanup projects at the Hanford Site are subject to the NEPA review process. As stated in the Tri-Party Agreement, the NEPA requirements are to ensure that the potential environmental impact of investigation and cleanup activity is assessed. These assessments, when determined to be required, will be made primarily as part of the CERCLA remedial action and RCRA corrective action processes.

13.11 NATIONAL HISTORIC PRESERVATION ACT OF 1966

The *National Historic Preservation Act* establishes national policy to preserve historic places, which include sites, structures, and objects significant in American history, archeology, or culture. The Hanford Facility has in place requirements for the preservation of historical sites and cultural resources. During any future construction activity for a TSD unit, the site will be monitored for the presence of archaeological resources in accordance with regulations issued pursuant to, or other requirements of, the *American Antiquities Preservation Act of 1906*, the *American Indian Religious Freedom Act of 1978*; the *Historic Sites, Buildings and Antiquities Act of 1935*; and the *Archaeological and Historic Preservation Act of 1979*.

13.12 SAFE DRINKING WATER ACT OF 1974

The *Safe Drinking Water Act* provides for protection of public health by setting standards for water supplied for public consumption and by protecting public drinking water sources. Drinking water systems at the Hanford Facility are in compliance with these standards.

13.13 TOXIC SUBSTANCES CONTROL ACT OF 1976

The *Toxic Substances Control Act* provides for protection of human health and the environment from exposure to certain hazardous and toxic chemical substances and mixtures. The Hanford Facility has in place a program for the cleanup, treatment, and disposal of materials regulated by the *Toxic Substances Control Act*.

13.14 WILD AND SCENIC RIVERS ACT OF 1968

The Hanford Facility does not affect any rivers presently designated under the *Wild and Scenic Rivers Act*.

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14.0 CERTIFICATION [K]

The following certification, required by WAC 173-303-810(13), for all applications and reports submitted to Ecology is hereby included:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Edward S. Goldberg — 10/3/91

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

Thomas M. Anderson — 9/23/91

Co-Operator* — Date
Thomas M. Anderson, President
Westinghouse Hanford Company

* Westinghouse Hanford Company has responsibilities for the following treatment, storage, and/or disposal units on the Hanford Facility and is signing for the purpose of these units only: 242-A Evaporator, Grout Treatment Facility, T Plant Treatment Tank, 241-Z Treatment Tank, B Plant, 222-S Laboratory Complex Treatment and Storage Tanks and Storage Area, 204-AR Waste Unloading Station, PUREX Plant, Hanford Waste Vitrification Plant, 242-A Evaporator/PUREX Plant Condensate Treatment Facility, Double-Shell Tank System, PUREX Storage Tunnels, TRUSAF, Hanford Central Waste Complex--Radioactive Mixed Waste Storage Facility and the Waste Receiving and Processing Facility, Liquid Effluent Retention Facility, Low-Level Burial Grounds, Maintenance and Storage Facility, Hanford Patrol Academy Demolition Site, 616 Nonradioactive Dangerous Waste Storage Facility, and the 600 Area Purgewater Storage and Treatment Facility.

14.0 CERTIFICATION [K]

The following certification, required by WAC 173-303-810(13), for all applications and reports submitted to Ecology is hereby included:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Edward A. Goldberg — 10-3-91

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

William R. Wiley — 24 Sept. 1991

Co-Operator* — Date
William R. Wiley, Director
Pacific Northwest Laboratory

* Pacific Northwest Laboratory has responsibilities for the following treatment, storage, and/or disposal units on the Hanford Facility and is signing for the purpose of these units only: 305-B Storage Unit, 325 Waste Treatment Unit, Thermal Treatment Test Facilities, Physical/Chemical Treatment Test Facilities, and Biological Treatment Test Facilities.

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40 CFR 122, *EPA Administered Permit Programs: The National Pollutant Discharge Elimination System*, Title 40, Code of Federal Regulations, Part 122, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 123, *State Program Requirements*, Title 40, Code of Federal Regulations, Part 123, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 124, *Procedures for Decisionmaking*, Title 40, Code of Federal Regulations, Part 124, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 125, *Criteria and Standards for the National Pollutant Discharge Elimination System*, Title 40, Code of Federal Regulations, Part 125, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 141, *National Primary Drinking Water Regulations*, Title 40, Code of Federal Regulations, Part 141, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 261, *Identification and Listing of Hazardous Waste*, Title 40, Code of Federal Regulations, Part 261, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 262, *Standards Applicable to Generators of Hazardous Waste*, Title 40, Code of Federal Regulations, Part 262, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 263, *Standards Applicable to Transporters of Hazardous Waste*, Title 40, Code of Federal Regulations, Part 263, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 264, *Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*, Title 40, Code of Federal Regulations, Part 264, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 265, *Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities*, Title 40, Code of Federal Regulations, Part 265, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 266, *Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities*, Title 40, Code of Federal Regulations, Part 266, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 267, *Interim Standards for Owners and Operators of New Hazardous Waste Land Disposal Facilities*, Title 40, Code of Federal Regulations, Part 267, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 268, *Land Disposal Restrictions*, Title 40, Code of Federal Regulations, Part 268, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 270, *EPA Administered Permit Programs: The Hazardous Waste Permit Program*, Title 40, Code of Federal Regulations, Part 270, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 302, *Designation Reportable Quantities, and Notification*, Title 40, Code of Federal Regulations, Part 302, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 355, *Emergency Planning and Notification*, Title 40, Code of Federal Regulations, Part 355, U.S. Environmental Protection Agency, Washington, D.C.

40 CFR 761, *Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions*, Title 40, Code of Federal Regulations, Part 761, U.S. Environmental Protection Agency, Washington, D.C.

49 CFR 171, *General Information, Regulations, and Definitions*, Title 49, Code of Federal Regulations, Part 171, U.S. Department of Transportation, Washington, D.C.

49 CFR 172, *Hazardous Materials Tables and Hazardous Materials Communications Regulations*, Title 49, Code of Federal Regulations, Part 172, U.S. Department of Transportation, Washington, D.C.

49 CFR 173, *Shippers-General Requirements for Shipments and Packagings*, Title 49, Code of Federal Regulations, Part 173, U.S. Department of Transportation, Washington, D.C.

49 CFR 178, *Shipping Container Specification*, Title 49, Code of Federal Regulations, Part 178, U.S. Department of Transportation, Washington, D.C.

49 CFR 171-180, *Hazardous Materials Regulations*, Title 49, Code of Federal Regulations, Part 171-180, U.S. Department of Transportation, Washington, D.C.

49 CFR 213, *Track Safety Standards*, Title 49, Code of Federal Regulations, Part 213, U.S. Department of Transportation, Washington, D.C.

15.3 FEDERAL AND STATE ACTS

American Antiquities Preservation Act of 1906, 16 USC 432.

American Indian Religious Freedom Act of 1978, 42 USC 1996.

Anti-Deficiency Act of 1982, as amended, 31 USC 665.

Archaeological and Historic Preservation Act of 1960, 16 USC 469.

Archaeological Resources Protection Act of 1979, 16 USC 470aa.

Atomic Energy Act of 1954, as amended, 42 USC 2011.

Clean Air Act of 1977, as amended, 42 USC 7401.

Clean Water Act of 1977, as amended, 33 USC 1251.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, 42 USC 9601 et seq.

Emergency Planning and Community Right-to-Know Act of 1986

Endangered Species Act of 1973, as amended, 16 USC 1531 et seq.

Federal Insecticide, Fungicide, and Rodenticide Act, 1975, as amended, 7 USC 136 et seq.

Fish and Wildlife Coordination Act of 1934, as amended, 16 USC 661.

Hanford Reach Study Act, Public Law 100-605, November 4, 1988, 102 Stat. 3043.

Hazardous and Solid Waste Amendments of 1984, Public Law 98-616, 98 Stat. 3221, 42 USC 6912(a); 6921, 6922, 6924, 6925, 6926, 6930, 6935, 6937, 6939, 6991, and 6993.

Hazardous Materials Transportation Act, 49 USC 1801 et seq.

Hazardous Materials Transportation Uniform Safety Act of 1990, Public Law 101-615.

Historic Sites, Buildings and Antiquities Act of 1935, 16 USC 461-467.

National Environmental Policy Act of 1969, 422 USC 4321 et seq.

National Historic Preservation Act of 1966, as amended, 16 USC 470 et seq.

Privacy Act of 1974, as amended, 5 USC 552a.

Resource Conservation and Recovery Act of 1976, as amended, 42 USC 6901 et seq.

Safe Drinking Water Act of 1974, as amended, 42 USC 300f et seq.

Shoreline Management Act of 1971, Revised Code of Washington, Chapter 90.58.010 et seq., Olympia, Washington.

State of Washington Hazardous Waste Management Act of 1976, as amended, Revised Code of Washington, Chapter 70.105, Olympia, Washington.

Superfund Amendment and Reauthorization Act of 1986, 42 USC 11001 et seq.

Toxic Substances Control Act of 1976, 15 USC 2601 et seq.

Washington Clean Air Act of 1967, Revised Code of Washington, Chapter 70.94, as amended, Olympia, Washington.

Wild and Scenic Rivers Act of 1968, as amended, 16 USC 1271.

15.4 WASHINGTON ADMINISTRATIVE CODE

WAC 173-201, *Water Quality Standards for Surface Waters of the State of Washington*, Washington State Department of Ecology, Olympia, Washington.

WAC 173-303, *Dangerous Waste Regulations*, Washington State Department of Ecology, Olympia, Washington.

WAC 173-340, *Model Toxics Control Act Cleanup Regulation*, as amended, Washington State Department of Ecology, Olympia, Washington.

WAC 173-400 through 495, *General Regulations for Air Pollution Sources*, Washington State Department of Ecology, Olympia, Washington.

WAC 246-247, *Radiation Protection - Air Emissions*, Washington State Department of Health, Olympia, Washington.

WAC 246-272, *On-Site Sewage Disposal*, Washington State Department of Health, Olympia, Washington.

15.5 THE U.S. DEPARTMENT OF ENERGY ORDERS

5000.3A, *Occurrence Reporting and Processing of Operations Information*

5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*

5820.2A, *Radioactive Waste Management*

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APPENDIX 1A

SOLID WASTE MANAGEMENT UNITS

APPENDIX 1A

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1A1.0 SOLID WASTE MANAGEMENT UNITS

The requirement to address solid waste management units (SWMU) at a RCRA Facility was enacted as part of the *Hazardous and Solid Waste Amendments of 1984* to RCRA [under Section 3004(u), "Continuing Releases At Permitted Facilities"]. Section 3004(u) states:

> "Standards promulgated under this section shall require, and a permit issued after the date of enactment of the Hazardous and Solid Waste Amendments of 1984 by the administrator or a State shall require, corrective action for all releases of hazardous waste or constituents from any solid waste management unit at a treatment, storage, or disposal facility seeking a permit under this subtitle, regardless of the time at which waste was placed in such unit. Permits....."

Because this requirement is part of the 1984 Amendments, the EPA regulations for implementing Section 3004(u) currently are proposed under 40 CFR 264, Subpart S (264.501 through 264.560). The latest version of these proposed rules was issued for comment in July 1990, and also included other proposed revisions to 40 CFR 264 (in addition to Subpart S), Part 265, Part 270, and Part 271.

1A2.0 IDENTIFICATION OF SOLID WASTE MANAGEMENT UNITS

Currently, over 1,400 waste management units have been identified within the Hanford Site, the majority of which are identified as solid waste management units (SWMUs) in accordance with the *Resource Conservation and Recovery Act* (RCRA) *of 1976*. As surveys and scoping studies are performed in support of the ongoing onsite cleanup program, additional SWMUs likely will be identified. The amount of information that currently exists for individual SWMUs varies significantly. It is intended that SWMUs be investigated in accordance with the past-practice process of the Tri-Party Agreement. In support of the issuance of a RCRA permit, it is anticipated that the EPA will conduct an initial RCRA facility assessment. Follow-on RCRA Facility assessments will be conducted in accordance with the Tri-Party Agreement, if necessary, to obtain additional information on currently identified SWMUs and newly identified SWMUs.

In support of the RCRA permitting of the Hanford Facility, all known SWMUs must be identified to include any releases of hazardous waste (or constituents) from these units. Because of the number and complexity of SWMUs on the Hanford Site, a realistic approach to the identification and documentation of SWMUs is needed. The proposed approach to satisfy the requirements for identifying and updating of SWMUs and releases from SWMUs uses a combination of the following:

- Hanford Waste Information Data System (WIDS)
- *Hanford Site Waste Management Units Report* (DOE-RL 1988d)
- Set of Hanford SWMU topographical maps.

Because of the number of SWMUs and the age of some of these units, it is not feasible to provide all available drawings associated with these SWMUs. The existing maps contained in the Hanford Site Waste Management Units Report will be used until maps more in line with regulatory requirements are developed.

1A2.1 WASTE INFORMATION DATA SYSTEM

The Waste Information Data System (WIDS) is an electronic database that identifies all currently identified SWMUs located within the DOE-RL operated areas. The WIDS also includes other waste management units (i.e., non-SWMUs) in support of the overall cleanup mission of the Hanford Site. These include one-time spills, sanitary waste sites, and structures awaiting decontamination and decommissioning. The SWMUs are clearly designated from the non-SWMUs within the WIDS. The majority of the descriptive information requested in 40 CFR 270.14, if available, is included in the WIDS. This includes the type and location of the unit, when the unit was operated, general dimensions and description, and general descriptions of waste placed in the unit to include estimated quantities of radionuclides and chemicals contained in some units. As additional information on the SWMUs is made available, this information is entered into the WIDS. The WIDS will be used as the official listing of SWMUs for the DOE-RL operated areas. The EPA and Ecology have been provided with electronic access to the database.

As additional SWMUs are identified as a result of investigations and scoping studies conducted within the DOE-RL operated areas, the SWMUs will be entered into the WIDS, along with required information concerning the unit. A special electronic file will be maintained within the WIDS system that identifies all SWMUs that have been entered into the system within the last 30 days. This file automatically will be shown when WIDS is accessed by users, including EPA and Ecology, to ensure that all users are aware of new entries. This will satisfy the requirement for notification of newly identified SWMUs. A second electronic file will be maintained to shown all previously entered SWMUs whose descriptive data have been modified within the last 30 days. This file will be accessible upon request. Modifications will include any new information concerning releases of hazardous materials from the SWMUs.

1A2.2 HANFORD SITE WASTE MANAGEMENT UNITS REPORT

The Hanford Site Waste Management Units Report (HSWMUR) currently exists and is updated annually in accordance with the Tri-Party Agreement. The HSWMUR provides summary information on each waste unit contained within the

WIDS. The annual update will reflect all units added to the database during the preceding year, along with all updated information on all waste units.

1A2.3 SET OF HANFORD SOLID WASTE MANAGEMENT UNITS TOPOGRAPHICAL MAPS

The HSWMUR discussed previously includes a set of maps showing the location of all the SWMUs. These maps currently are not topographical in nature. Efforts are currently underway to develop a basemap for the Hanford Site. Because of the size of the site and the number of SWMUs, it will take time to survey and develop a complete set of topographical maps which meet the requirements of the regulations. As developed, these maps will replace the maps contained within the HSWMUR and will be updated annually along with the report. The existing maps are proposed to be used in lieu of the topographical maps until the topographical maps are developed.

1A2.4 SCHEDULES OF COMPLIANCE

Schedules of compliance for the DOE-RL operated areas will be developed and maintained within the Tri-Party Agreement. All identified SWMUs have been assigned to operable units within the Tri-Party Agreement along with other waste management units. Newly identified SWMUs, when identified, will be assigned to the appropriate operable unit via the Tri-Party Agreement change process. Either CERCLA response action authority or RCRA corrective action authority is assigned as the prime authority over the investigation and cleanup process for each operable unit. The schedules of compliance for those assigned RCRA corrective action authority are considered as part of the permit via reference to the Tri-Party Agreement. The Tri-Party Agreement change control process will be used to modify the schedules of compliance as necessary, meeting the intent of 40 CFR 270.34 (proposed). Remedy selections, either as a corrective measure or as an interim measure, will be incorporated into the RCRA permit as major permit modifications.

The schedules of compliance will include any follow-on RCRA Facility Assessments which may be conducted, RCRA Facility Investigations, Corrective Measure Studies, and Corrective Measure Implementations. They will also include any Interim Measures which are identified to be conducted.

APPENDIX 1B

GLOSSARY OF TECHNICAL TERMS

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APPENDIX 1B

GLOSSARY OF TECHNICAL TERMS

Accuracy--Relates to the quality of the result, and is distinguished from precision that relates to the quality of the operation by which the result is obtained.

Advection--Transport of water or an aqueous property solely by mass motion.

Analyte--That for which an analysis is being conducted.

ANOVA (Analysis of Variance)--Name given to variety of statistics procedures. All of these procedures compare the means of different groups of observations to determine whether there are any significant differences among the groups.

Anticlinal--Pertaining to an anticline.

Anticline--A fold, generally convex upward, whose core contains the stratigraphically older rocks.

Aquifer--A body of rock that is sufficiently permeable to conduct groundwater and yield economically significant quantities of water to wells and springs.

Aquitard--A confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.

Assessment Level Monitoring--A program of monitoring groundwater under interim requirements. After a release of contaminants to groundwater has been determined, the rate of migration, extent of contamination, and hazardous constituent concentration gradients of the contamination must be identified.

Background--The natural background of the Hanford Site. Includes all contributions from anthrogenic sources unrelated to the Hanford Site operations (e.g., regional agriculture chemicals, nuclear weapons testing fallout, etc.).

Bar--A mass of sand, gravel or alluvium deposited on the bed of a stream, sea, or lake or at the mouth of a stream forming an obstruction to water navigation.

Basalt--A general term for dark colored mafic igneous rocks, commonly extrusive but locally intrusive.

Bottom Zones--Refers to the base of basalt flows where aquifers can be found.

Carbonate--A compound containing the radical carbonate.

Cataclysmic--Any geologic event that produces sudden and extensive changes in the Earth's surface.

Channelways--Ancient or recent streams or river beds including flood zones.

Cobble--A rock fragment that ranges from 64 to 256 millimeters in diameter.

Compliance--Not exceeding regulations.

Confined Aquifer--Groundwater bounded above and below by impermeable layers.

Conglomerate--Rounded water worn fragments of rock or pebbles, cemented together by another mineral substance.

Conservative Tracer--A tracer that does not chemically interact or degrade the aquifer system (i.e., the total quantity of the material in the solution remains constant).

Contaminant Mobility--The capability of any physical, chemical or biological substance having an adverse effect on air, water or soil and that can be transported readily by wind or water.

Control Chart--Area graphical presentations of analytical data to determine if results are within desired limits.

Cross Section--A profile or portraying of an interpretation of a vertical section of the earth explored by geophysical and or geological methods.

Detection--The lowest concentration by which an analyte can be detected on a field or laboratory instrument. Often recorded in the parts per million or parts per billion.

Detrital--Pertaining to or formed by detritus material.

Detritus--A collective term used for loose rock and mineral material that is worn away by mechanical means, as by disintegration or abrasion (e.g., sand, silt and clay).

Diffusion--The actual transport of mass, in the form of discrete atoms, through the lattice of a crystalline solid.

Discharge--The rate of flow at any given moment, expressed in volume per unit time (e.g., cubic meters/second).

Dispersivity--Ability of a contaminant to disperse within the groundwater by molecular diffusion and chemical mixing.

Distribution Coefficient--The ratio of the concentration of a solute sorbed by ion exchange substances such as Earth materials, particularly clays, to the concentration of the solute remaining in solution. A large distribution coefficient implies that the substance is readily sorbed and is redissolved slowly. The concentration of material in the solid phase (i.e., rock or sediment) (moles per gram) divided by the concentration of material in the aqueous phase (moles per liter).

Domenico-Robbins--A two dimensional analytical transport model developed by Domenico and Robbins (1985).

Drinking Water Standard--Contaminant concentration specified in the *Safe Drinking Water Act.*

Drive-Barrel--Heavy walled pipe used in impact drilling. Soil and rock are driven into a pipe connected to a cable as it is dropped rapidly on to the ground. The soil or rock are then extracted by striking the pipe.

Driving Force--The hydraulic head that causes water to flow in one direction on another.

Effective Porosity--The ratio of the volume of the void spaces of a soil mass that can be drained by gravity to the to the total volume of the mass of the soil.

Eolian--Applied to deposits transported by the wind such as sands and other loose material.

Epiclastic--A term applied to mechanically deposited sediments (e.g., mud, gravel, sand) consisting of weathered products of older rocks. A rock formed at the earth's surface by consolidation of fragments of pre-existing rocks.

Epoch--A division of geologic time which identifies an abrupt change in the environment.

Erosional Windows--Can be considered a window to the past where portions of the land surface has been eroded away exposing landforms that represent the past.

Evapotranspiration--The sum total of that portion of precipitation that is returned to the atmosphere through evaporation and the transpiration of plants.

Facies--Part of a rock body as differentiated from other parts by appearance or composition and that reflects the environment in which it was formed.

Fanglomerate--A fanglomerate is composed of heterogenous material that was originally deposited in an alluvial fan or delta as loose unconsolidated detrital material and has since become cemented into rock.

Fixed Limits--A constant compliance limit or a fixed standard such as maximum concentration limit or assessment level monitoring.

Flow Tops--Pertaining to the highest portion of individual basalt flows.

Fluvial-Lacustrine--Said of those deposits formed by the streams flowing from lakes.

Formation(s)--Something naturally formed, commonly differing from adjacent rocks or soils. Most formations possess certain distinctive or repetitive combinations of distinctive rock types.

Geophysical--Pertaining to that science that deals with the exploration or prospecting of the earth using instruments and applying the methods of physics and engineering by observation of magnetic, seismic, electrical, and thermal distribution.

Glaciofluvial--Pertaining to streams flowing from glaciers or to the deposits made from these streams. In the Hanford Site area, this pertains to the deposited sands and gravels that were deposited because of the Missoula flood.

Granule--A rock fragment larger than a very coarse sand grain and smaller than a pebble. The fragment ranges in size from 2 to 4 millimeters.

Gravels--An accumulation of water worn pebbles. Consists of rock grains or fragments that range in size from 4.76 to 76 millimeters.

Groundwater Mounds--A mound shaped elevation in a water table that builds up as a result of the downward percolation of water through the zone of aeration.

Hard-tool--Drill bit used in cable tool drilling to crush rock. The slurry created by the bit is retrieved and examined.

Henry's Law--The weight of a gas dissolved by a liquid is proportional to the pressure of the gas.

High Energy--Refers to the environment of sediment deposition where the stream or river flow or wave action is of sufficient quantity to carry significant amounts of suspended soil and rock particles.

High-activity Waste--High- and low-activity is reflective of the relative concentration of radionuclides in mixed waste.

High-level Waste--Highly radioactive waste material that results from the reprocessing of spent nuclear fuel, including liquid waste produced directly in reprocessing and any solid waste derived from the liquid that contains a combination of transuranic waste and fission products in concentrations requiring permanent isolation.

Holocene--Recent. That period in time (epoch) since the last ice age in North America; also those sediment deposited during that epoch.

Hydraulic Head--The height of the free surface of a body of water above a given subsurface point.

Hydraulic Conductivity--The ratio of the groundwater flow velocity to the driving force for fluid flow through porous medium under saturated conditions.

Hydraulic Gradient--As applied to an aquifer, the rate of change of the hydraulic head per unit of distance at a given point and direction.

Hydrogeology--A term used interchangeably with geohydrology referring to the hydrologic or flow characteristics of groundwater.

Hydrologic Properties--Properties of a rock related to the capacity to transmit, hold, and deliver water.

Indicator--A geologic or other feature that suggests the presence of a geochemical anomaly inherent to the local geologic setting.

Indurated--The consolidation of a rock or soil hardened by heat, pressure or cementation.

Infiltration--The flow of fluid (water) into a solid substance through pores or small openings.

Intercalated--Said of a relatively thin layer of soil or rock material that alternates with thicker layers of some other kind of soil or rock.

Intermittent--Periodic. Stopping and starting again in intervals.

Interval--The vertical difference between soil or rock bodies of differing origin or composition.

Loess--A homogeneous, nonstratified (nonlayered) unindurated soil consisting predominantly of silt of eolian (windblown) deposition. Often referred to as 'Palouse Soil' located in the far central southeastern portion of Washington state.

Low-activity Waste--See high-activity waste.

Low-level Waste--Waste that contains radioactivity and is not classified as high-level waste, transuranic waste, or spent nuclear fuel or 11e(2) by-product material as defined in U.S. Department of Energy Order 5820.2A. Test specimens of fissionable material irradiated for research and development only, and not for the production of power or plutonium, may be classified as low-level waste, provided the concentration of transuranic is less than 100 nanocuries per gram.

Maximum Concentration Limit--Contaminant concentration specified in the *Safe Drinking Water Act*.

Miocene--The fourth of the five epochs of which the Tertiary period is divided. The Miocene lasted from between 24 million years ago to 1.8 million years ago. Also those sediments that were deposited during that epoch.

Mixed Waste--Waste that contains both hazardous and dangerous waste subject to RCRA, as amended, and the Ecology *Dangerous Waste Regulations*, and radioactive waste subject to the *Atomic Energy Act*.

Model--A working hypothesis or precise simulation, by means of description, statistical data, or analogy of a phenomenon or process that cannot be observed directly or that is difficult to observe directly.

Monocline--A steplike bend (flexure) in otherwise flatlying layers or beds of rock.

Paleosols--A buried soil of the ancient past.

Palouse Soil--Refer to loess.

Parameter--In statistics, a numerical quantity (such as the mean) which characterizes the distribution of a random variable or a population.

Permeability--The property or capacity of a porous rock, sediment or soil for transmitting a fluid (e.g., groundwater).

Permeameter--An instrument for measuring permeability.

Perennial--Streams that flow throughout the year from source to mouth.

pH--The negative logarithm of the hydrogen-ion activity in a solution, a measure of the acidity or basicity of a solution.

Physiography--The study of the genesis and evolution of land forms.

Pleistocene--The earliest of the two epochs comprising the Quaternary period. The Pleistocene lasted from between 1.8 million years ago to 10,000 years ago. Also, those sediments that were deposited during that epoch.

Porosity--The percentage of the bulk volume of a rock or soil that is occupied by interstices or voids.

Potentiometric--Surface to which water in an aquifer would rise by hydrostatic pressure or head.

Practical Quantification Limits--The lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions.

Pre-Missoula--As pertaining to before the time of the flooding caused by the breaching of ice dams that contained Lake Missoula in northwest Montana.

Precision--The degree of agreement or uniformity of repeated measurements of a quantity; the degree of refinement. Refer to accuracy.

Prediction Interval--In a regression analysis, a value or set of values for which one can assert with given probability that they will contain a future observation.

Purgewater--Water being excavated from wells or from wells that are undergoing aquifer testing.

Quartzose--Containing quartz as the a principal constituent.

Recharging--The quantity of water that is added to the zone of saturation or the aquifer. Intake.

Recovery Phase--The time an aquifer requires to reach equilibrium after pumping such as in a slug test.

Sand--Detrital material varying in diameter from very fine grained (1/16 to 1/8 millimeters) to very coarse grained (2 millimeters).

Sandy--A rock or soil in which one of the constituents is sand. Refer to sand.

Sediment--Solid fragmental material that originates from the weathering of rocks and is transported or deposited by air, water or ice, or that accumulates by other natural agents, such as chemical precipitation from solution (water) and that forms in layers on the Earth's surface at ordinary temperatures in loose, unconsolidated form (e.g., sand, silt, gravels, mud).

Seismic--Pertaining to an earthquake or earth vibration.

Silt--A soil particle that ranges in size from 1\256 to 1\16 millimeters in diameter.

Silty--A rock or soil in which one of the constituents is silt. Refer to silt.

Slope Wash--Soil and rock material that is being or has been moved down slope predominantly by the action of gravity assisted by running water that is not concentrated into channels.

Slope--The inclined surface of hill, mountain, plateau, plain or any other part of the earths surface.

Slug testing--A single well test to determine the insitu hydraulic conductivity of an aquifer by the instantaneous addition or removal of a known quantity (slug) of water into or from a well, and the subsequent measurement of the resulting well recovery time.

Specific Conductance--A measure of the electrical conductivity of a liquid.

Stratigraphic-- Said of a stratum by which an arbitrary but systematic arrangement, zonation, or partitioning of a sequence of rock layers, of the earth's crust, into units with reference to any or all of the attributes, properties, or characteristics that strata possess.

Structural--Pertaining to, part of, or consequent upon geologic structures.

Structures (tectonic)--Of, pertaining to, or designating rock structure and deformations as a result of forces caused by land movement and earthquakes.

Suprabasalt--Those sediments that are found above basalt flows.

Syncline--A fold in the earth's crust in which the stratigraphically youngest can be found. A syncline is an upward concaving fold.

Temperature--Degree of hotness or coldness of a body or environment.

Tolerance--A permissible deviation from a specified value, expressed in actual values or more often as a percentage of the nominal value.

Topography--The general configuration of a land surface or any part of the earth's surface, including its relief and its natural and man made features.

Transmissive Zone--Pertaining to transmissivity. The zone where intercommunication is possible between differing aquifers.

Transmissivity--The rate (flow) at which water is transmitted through a unit width of aquifer.

Transuranic Waste--Without regard to source or form, waste that is contaminated with alpha-emitting transuranium radionuclides with half-lives greater than 20 years and concentrations greater than 100 nanocuries per gram at the time of assay. At the Hanford Site, transuranic waste also includes uranium-233 and radium sources.

Travel Time--The period of time necessary for a dangerous waste constituent released to the soil to enter any onsite or offsite aquifer or water supply system.

Tuff--A general term for all consolidated volcanic fragments.

Turbidity--The state, condition, or quality of opaqueness or reduced clarity of a fluid, due to presence of suspended matter.

Vadose--Zone of aeration. A subsurface zone containing water under pressure less than that of atmosphere, including water held by capillarity. This zone is limited above by land surface and below by the surface of saturation (i.e., water table).

Vapor Pressure--The pressure at which a liquid and its vapor are at equilibrium at a given temperature.

Velocity--The time rate of motion in a given direction (meter/second).

Veneer--A thin but extensive layer of sediments covering an older geologic layer or stratum.

Volcanic--Of, pertaining to, like, or characterized by or composed of material originating for volcanoes or fissures.

Volcaniclastic--Pertaining to clastic or fragmental rock material containing volcanic material in whatever proportion, and without regard to its origin or environment.

Water Table--The upper surface of a saturation zone except where that surface is formed by impermeable layer.

Yakima Fold Belt--The Yakima Fold Belt is characterized by long, narrow anticlines and broad synclines extending generally eastward from the Cascade Range to the approximate center of the Columbia Plateau.

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APPENDIX 2A

LOCATION MAPS

9 2 1 2 4 5 7 5

APPENDIX 2A

CONTENTS

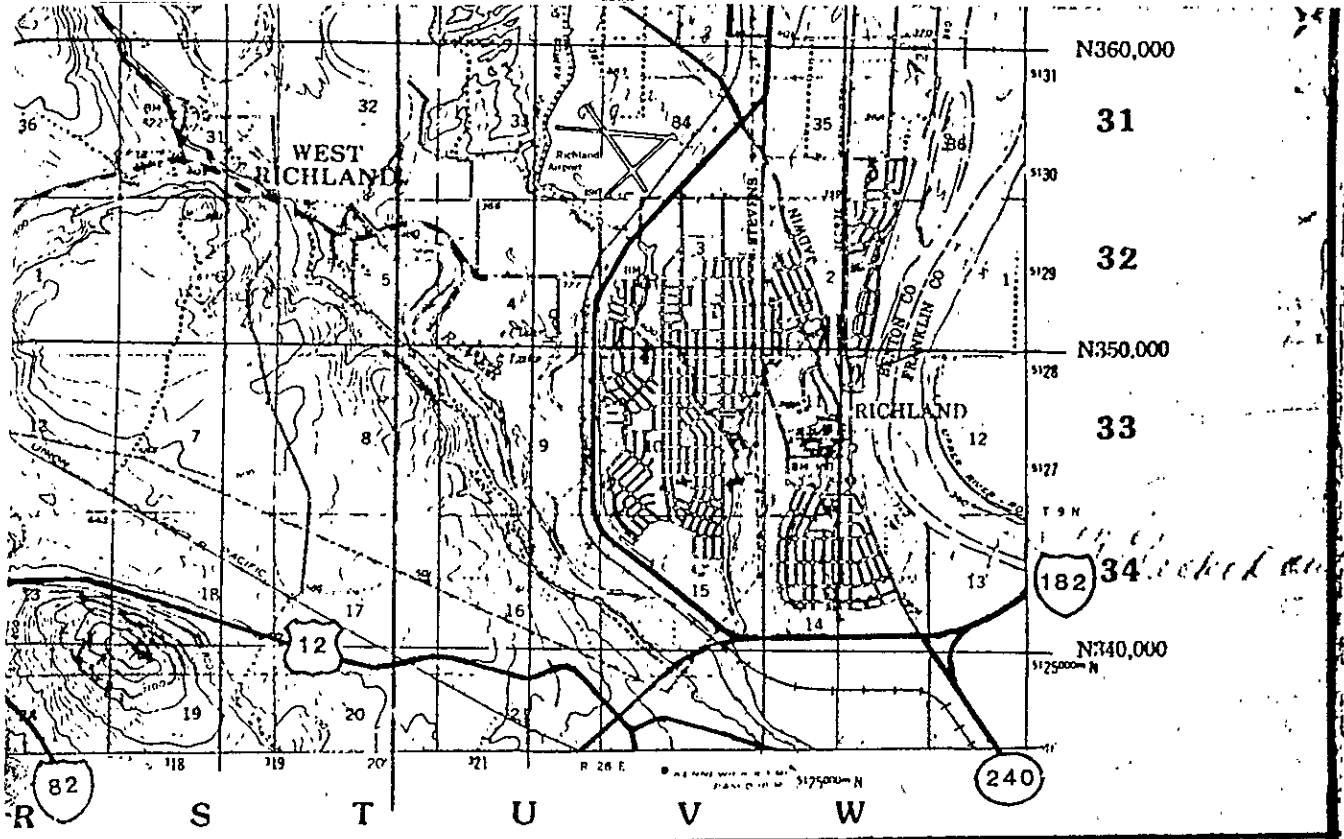
H-6-958 Hanford Site Map*

Treatment, Storage, and/or Disposal Location Maps

* The Hanford Site Map (H-6-958) is being updated. The update will include two additional portions as part of the Hanford Site. These portions are:

(1) The 1100 Area, as outlined--map grid coordinates V,29

(2) The small portion, as outlined--map grid coordinates W,29, located west of the marked 3000 Area.



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APPD	
APPD	
RESPONSIBLE ENGINEER R.L. MARTELL	6/89
DRAFTING APPD	
CHECKED	
DRAWN K.D. JUNT	3/89

U. S. Department of Energy
Richland Operations Office

Westinghouse Hanford Company

OVERALL HANFORD FACILITIES

SCALE	INDEX NO
AS SHOWN	600 GEN	0100

CLASSIFICATION	BY	DRAWING NO	SHEET NO	SHEETS
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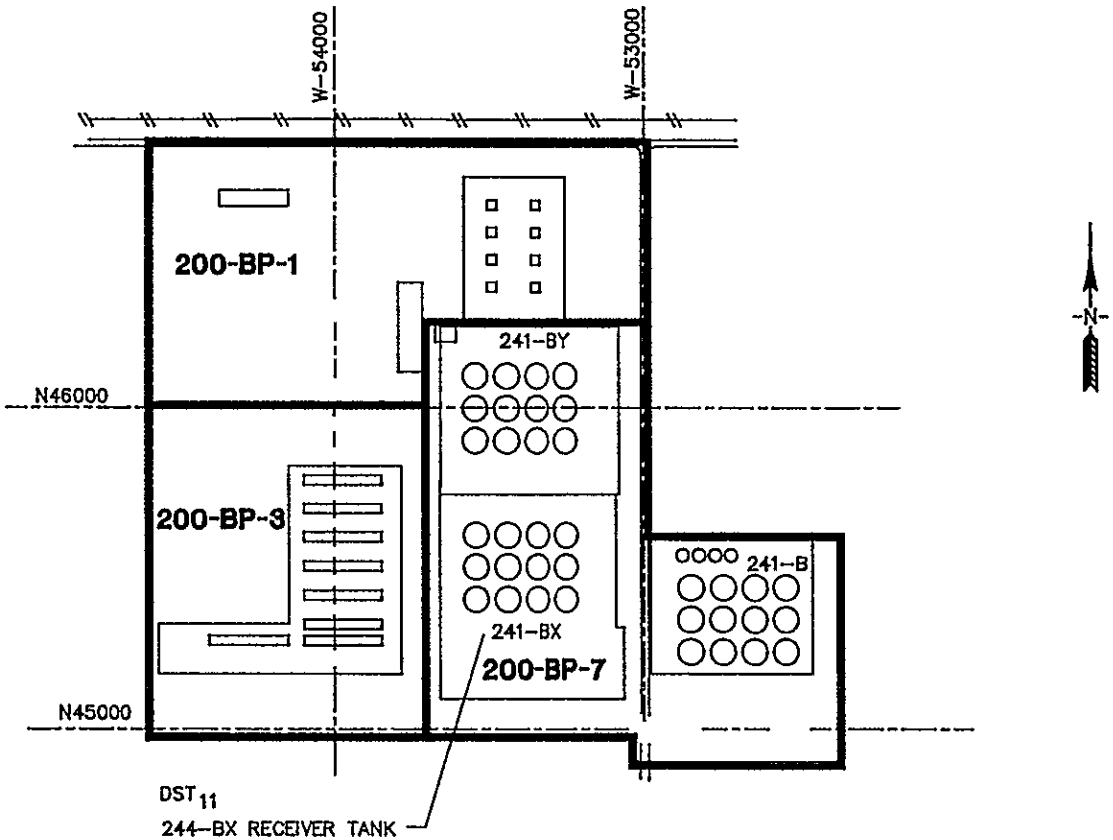

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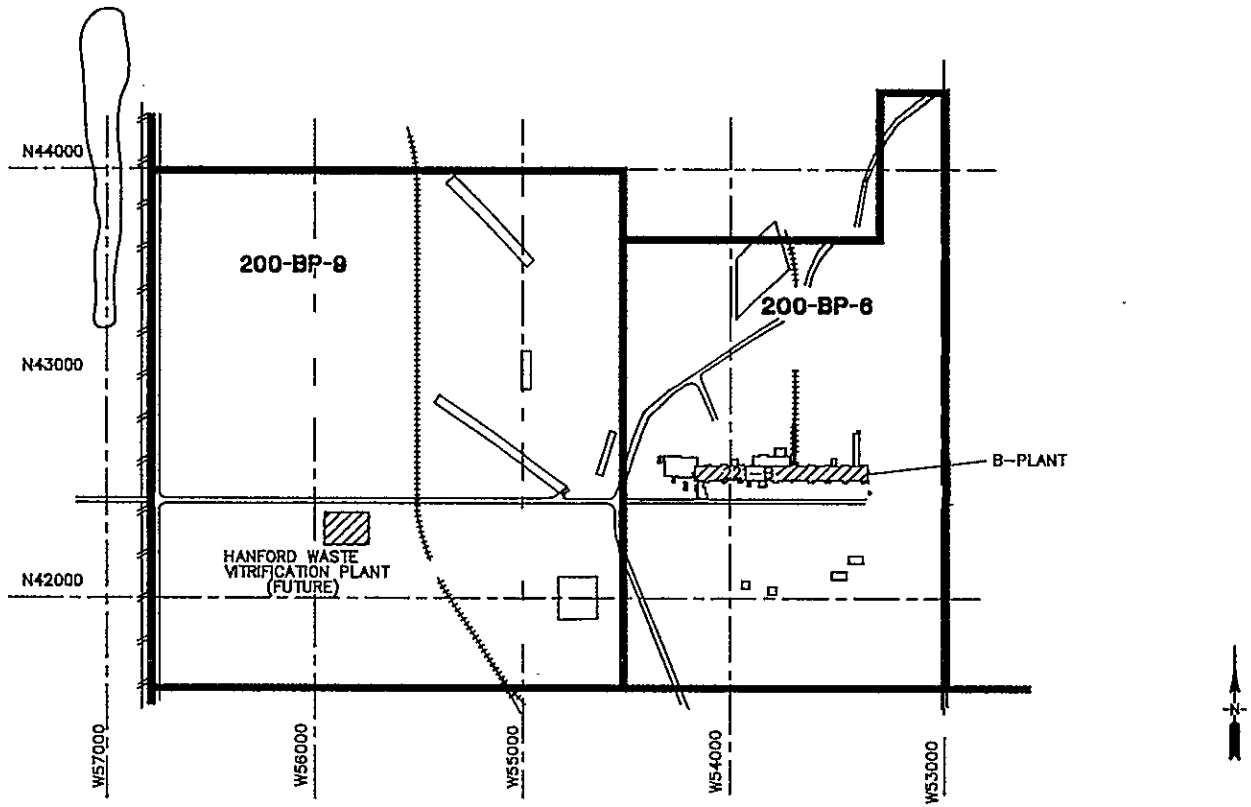
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Units
200-BP-1, 200-BP-3 and 200-BP-7

OU\071991-E



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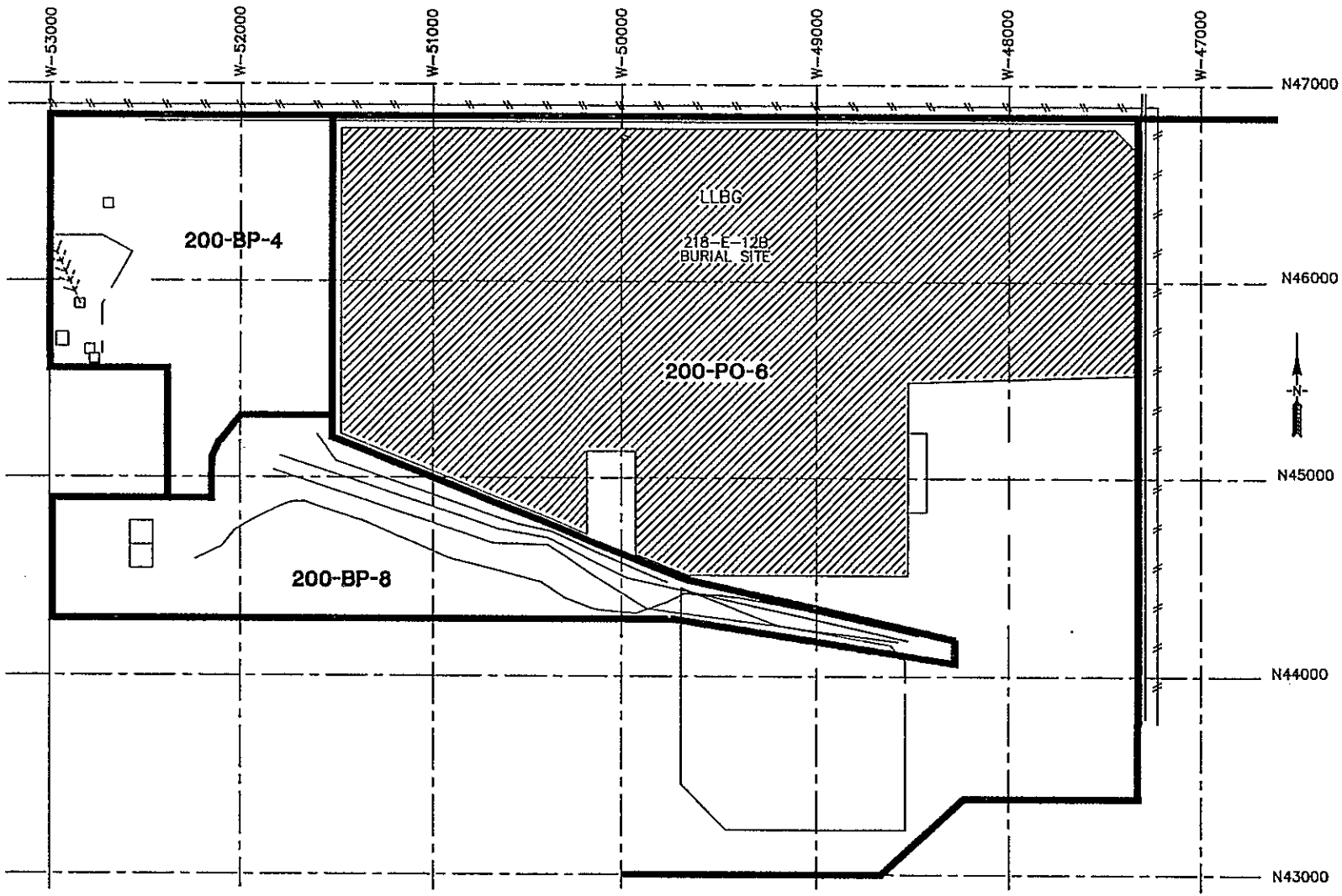
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Units 200-BP-6 and 200-BP-9

OU\071991-J



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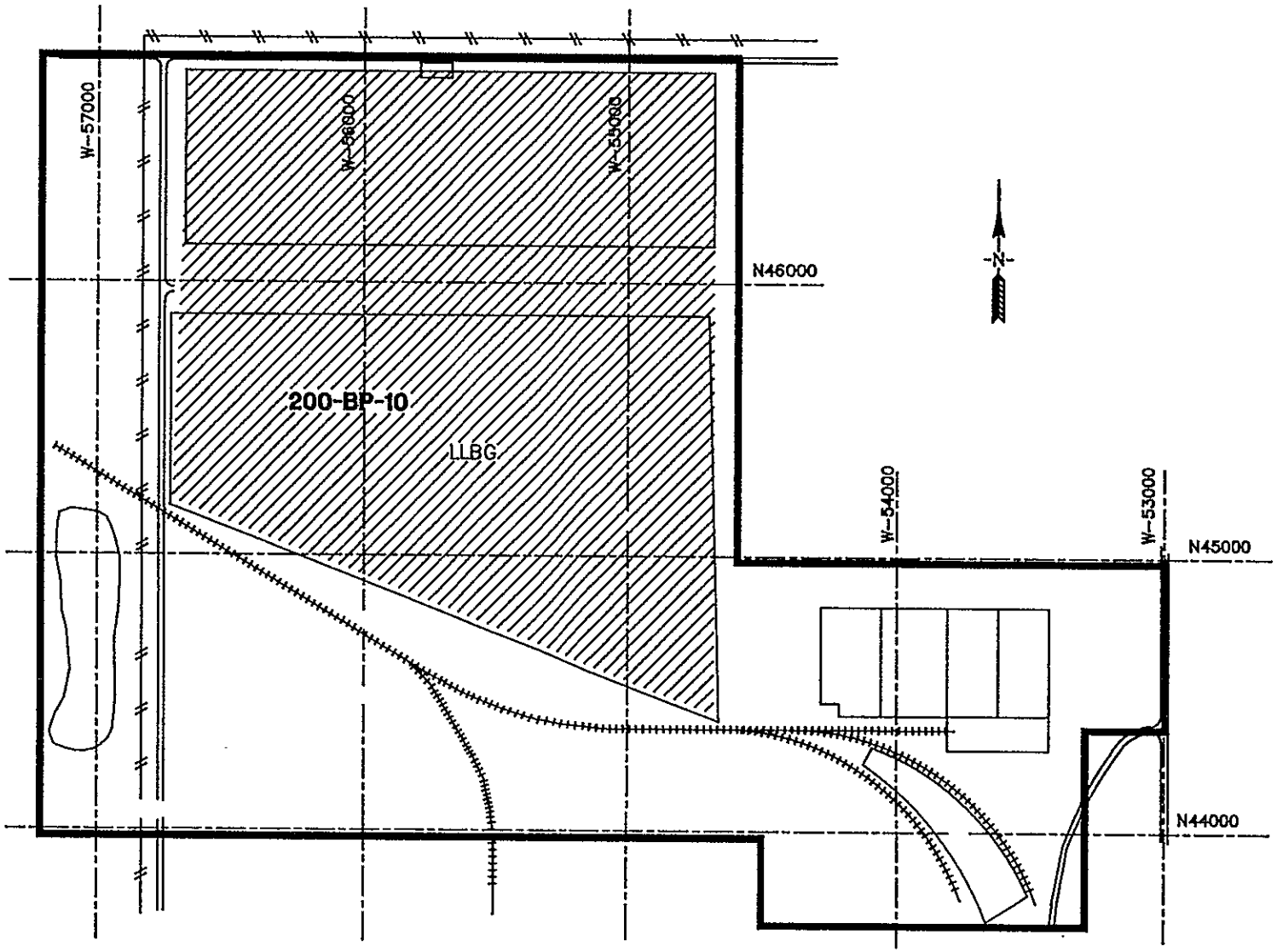
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Units
200-BP-4, 200-BP-8 and 200-PO-6 (Partial)

OU\071991-G



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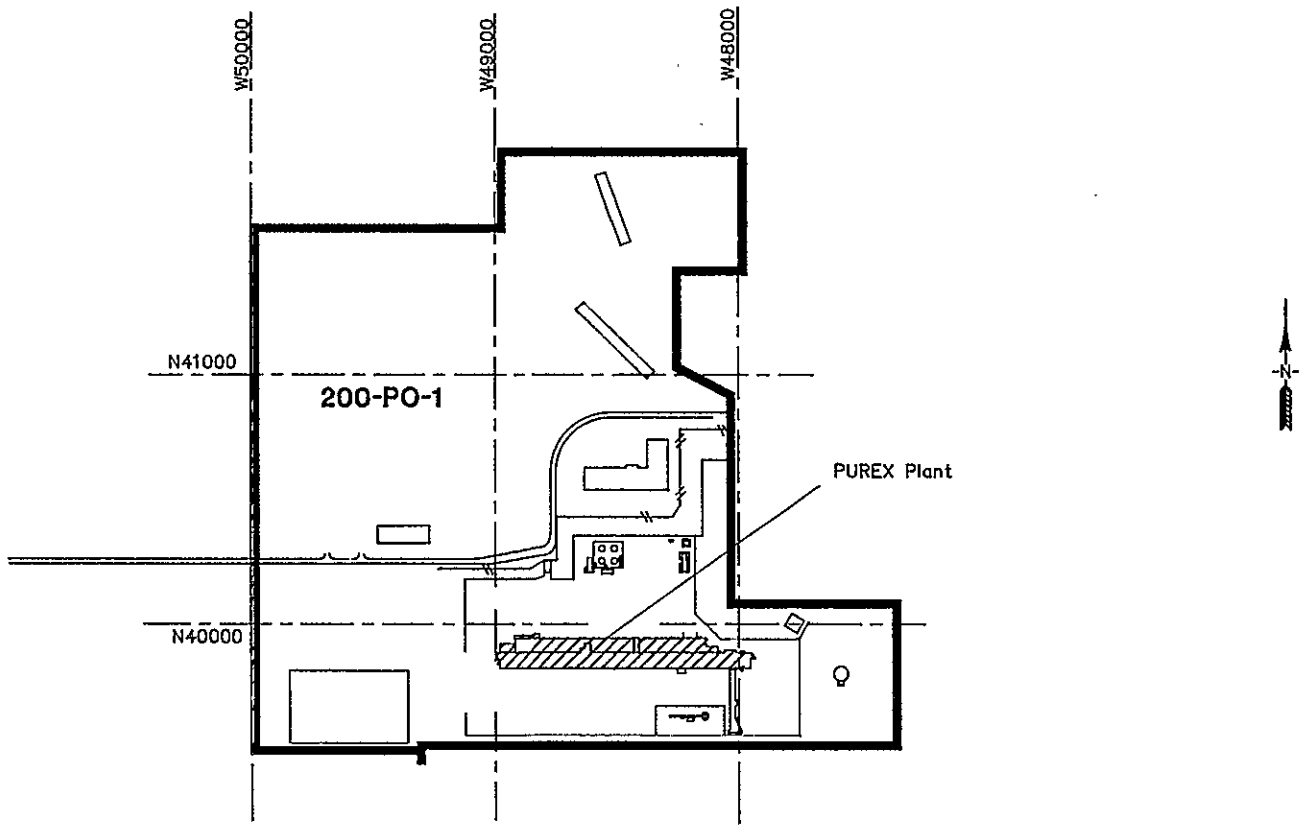
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Unit 200-BP-10

OU\071991-K



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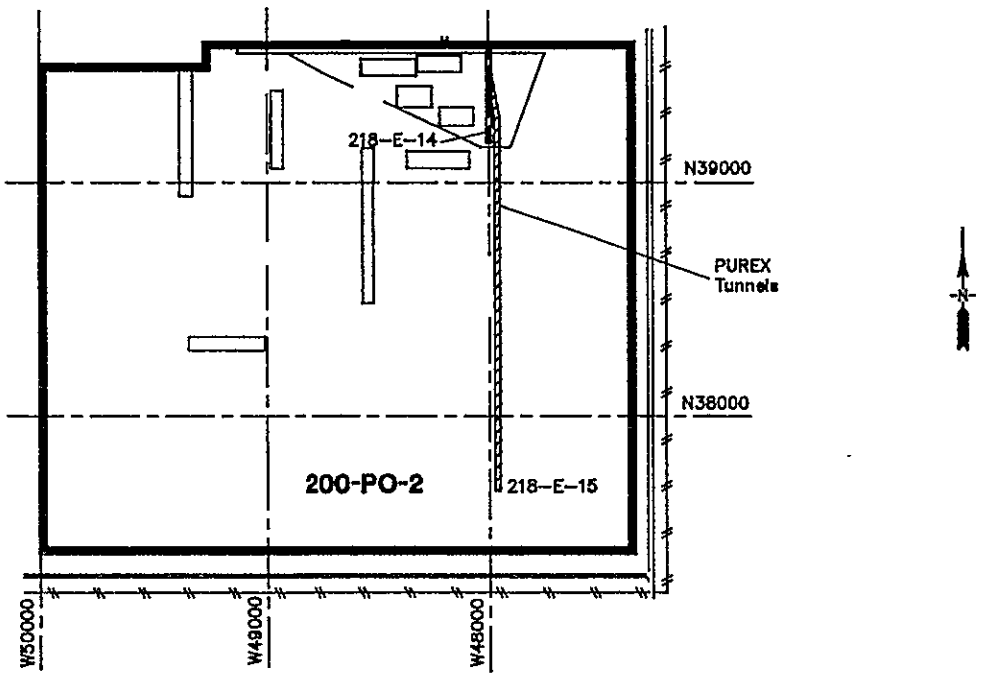
JJA			1/91	3.0	INFORMATION UPDATE

Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Unit 200-PO-1

OU\071991-M



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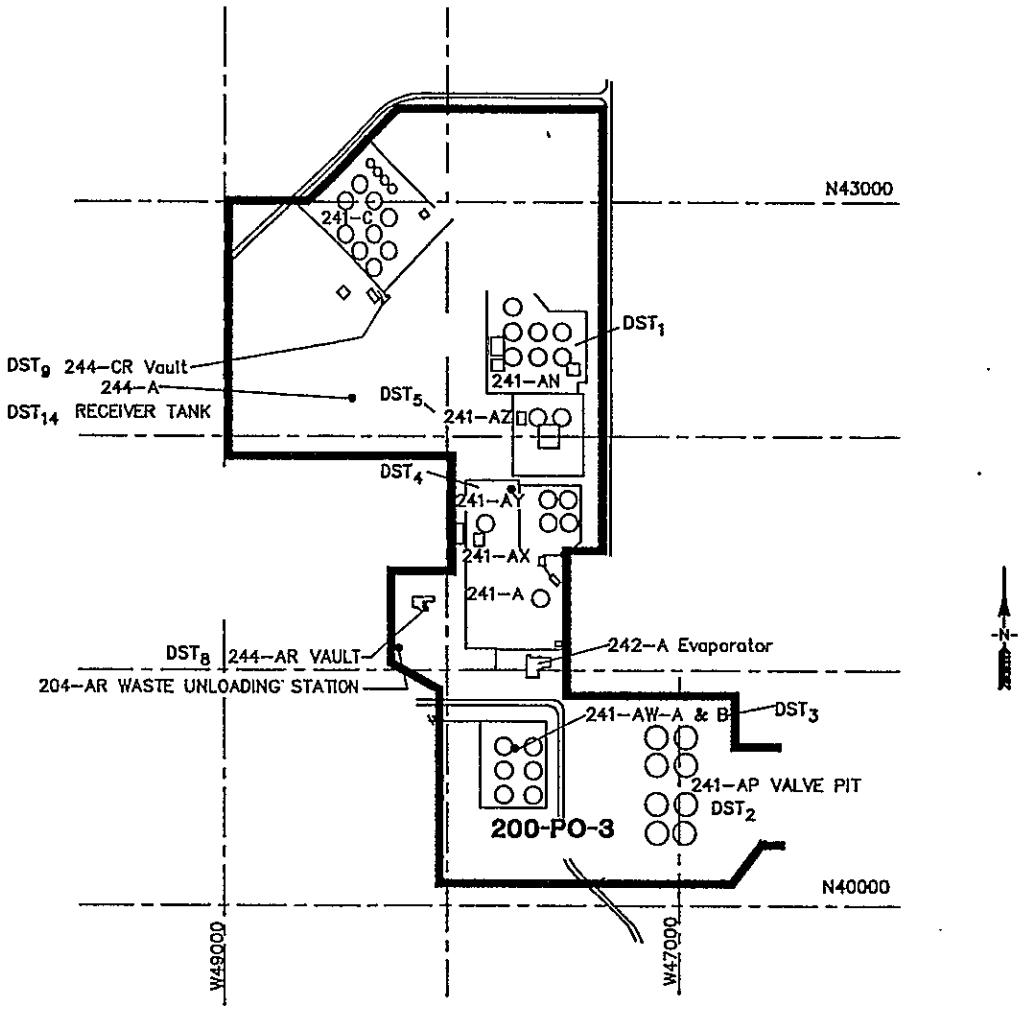
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Unit 200-PO-2

OU\071991-N



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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Unit 200-PO-3 (Partial)

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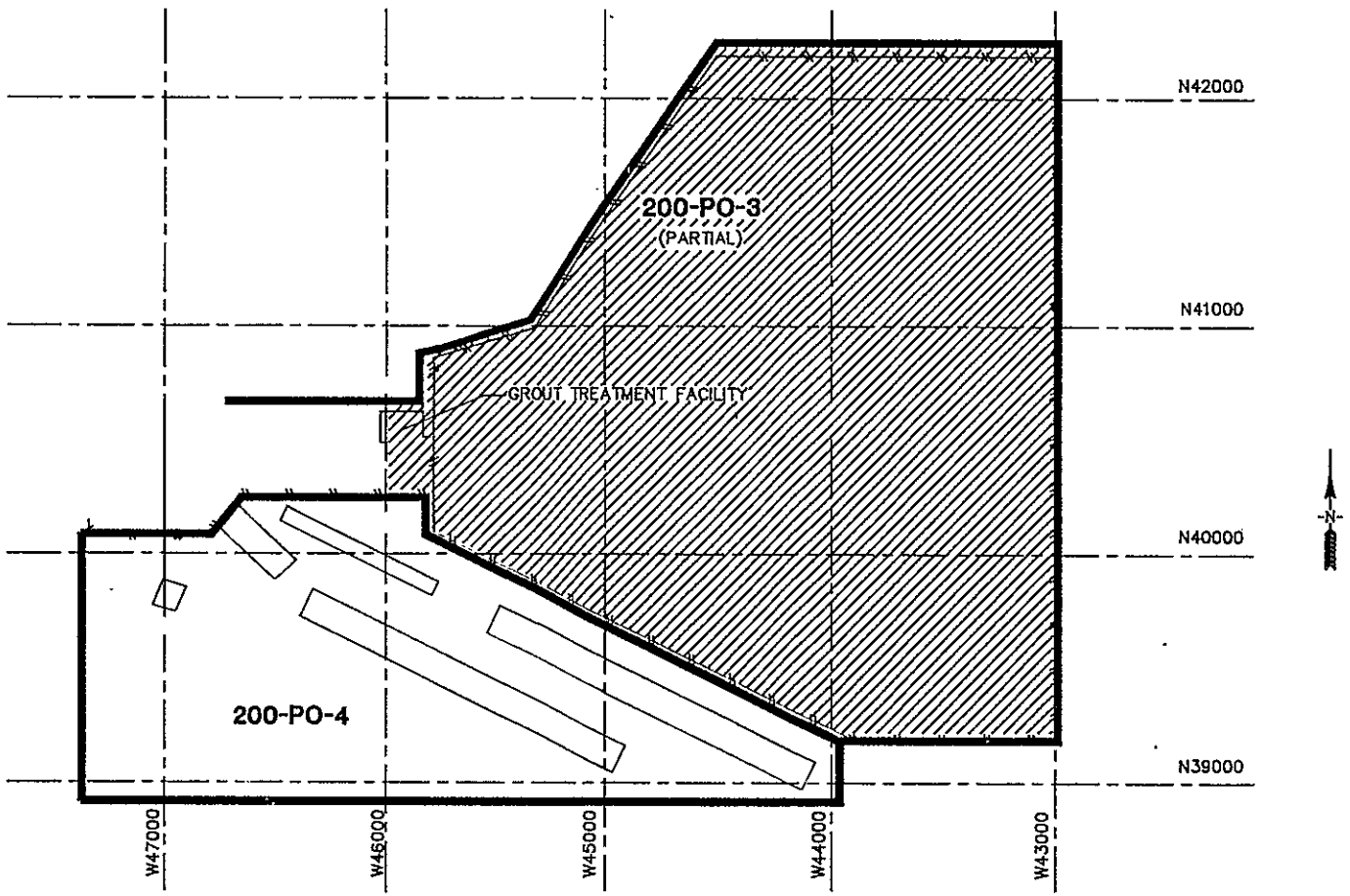

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Units 200-PO-4 and 200-PO-3 (Partial)

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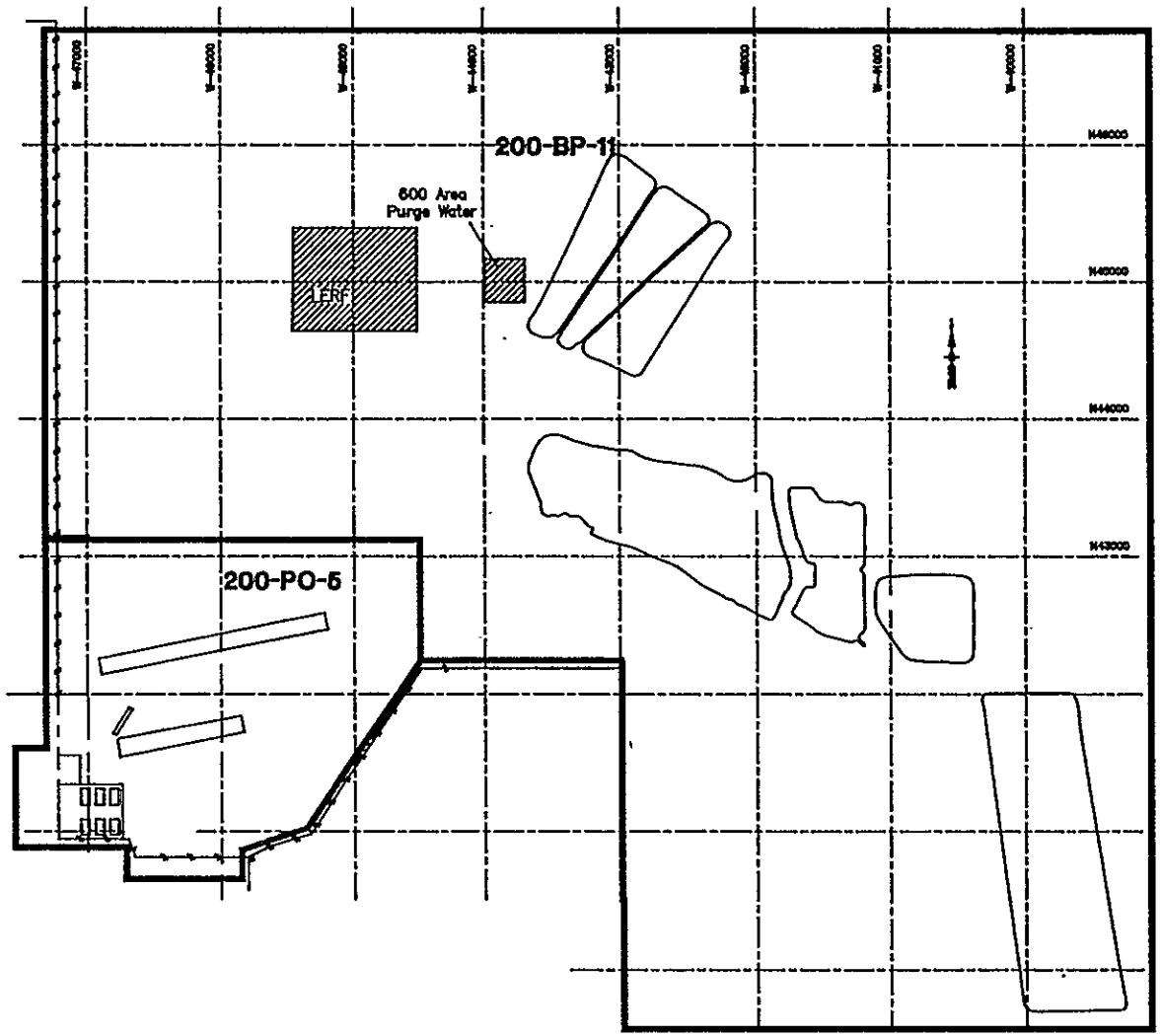

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 East Area
Operable Units 200-PO-5 and 200-BP-11
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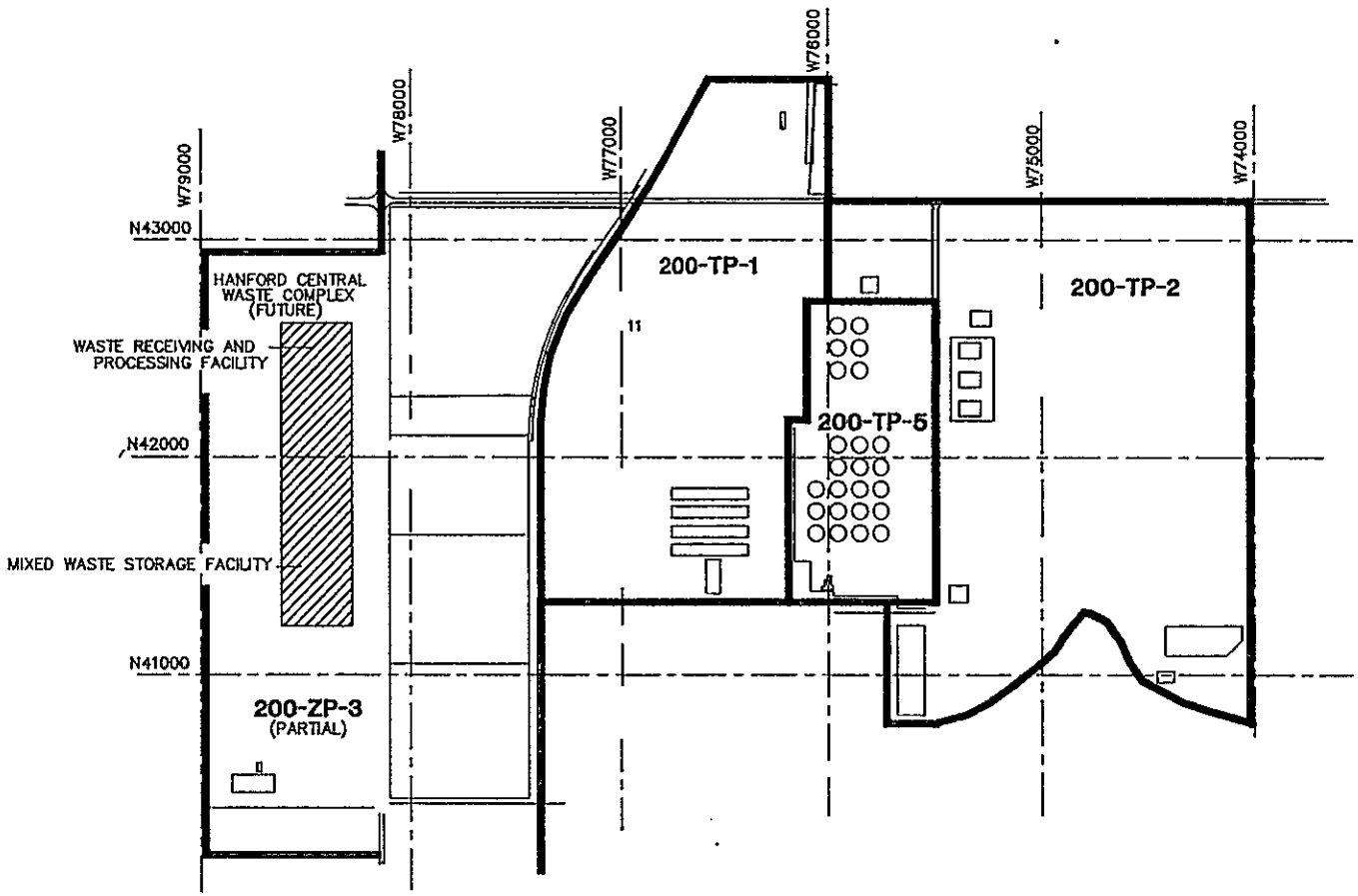

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 West Area
Operable Units
200-TP-1, 200-TP-2, 200-TP-5
and 200-ZP-3 (Partial)

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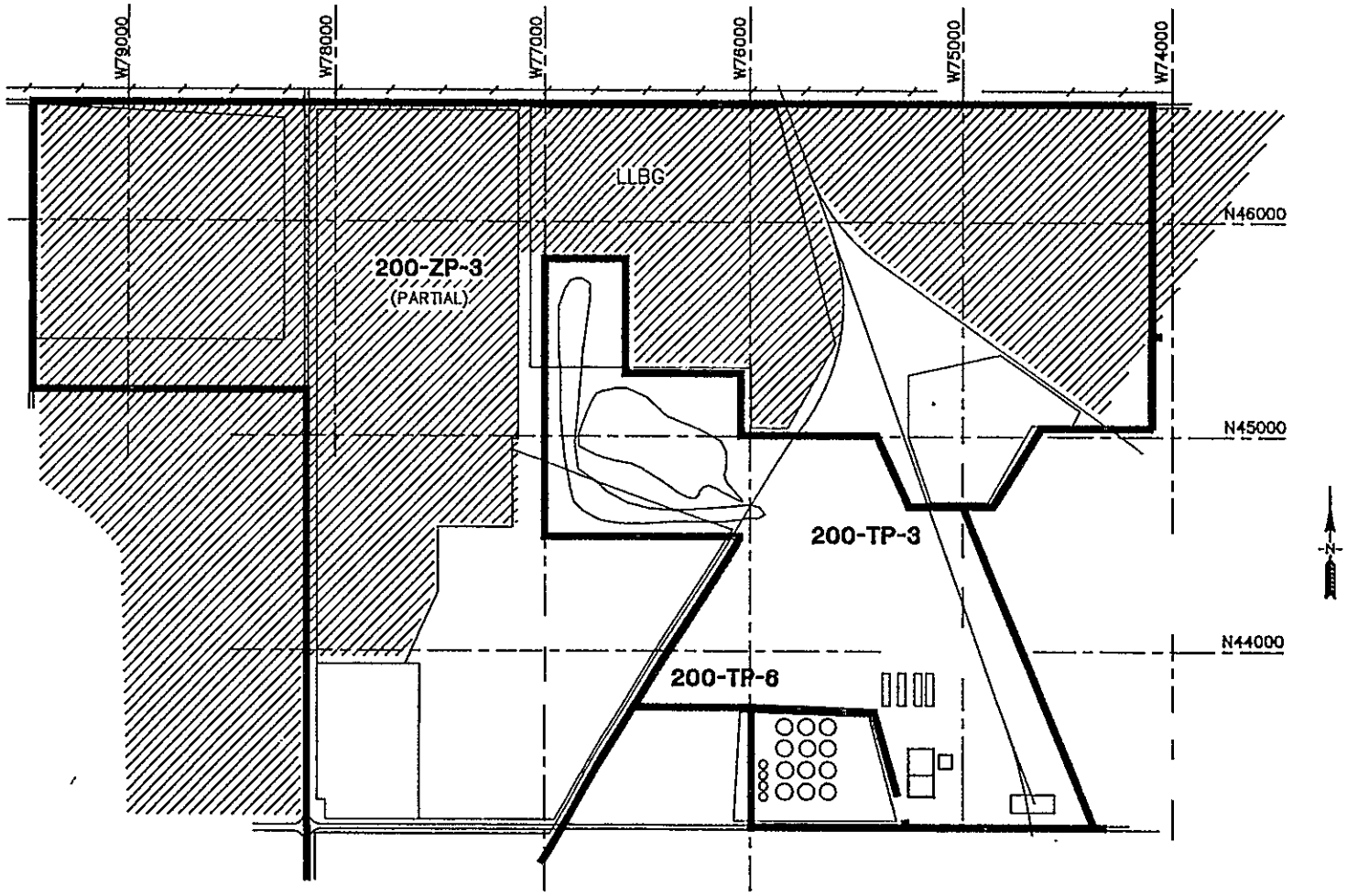

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200-West Area
Operable Units
200-TP-3, 200-TP-6 and 200-ZP-3 (Partial)

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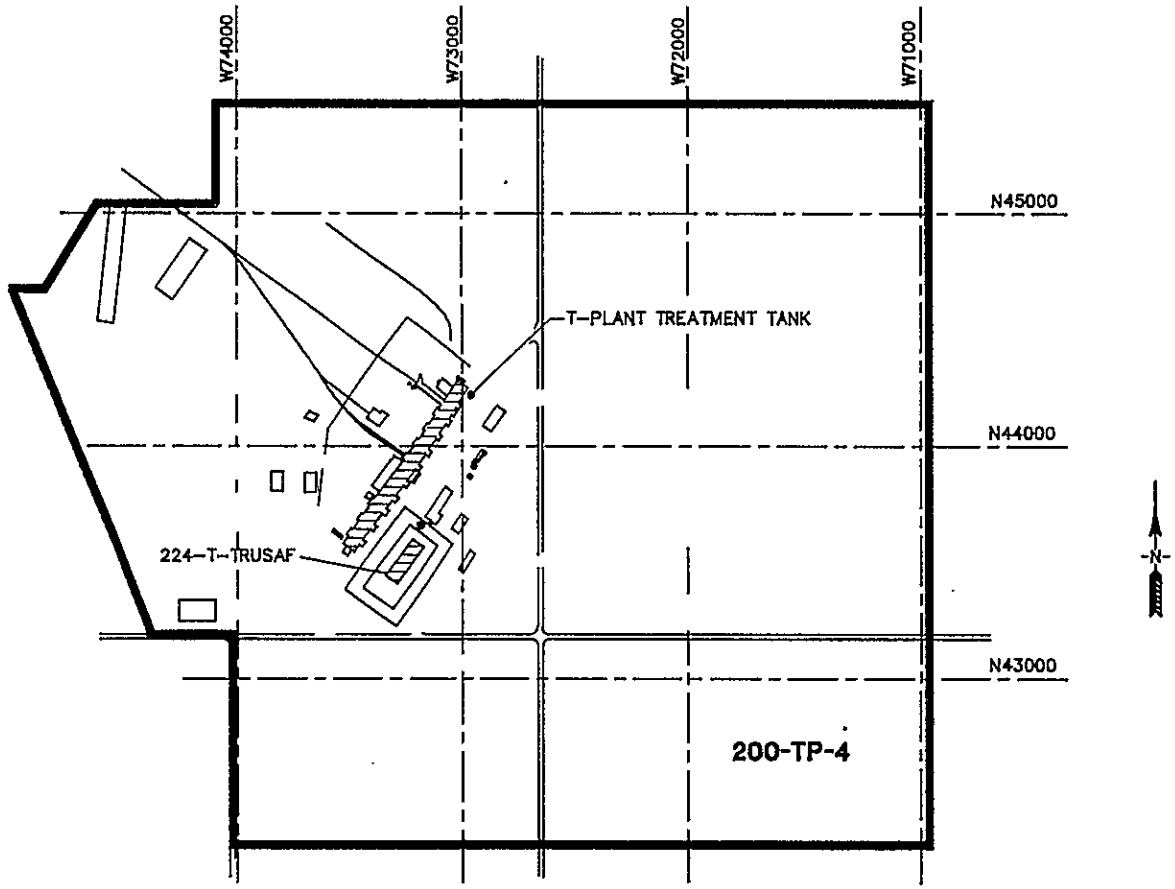

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 West Area
Operable Unit 200-TP-4

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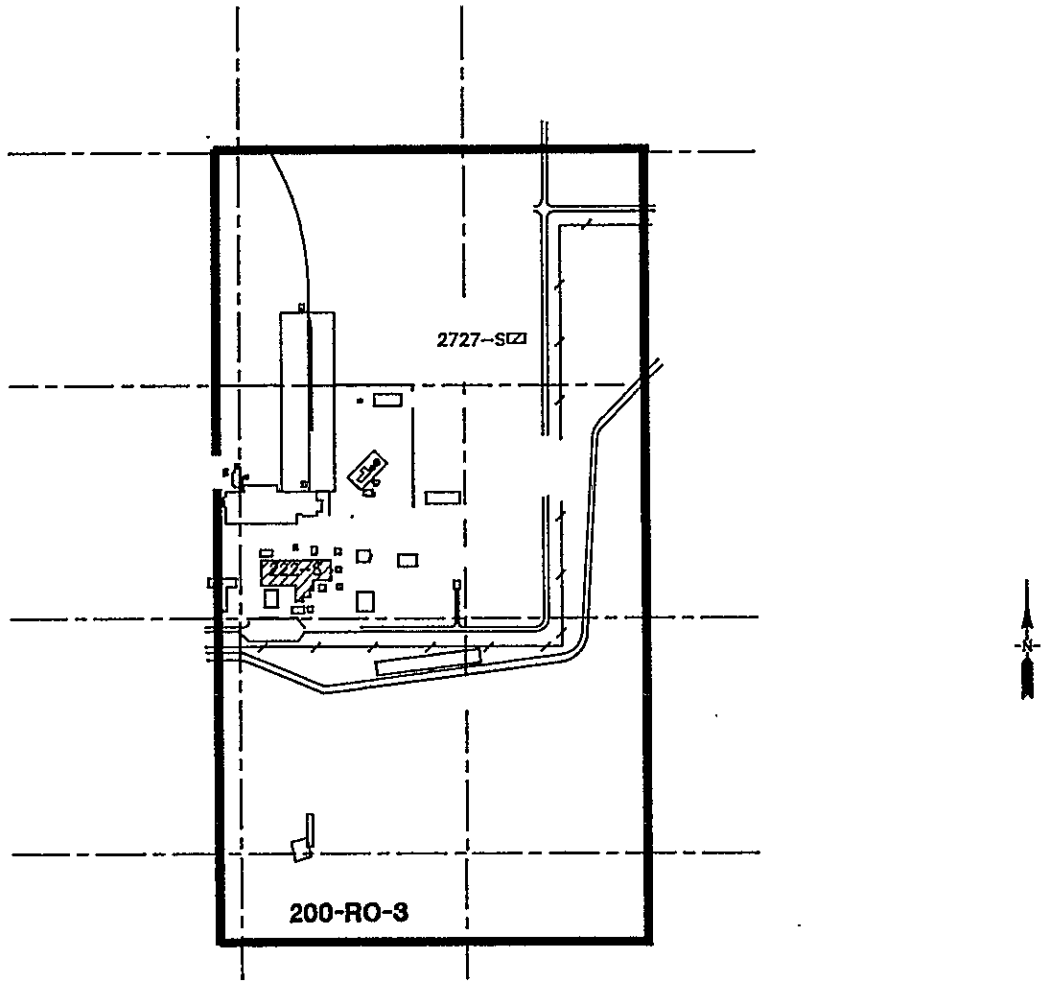

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 West Area
Operable Unit 200-RO-3

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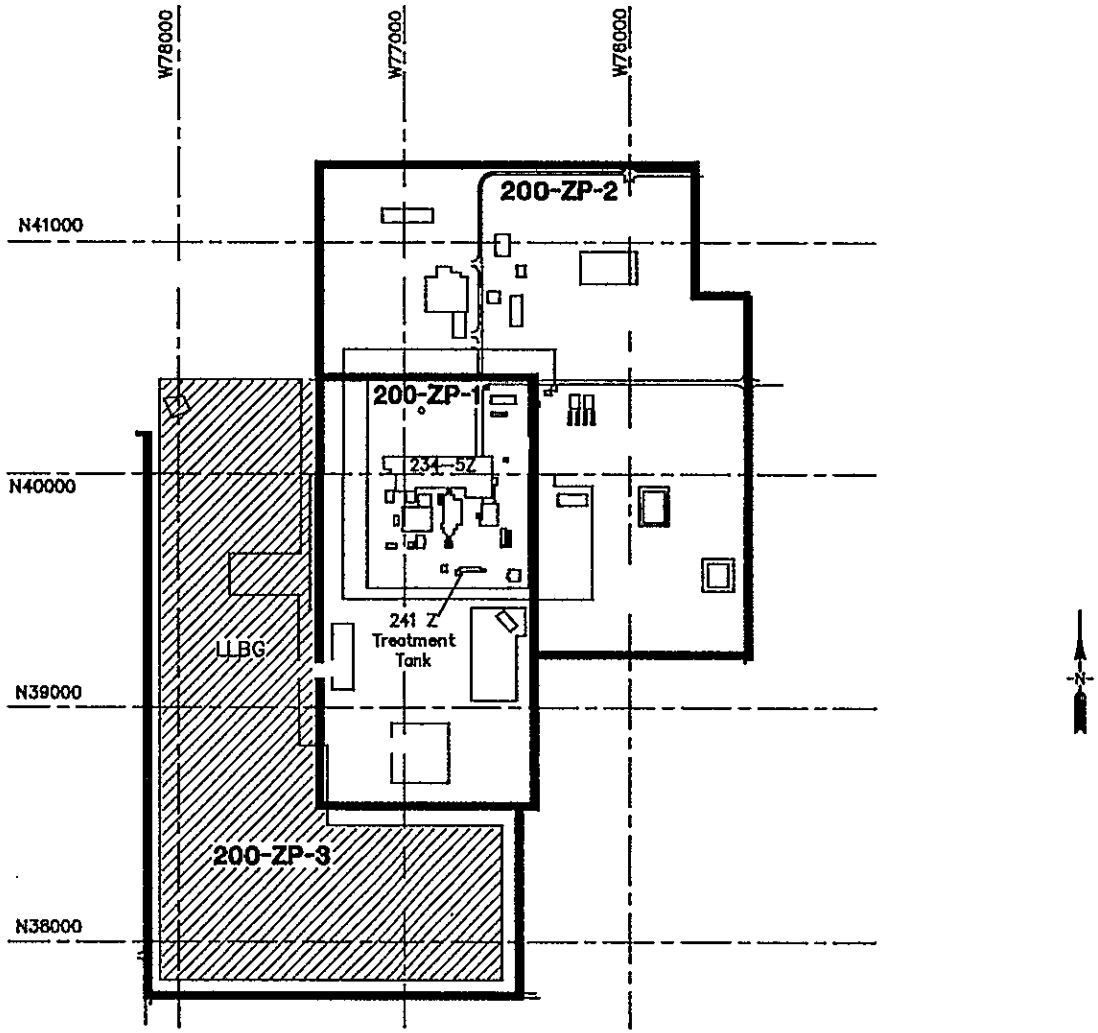

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 West Area
Operable Units 200-ZP-1, 200-ZP-2
and 200-ZP-3 (Partial)
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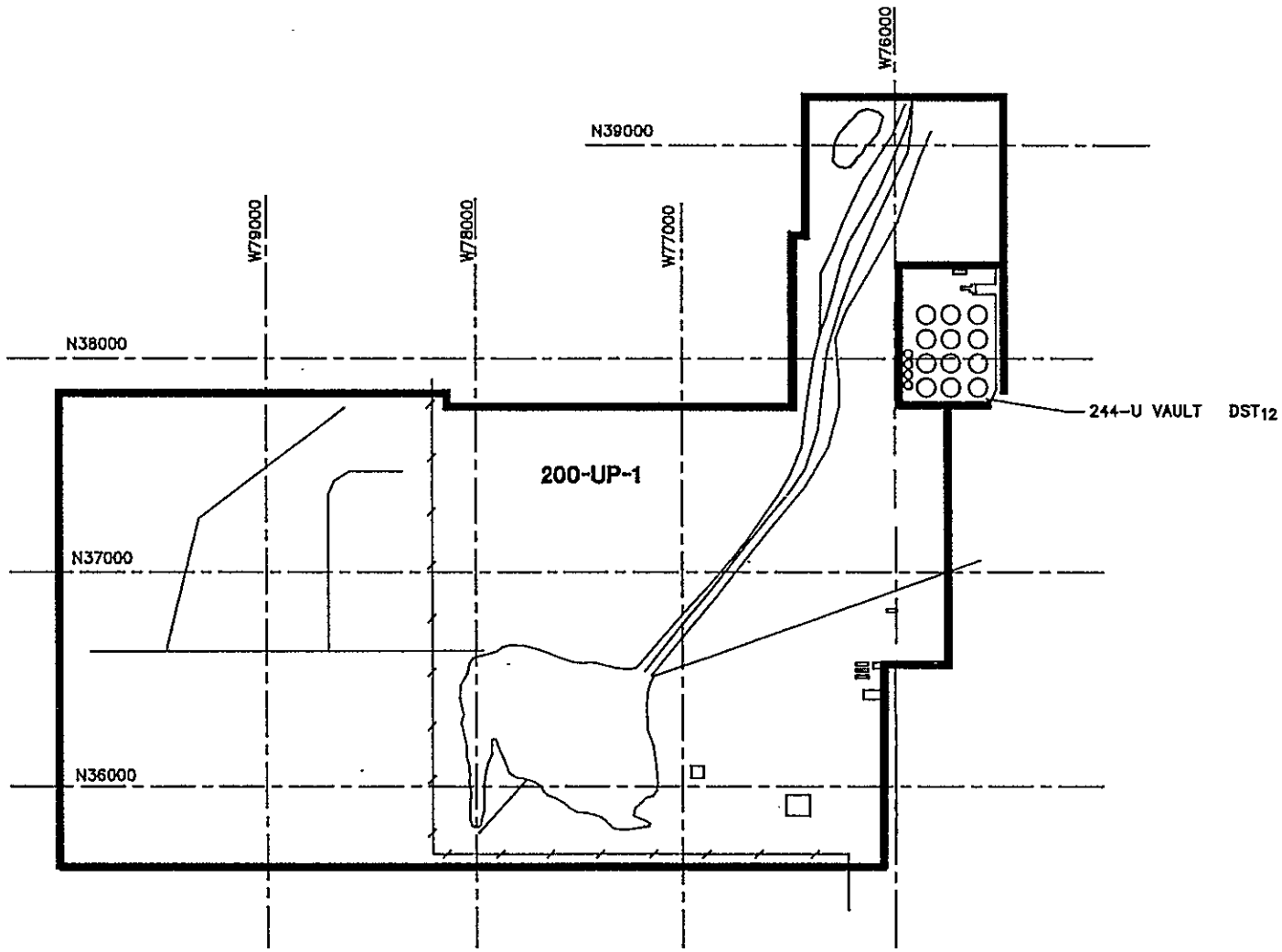

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Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

200 West Area
Operable Units 200-UP-1 and 200-UP-3

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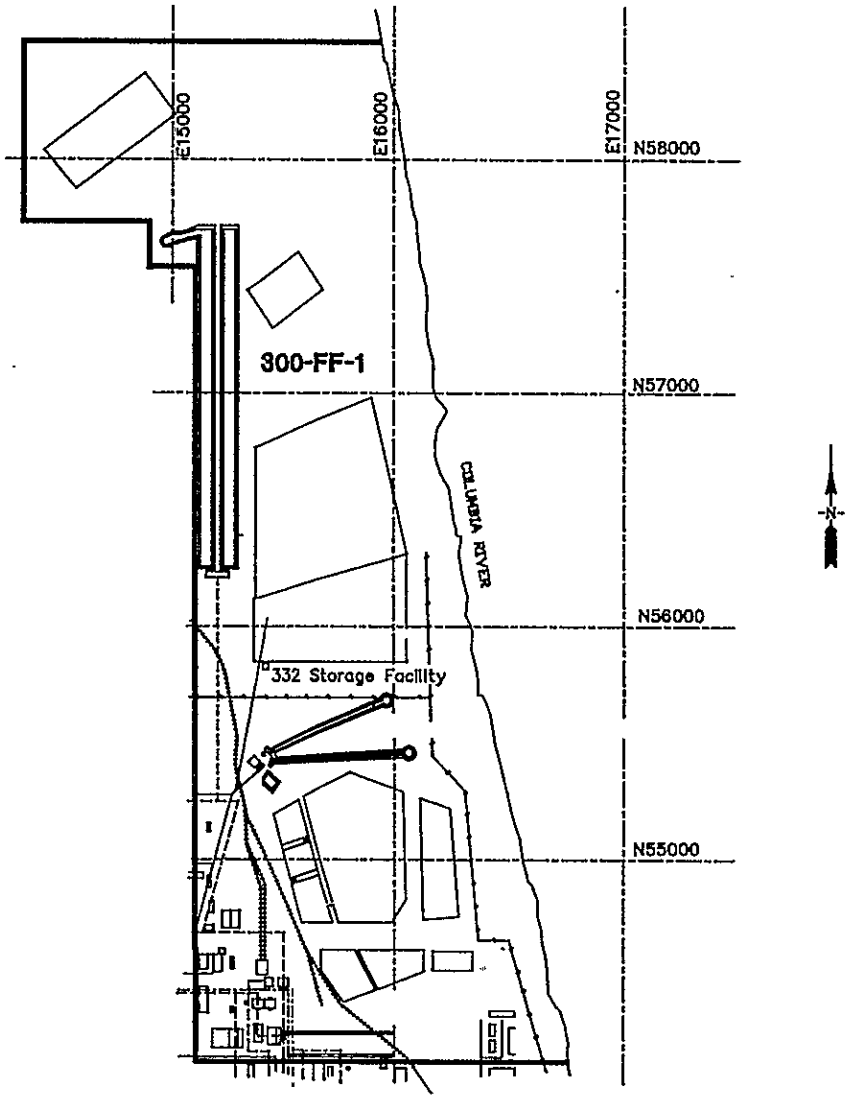

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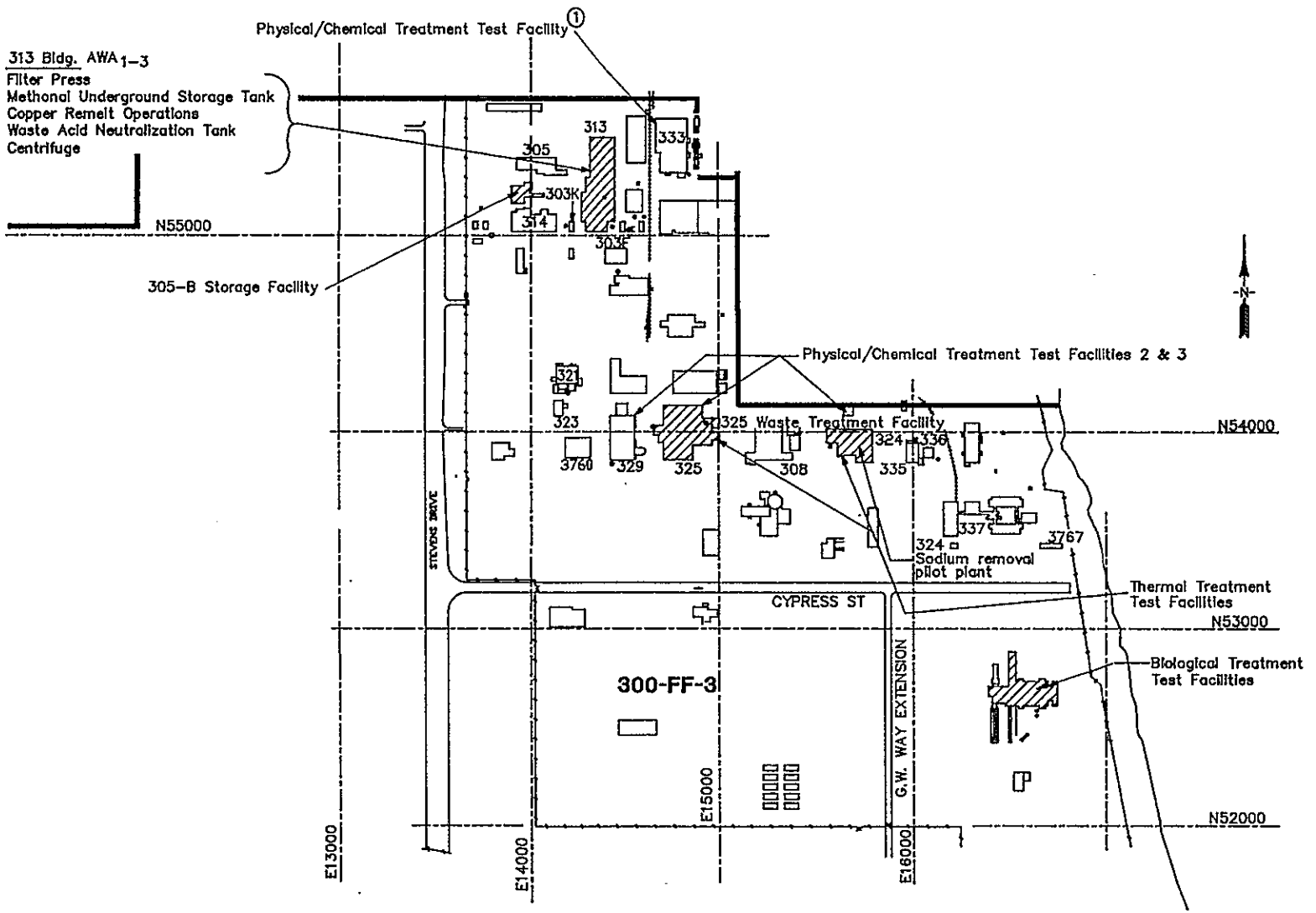
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

300 Area

Operable Unit 300-FF-1

OU\072091-B



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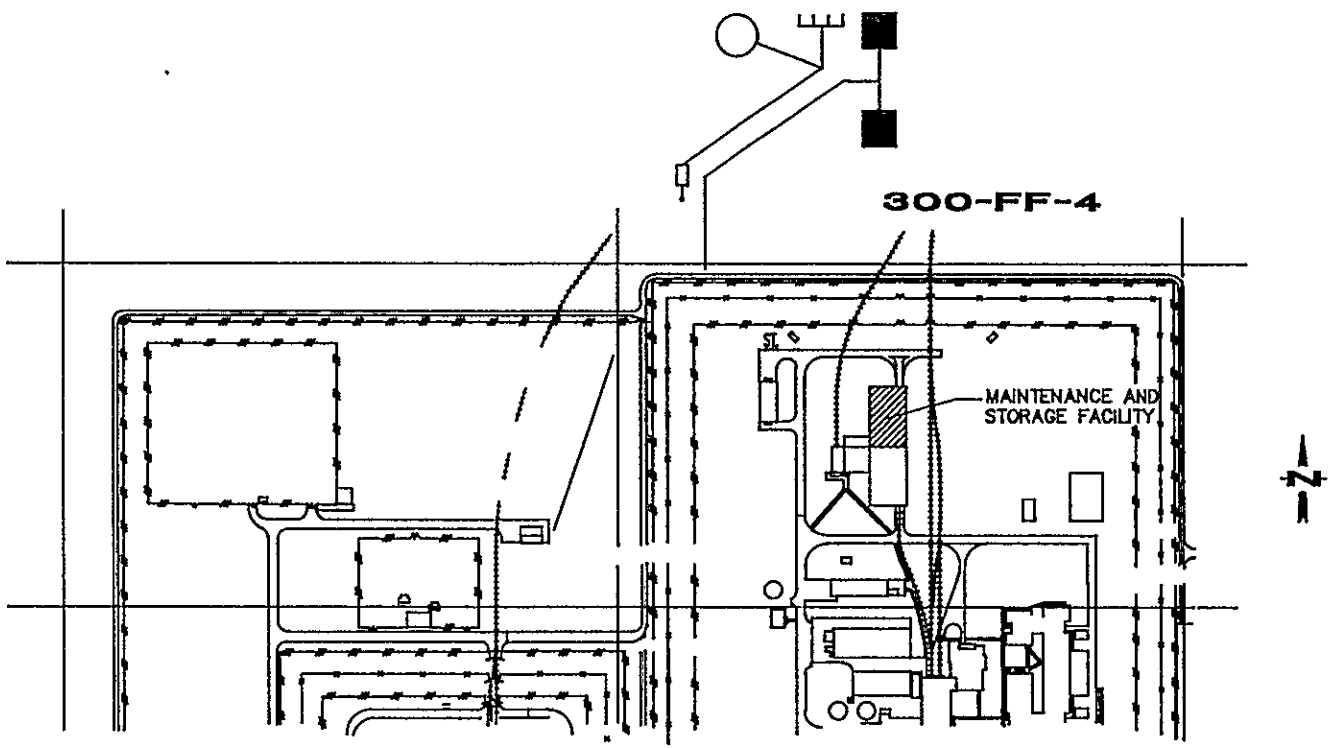
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

300 Area
Operable Unit 300-FF-3

OU/072091-C



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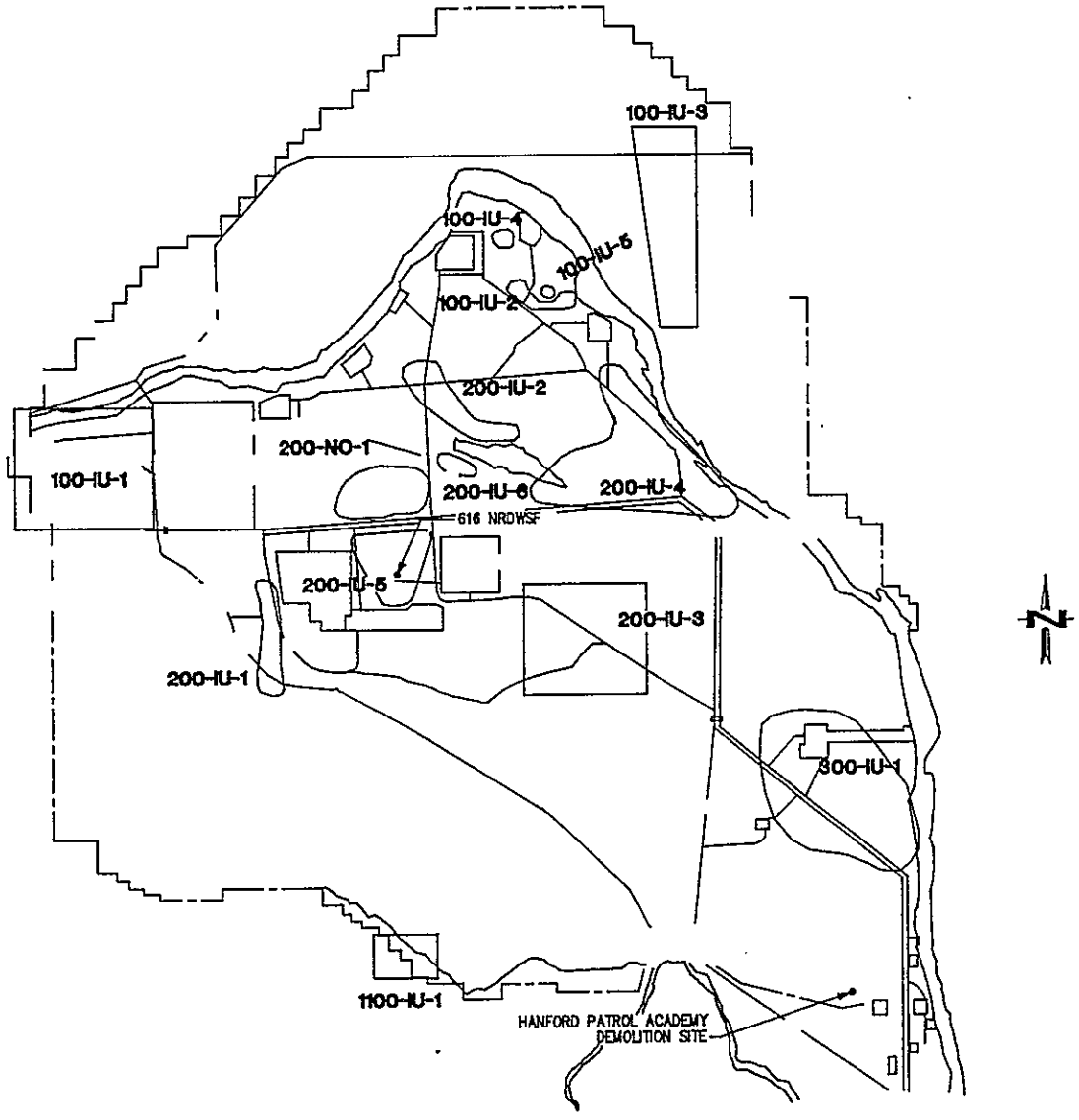
Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99350

400 Area North

Partial Operable Unit 300-FF-4

OU\072091-J



600 Area

Operable Units

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JJA			1/91	3.0	INFORMATION UPDATE

Westinghouse Hanford Company
P.O. Box 1970
Richland, WA 99352

600 Area
Operable Units

OU\072091-D

APPENDIX 2B

HANFORD FACILITY LEGAL DESCRIPTION

APPENDIX 2B

HANFORD FACILITY LEGAL DESCRIPTION

The Hanford Site being a tract of land located in Benton County, WA, the aforesaid tract being more particularly described as follows:

Commencing at the point of intersection of the E.-W. centerline of sec. 14, T.10N., R.28E. Willamette Meridian, with the western navigation line of the Columbia River;

Thence northerly 200 feet along said line of navigation to the TRUE POINT OF BEGINNING;

Thence W. to a point on the W. right-of-way line of George Washington Way, which line is the boundary of the City of Richland;

Thence southerly 100 feet or less, along said right-of-way line of George Washington Way to a point on the N. right-of-way line of Horn Rapids Road, an unplatted road;

Thence W. along the N. right-of-way line of Horn Rapids Road approximately 1/2 mile to the E. right-of-way line of Stevens Drive, an unplatted road;

Thence S. along said E. right-of-way line to a point on the N. right-of-way line of Spengler Street, a platted street;

Thence W. 145 feet to the W. right-of-way line of Stevens Drive;

Thence S. to a point 30 feet N. of the S. line of sec. 27, T.10N., R.28 E.W.M.;

Thence W. along a line 30 feet N. of, and parallel with, the S. line of sec. 27 to the E. line of the S.W. 1/4 of the S.E. 1/4 of said section;

Thence N. along the E. line of the S.W. 1/4 of the S.E. 1/4 of sec. 27 to the S.E. corner of the N.W. 1/4 of the S.E. 1/4 of said sec. 27;

Thence W. along the S. line of the N.W. 1/4 of the S.E. 1/4 to the W. line of the E. 1/2 of sec. 27;

Thence N. along the W. line of the E. 1/2 of sec. 27, and of the E. 1/2 of sec. 22 and the E. 1/2 of sec. 14 to the N. right-of-way line of Horn Rapids Road;

Thence westerly and northwesterly along the N. right-of-way line of Horn Rapids Road 26,000 feet more or less to the line's intersection with the N. right-of-way line of State Highway 240, in the N.E. 1/4 of sec. 11, T.10N., R.27E.W.M.;

Thence northwesterly along said N. right-of-way line of the highway, 75 feet N. of and parallel with the centerline of said highway to a point in sec. 3, T.10N., R.27E.W.M., which point is on the eastward extension of the N. right-of-way line of a county road from Horn Rapids to Benton City;

Thence along the northerly and westerly right-of-way line of said road, 75 feet northerly and westerly of, and parallel with, the center line of said road to a point on the E. line of sec. 8, T.10N., R.27E.W.M.;

Thence N. to the E. quarter corner of said section;

Thence W. to the S.W. corner of the E. 1/2 of the N.E. 1/4 of sec. 12, T.10N., R.26E.W.M.;

Thence N. to the N. line of said sec. 12;

Thence W. to the N.E. corner of the N.W. 1/4 of the N.W. 1/4 of the N.W. 1/4 of sec. 11, T.10N., R.26E.W.M.;

Thence S. 660 feet;
Thence W. 660 feet to the E. line of sec. 10, T.10N., R.26E.W.M.;
Thence S. to the S.E. quarter corner of said sec. 10;
Thence W. along the E.-W. centerline of sec. 10 to the W. line of said section;
Thence N. along the W. section line to the S.E. corner of sec. 4, T.10N., R.26E.W.M.;
Thence W. along the S. line of sec. 4 and sec. 5 to the S.W. corner of the S.E. 1/4 of the S.E. 1/4 of sec. 5;
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Thence N. to the S.E. corner of the N. 1/2 of the N.W. 1/4;
Thence W. along the S. line of the N. 1/2 of the N.W. 1/4 to the W. line of sec. 5;
Thence N. to the S.E. corner of sec. 31, T.11N., R.26E.W.M.;
Thence W. along the S. line of the E. 1/2 of the S.E. 1/4 of sec. 31 to the E. line of said E. 1/2 of the S.E. 1/4 of sec. 31;
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Thence W. along the S. line of the N. 1/2 of the N.W. 1/4 to the W. line of said sec. 31;
Thence N. along the W. line of sec. 31 to the S.E. corner of sec. 25, T.11N., R.25E.W.M.;
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Thence N. along the W. line of the N.W. 1/4 of the S.E. 1/4 to the S.E. corner of the N.W. 1/4 of sec. 25;
Thence W. along the S. line of the N.W. 1/4 of sec. 25 to the W. line of sec 25;
Thence N. along the W. line of sec. 25 and the W. line of sec. 24 to the N. line of the S. 1/2 of the S. 1/2 of sec. 23;
Thence W. along the N. line of the S. 1/2 of the S. 1/2 of sec. 23 and the N. line of the S. 1/2 of the S. 1/2 of sec. 22 and the N. line of the S. 1/2 of the S. 1/2 of sec. 21 to the E. line of sec. 20;
Thence S. to the S.E. corner of sec. 20;
Thence W. along the S. line of sec. 20 and the S. line of sec. 19 to the S.E. corner of the S.W. 1/4 of the S.W. 1/4 of sec. 19;
Thence N. to the N.E. corner of the S.W. 1/4 of the S.W. 1/4 of sec. 19;
Thence W. to the W. line of sec. 19, all being in T.11N., R.25E.W.M.;
Thence continuing W. to the S.W. corner of the N.E. 1/4 of the S.E. 1/4 of sec. 24, T.11N., R.24E.W.M.;
Thence N. to the N.W. corner of said N.E. 1/4 of the S.E. 1/4 of sec. 24;

Thence W. to the S.W. corner of the S.E. 1/4 of the N.W. 1/4 of sec. 24;
Thence N. to the N.W. corner of said S.E. 1/4 of the N.W. 1/4 of sec. 24;
Thence W. to the W. line of sec. 24;
Thence N. to the N.W. corner of sec. 24;
Thence W. to the S.E. quarter corner of sec. 14;
Thence N. to the N.W. quarter corner of sec. 14;
Thence W. along the N. line of sec. 14 to the N.W. corner of sec. 14;
Thence N. along the W. line of sec. 11 and sec. 2 to the N.W. corner of sec. 2, all being in T.11N., R.24E.W.M., and continuing N. along the W. lines of secs., 35, 26, 23, 14, 11, and 2, all being in T.12N., R.24E.W.M.;
Thence continuing N. along the W. lines of secs. 35 and 26 in T.13N., R.24E.W.M., to the N.W. corner of sec. 26;
Thence W. along the S. line of sec. 22 to the S.E. quarter corner of sec. 22;
Thence N. along the N.-S. centerline of sec. 22 to the N.E. quarter corner of sec. 22;
Thence W. along the S. line of sec. 15 to the S.W. corner of sec. 15;
Thence N. along the W. line of sec. 15 to the S.W. corner of the N. 1/2 of the N.W. 1/4 of sec. 15;
Thence E. along the S. line of the N. 1/2 of the N.W. 1/4 of sec. 15 to the S.W. corner of the N.W. 1/4 of the N.E. 1/4 of sec. 15;
Thence N. along the W. line of the S.W. 1/4 of the N.E. 1/4 of sec. 15 and continuing N. along the centerline of sec. 10 to the W. navigation line of the Columbia River, following said navigation line easterly, northerly, and southerly to a point directly W. of the S. line of Tract 4 of Ringold Tracts according to the plat filed in the records of Franklin County.
Thence southerly along the said W. line of navigation to the TRUE POINT OF BEGINNING.
EXCEPTING FROM THE ABOVE-DESCRIBED LAND THE FOLLOWING, EXCLUDING that portion of the Hanford Railroad and any Hanford Site access roads which may traverse these leased parcels.:
The N. 1/2 of the N.W. 1/4, and that portion of the N.W. 1/4 of the N.E. 1/4 in sec. 14, T.13N., R.24E.W.M. in the jurisdiction of the BONNEVILLE POWER ADMINISTRATION.
Sec. 1, T.11N., R.26E.W.M. under quitclaim deed to the STATE OF WASHINGTON.
A tract of land leased to the STATE OF WASHINGTON lying in sections 7, 8, and 9, T.12N., R.26E.W.M., containing 1,000 acres more or less, more particularly described as follows: That part of the S. 1/2 of said sec. 7 bounded on the W. and N. by the following described line: BEGINNING at a point on the S. line of said sec. 7, which point is S. 88° 44' 47" W. 4,515.30 feet from the S.E. corner of the sec., and at coordinates N. 438,868.46 and E. 2,222,800.00 on the Washington State Grid System, South Zone; thence N. 1,781.54 feet; thence E. 2,200.00 feet; thence N. 907.19 feet more or less to the N. line of said S. 1/2 of the sec.; thence N. 88° 38' 43" E. along said line 2,275.48 feet more or less to the E. quarter corner of said sec. 7. The S. 1/2 of sec. 8. The S. 1/2, and the S. 1/2 of the N. 1/2 of sec. 9, EXCEPT that portion lying easterly of the following described line: BEGINNING at a point on the E. line of said sec. 9, which point is N. 0° 53' 09" W. 3,071.71 feet from the S.E. corner of the sec., and at coordinates N. 442,268.92 and E. 2,237,790.19 on the Washington State Grid System, South Zone; thence

northwesterly along a 1,055.37 foot radius curve to the right an arc distance of 1,064.64 feet (the chord of said arc bears N. 30° 21' 08" W. 1,020.05 feet) to a point on the N. line of the S. 1/2 of the N. 1/2 of said sec. 9, said point being at coordinates N. 443,149.16 and E. 2,237,274.74 on the Washington State Grid System, South Zone.

Two tracts of land leased to the WASHINGTON PUBLIC POWER SUPPLY SYSTEM more particularly described as follows:

(1) a tract of land (for the Hanford Generating Plant), commencing at the S.E. corner of sec. 28, T.14N., R.26E.W.M., said point having Washington State Coordinates, South Zone, of N. 486,994.01, and E. 2,236,672.11; thence N. 72° 02' 15" W. 3,483.15 feet, thence N. 67° 11' 41" W. 1,810 feet more or less to a point on the line of ordinary high water on the right bank of the Columbia River, which point is the TRUE POINT OF BEGINNING: thence S. 67° 11' 41" E. 1,810 feet more or less to a point, having Washington State Coordinates, South Zone, of N. 488,068.19 and E. 2,233,358.73, thence N. 22° 48' 19" E. a distance of 1,595 feet to a point, having Washington State Coordinates, South Zone, of N. 489,538.48 and E. 2,233,976.96, thence N. 67° 11' 41" W. 1,108 feet more or less to a point on the line of ordinary high water on the right bank of the Columbia River, thence southwesterly along the said line of ordinary high water to the TRUE POINT OF BEGINNING, containing 53.42 acres more or less; THIS PARCEL AMENDED BY DELETING THE FOLLOWING: Beginning at the S.E. corner of the leased parcel, which point is at coordinates N. 488,068.19 and E. 2,233,358.73 on the Washington State Coordinate, South Zone; thence N. 22° 48' 19" E. 1,060 feet; thence N. 67° 11' 41" W. 200 feet; thence S. 22° 48' 19" W. 1,060 feet; thence S. 67° 11' 41" E. 200 feet to the point of beginning; containing 4.85 acres, more or less;

(2) a tract of land (for WNP sites), beginning at the S.W. corner of sec. 11, T.11N., R.28E.W.M., said corner having Washington State coordinates, South Zone, of N. 408,335.30 and E. 2,307,653.50, thence N. 0° 41' 08" E. 8,065.28 feet to the TRUE POINT OF BEGINNING; thence W. 11,153.57 feet; thence S. 01° 01' 23" E. 3,000.48 feet; thence S. 88° 53' 54" W. 5,200.96 feet; thence N. 0° 31' 41" W. 3,690.15 feet; thence E. 1,430.00 feet; thence N. 1,865.69 feet; thence N. 87° 46' 08" E. 3,703.83 feet; thence S. 01° 01' 23" E. 1,600.25 feet; thence E. 11,189.29 feet; thence N. 01° 01' 23" E. 1,800.29 feet; thence N. 89° 07' 55" E. 3,300.38 feet to the line of Navigation of the W. bank of the Columbia River, thence southerly along said line of Navigation to a point that bears N. 89° 15' 21" E. from the TRUE POINT OF BEGINNING; thence S. 89° 15' 21" W. 3,850.32 feet more or less to the TRUE POINT OF BEGINNING.

The following parcel of land used by Bonneville Power Administration under a use permit commonly referred to as the Ashe Substation Site legally described as follows:

A parcel of land in the W. 1/2 S.E. 1/4, the S.E. 1/4 N.W. 1/4 and the S.W. 1/4 of Section 32, Township 12 North, Range 28 East, Willamette Meridian, Benton County, Washington, more particularly described as follows: Commencing at a Bonneville Power Administration monument set at the intersection of the north-south and east-west base lines for the Ashe Substation Site in the S.E. 1/4 S.W. 1/4 of Section 32, Township 12 North, Range 28 East, Willamette Meridian. This monument is located N.26°49'15"E., 1503.1 feet from a 2-inch brass disc on the south line of Section 32, said disc being set by WPPSS survey of August 11, 1971. Thence N.52°10'10"E., 1200.0 feet to the true point of beginning. Thence S.37°49'50"E., 400.0 feet;

thence S.52°10'10"W., 1100.0 feet; thence S.37°49'50"E., 1287.7 feet to a point on the south line of Section 32; thence S.87°46'12"W., along said south line of Section 32, a distance of 984.0 feet; thence N.37°49'50"W., 2014.8 feet; thence N.52°10'10"E., 1900.0 feet; thence S.37°49'50"E., 900.0 feet to the true point of beginning; containing 75.09 acres, more or less.

APPENDIX 2C

QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM FOR THE HANFORD FACILITY

APPENDIX 2C

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APPENDIX 2C

QUALITY ASSURANCE AND QUALITY CONTROL PROGRAM FOR THE HANFORD FACILITY

This quality assurance and quality control program is applicable to the broad range of permitted activities that will be performed on the Hanford Facility. The provisions prescribed set forth the minimum requirements for the development of an overall quality assurance program for TSD units for which a final status permit has been, or will be, sought. The unit-specific permit applications will be prepared based on requirements defined herein that are applicable to the specific scope of the permit application. The requirements selected, and the degree of their application, will be commensurate with the scope of the unit-specific permit application and the criteria described in Section 2C5.1. When identification of the contractor(s) associated with a specific unit is known at the time of submittal of the unit-specific permit application, the application will briefly describe the applicable quality assurance program document(s), in addition to the identification of the specific quality assurance requirements.

2C1.0 DEFINITIONS

Definitions for terminology used in this appendix that are not defined under WAC 173-303-040 are provided in this section.

Item--An all-inclusive term used in place of the following: appurtenance, facility, sample, assemble, component, equipment, material, module, part, structure, subassembly, subsystem, system unit, documented concepts or data.

Process--A system of actions that achieves an end or result.

Quality--The degree to which an item or process meets or exceeds the end user's requirements and expectations.

Quality assurance--Those systematic actions that provide confidence that quality is achieved.

Quality control--The system of activities whose purpose is to control the attributes of an item or process in accordance with specified requirements and standards of performance.

2C2.0 QUALITY ASSURANCE AND QUALITY CONTROL REQUIREMENTS

This section outlines the quality assurance and quality control policy and requirements that the DOE-RL and its contractors will implement. Implementation of quality assurance and quality control programs contribute to the assurance that TSD units will comply with the RCRA and Ecology requirements.

2C3.0 POLICY

It is the policy of the DOE-RL that quality assurance programs be developed and implemented to ensure that risks and environmental impacts are minimized, and that safety, reliability, and performance are maximized through the use of effective management systems.

2C4.0 OBJECTIVES

The objectives of the programs are to ensure that (1) management provides planning, organization, direction, control, and support to achieve programmatic goals; (2) quality is achieved by personnel performing the activity; and (3) overall performance is reviewed and evaluated using an independent assessment process.

2C5.0 REQUIREMENTS

Requirements for the development and implementation of quality assurance programs are discussed in the following sections.

2C5.1 GENERAL

The DOE-RL and its contractors will develop and implement quality assurance programs that meet the requirements specified in this permit application. The quality assurance programs will be applicable to (1) design and construction of on-site TSD units; (2) characterization and laboratory analysis; (3) maintenance, operations, and closure of onsite TSD units; (4) postclosure of onsite disposal units; and (5) transportation of dangerous waste.

The level of quality assurance measures applied to an item or activity will vary as a function of its importance and the degree of confidence needed for the quality of the end results. A graded approach will be used to aid in the selective application of requirements to items and activities. The importance of an item or activity to the environment, human health, and safety, and the impact of failure of an item or activity to achieve stated

objectives will be the primary factors in determining the degree of rigor to be applied. Additional criteria such as complexity or uniqueness of the item or activity, special controls, ability to demonstrate functional compliance, quality history, and degree of standardization will be given due consideration in determining the appropriate quality assurance requirements. A decision process that addresses these elements will be established and used during the work planning phase for defining unit-specific quality assurance requirements. The process will take into consideration both the probability of an event occurring and the consequences of the event.

2C5.2 THE U.S. DEPARTMENT OF ENERGY FIELD OFFICE, RICHLAND

The DOE-RL will develop and implement a quality assurance program for the quality affecting activities performed by DOE-RL personnel.

2C5.2.1 Quality Assurance Program

The quality assurance program will address the following.

- Top management will retain and exercise the responsibility for the scope and implementation of an effective quality assurance program. Line management will be responsible for the achievement of quality. Each individual will be responsible for the quality of work they perform.

- The quality assurance program will be binding on personnel, including those having responsibility for planning and scheduling. Management will take the necessary actions to ensure that the quality assurance program is understood and implemented.

- The quality of items and processes will be ensured to an extent consistent with their risk using a graded approach.

- The quality assurance program will describe organizational structure, functional responsibilities, levels of authority, and interfaces.

- Readiness reviews will be performed before major scheduled or planned activities.

- Responsibility and authority to stop unsatisfactory work will be assigned such that planning and schedule considerations do not override safety considerations.

- Procedures defining requirements and systems for reporting events will be established in compliance with relevant Ecology regulations and U.S. Department of Energy Orders.

2C5.2.2 Procurement

The procurement section of the quality assurance program will address the following.

- Applicable technical and administrative requirements will be invoked on contractors, including the applicable requirements invoked by the Hanford Facility Permit.

- An evaluation will be performed to ensure that only qualified contractors are selected.

- Periodic assessments will be conducted to verify the quality of the contractor's work.

- Review of contractor's quality assurance programs will be performed.

2C5.2.3 Assessment

The assessment section of the quality assurance program will address the following.

- Planned and periodic independent assessments will be established and implemented. The assessments will verify compliance to the requirements contained in the Permit. Additionally, the assessments will consider the achievement of quality and the improvement of items and processes.

- Personnel performing independent assessments will monitor work performance, identify abnormal performance and precursors of potential problems, identify opportunities for improvement, identify areas where permit modifications might be appropriate, report results to a level of management having the authority to effect corrective action, and verify satisfactory resolution of problems.

- Personnel performing independent assessments will be technically knowledgeable and focus on improving the quality of the processes that lead to the end product.

- Scheduling of assessments and allocation of resources will be based on the status of and risk associated with the item or process being assessed.

2C5.3 THE U.S. DEPARTMENT OF ENERGY FIELD OFFICE, RICHLAND CONTRACTORS

The DOE-RL will require its contractors to develop and implement quality assurance programs using a graded approach for the quality affecting work they are contractually responsible to perform. The quality assurance programs may be unit-specific or apply to several units. Figure 2C-1 shows the control

elements that a contractor's quality assurance and quality control program needs to address relative to the work to be performed.

2C5.3.1 Work Activities

Work to be performed under the Hanford Facility Permit includes the following activities.

2C5.3.1.1 Design and Construction. Contractors performing design and/or construction of TSD units will be expected to either (1) develop and implement a quality assurance program during the design and construction work or (2) to demonstrate that the unit complies with applicable regulations and objectives through testing before use; in this case, the design and construction contractor(s) will not be required to implement quality assurance programs. Design and construction of a vault for the Grout Treatment Facility, a land disposal unit, or the Hanford Waste Vitrification Plant are examples where the contractors will be expected to have quality assurance programs. The contractor performing acceptance testing of a TSD unit will be required to have a quality assurance program applicable to the testing to be performed. The test plan, when completed in an acceptable manner, will demonstrate that the unit will be built and operated in compliance with applicable regulations. Construction control testing will be performed to ensure compliance to specified requirements.

2C5.3.1.2 Characterization and Laboratory Analysis. Contractors responsible for collecting representative samples, analyzing the samples, and reviewing and analyzing the data will be required to have quality assurance programs. Analyses, which are used for making decisions, will be controlled in accordance with the quality assurance program based on the data quality objectives established for the sample. The quality assurance and quality control starts before collection of samples and continues throughout the process including maintenance of records generated.

Presample collection activities include:

- Training and qualification of personnel
- Determining appropriate sampling equipment and sample containers to minimize contamination
- Documenting and approving sample selection point guidelines
- Developing and approving sampling procedures and methods
- Identifying test methods, calibrated equipment, and qualified personnel
- Establishing sample custody procedures including methods of preservation
- Identifying approved transportation and storage methods for samples

- Establishing specific objectives for the sample

- Identifying detection and quantification limits for the analytes to be analyzed.

Sample collection, transport, and analysis will be required to be performed in accordance with approved procedures to produce data that are of known quality commensurate with the intended use. Documentation will be reviewed to determine if the data are accurate and defensible, the data quality objectives are satisfied, and the waste is properly designated. Test results typically are used to characterize waste groundwater or to ensure that waste streams conform to established requirements.

2C5.3.1.3 Maintenance, Operation, and Closure. Contractors performing maintenance, operation, and closure activities related to TSD units will be required to have quality assurance programs that address the inspection and monitoring activities that follow corrective measures implementation to ensure that units are functioning as designed and closed in accordance with permit requirements. Storage unit quality assurance programs will include requirements to verify the integrity of the storage units. Closure includes not only land disposal units that will require postclosure permits but also the options to achieve clean closure or health-based closure. Inspections will be performed on TSD units to ensure that the units are being operated and maintained in accordance with permit requirements. Quality assurance and quality control requirements pertaining to various monitoring activities, including groundwater monitoring, needed during TSD unit operation, storage, and closure phases will be addressed in unit-specific quality assurance program document(s).

2C5.3.1.4 Postclosure. Contractors performing postclosure work, including maintenance, inspection, groundwater monitoring, and corrective actions, will be expected to develop and implement quality assurance programs for these types of activities.

2C5.3.1.5 Transportation. Transportation encompasses the movement of liquid or solid dangerous waste from a unit to a point of transfer, disposal, treatment, or storage. Movement can be accomplished by rail, road, or by pipeline. Typically, quality assurance programs are not prepared specifically for transportation activities, but are incorporated into quality assurance programs for the unit (either receiving or generating unit). Transportation includes preparations to move waste by characterizing the waste either by laboratory analysis or by understanding the process producing the waste stream, designation of waste based on the contents to be moved, appropriate packaging, and appropriate records traceable to the shipment. Transportation is performed in accordance with procedures in a manner that will mitigate the possibility of inadvertent discharges to the environment. Receipt of shipment(s) is performed to verify that shipping documents are traceable to waste material, that there are no discrepancies in the manifest or onsite waste tracking documentation, and that the waste is delivered to the correct unit.

2C5.3.2 Quality Assurance and Quality Control Elements

The following quality assurance and quality control elements are applicable to contractors performing RCRA permitted work activities. These elements can be addressed in any sequence and can be found in several contractor documents.

2C5.3.2.1 Program. The contractor's quality assurance and quality control program will address the following requirements.

- Senior management will retain and exercise the responsibility for the scope and implementation of an effective quality assurance program. Line management will be responsible for the achievement of quality. Each individual will be responsible for the quality of work they perform.

- The quality assurance program will be binding on personnel, including those having responsibility for planning and scheduling. Management will take necessary actions to ensure that the quality assurance program is understood and implemented.

- The quality of items and processes will be ensured to an extent consistent with their risk using a graded approach.

- Readiness reviews will be performed before major activities.

- The quality assurance program will describe organizational structure, functional responsibilities, levels of authority, and interfaces. The description will include the internal and external organizational elements that function within the scope of the quality assurance program and the interface among such elements.

- Responsibility and authority to stop unsatisfactory work will be assigned such that planning and schedule considerations do not override safety considerations.

- Procedures defining requirements and systems for reporting events will be established in compliance with the relevant Ecology regulations and DOE Orders.

2C5.3.2.2 Personnel Qualifications and Training. The contractor's quality assurance and quality control program will address the following requirements.

- Personnel performing or managing quality related work will be capable of performing their assigned task. Qualification requirements will be established for specific job categories.

- Training will include both education and enhancement of skills and practices. Personnel performing work that requires special skills and abilities will be qualified before performing the work. Dangerous waste worker training will be in accordance with Chapter 8.0 of this permit application.

- The training program will provide for maintenance of proficiency and will not be limited to attainment of initial qualification. The program will be subject to periodic review to determine its effectiveness.

2C5.3.2.3 Control of Nonconformance. The contractor's quality assurance and quality control program will address the following requirements.

- Nonconforming items and processes will be controlled to prevent inadvertent installation, test, or use. Items and processes that do not meet specified requirements or objectives will be identified, documented, analyzed, resolved, and followed up.

- Nonconforming items and processes will be analyzed and dispositioned by personnel who have adequate understanding of the subject area. Nonconforming items and processes also will be reviewed by the organization that originally approved the items or processes or a designated organization that is qualified and knowledgeable. The justification for disposition will be appropriately documented.

- Reworked, repaired, and replacement items and processes will be inspected and tested in accordance with original requirements or alternatives specified in the disposition.

- Elements of environmental data operations that do not satisfy desired prerequisites or performance objectives will be identified, documented, evaluated, validated when required, and their suitability for any given application determined. Evaluation, validation, and determination activities will be performed by personnel who have an adequate understanding of the subject area. These activities will be reviewed by organizations that established the prerequisites and/or performance objectives. The evaluation, validation, determination, and review process will be documented.

2C5.3.2.4 Documents and Records. The contractor's quality assurance and quality control program will address the following requirements.

- A process will be established and implemented to control the preparation, review, approval, issuance, use, and revision of documents that prescribe activities, specify requirements, or establish design.

- The scope of the document control system will be defined.

- Revisions to controlled documents will be reviewed and approved by the organization(s) that originally reviewed and approved the documents or by a designated organization that is qualified and knowledgeable.

- A process will be established and implemented to ensure that sufficient records are specified, prepared, reviewed, approved, and maintained to accurately reflect completed work. The maintenance of records will include provisions for retention, protection,

preservation, traceability, retrievability, and compliance to regulatory requirements.

- Records that require special processing and control, such as computer codes or information on high density media or optical discs, and hardware and software required to maintain and access records, will be controlled to ensure records are useable.

- A process will be established and implemented defining the records retention program. The records retention program will be consistent with the DOE-RL requirements; designating factors, such as duration and location; and assigned responsibility.

2C5.3.2.5 Work Processes. The contractor's quality assurance and quality control program will address requirements to control work processes including the performance of defined tasks or activities to achieve an end or result. Examples of work processes related to the RCRA permit application include preparation of reports and design documents; construction of a TSD unit; laboratory analysis of samples; review of test data; maintenance, operation, and closure of a TSD unit; postclosure monitoring; development and control of computer codes; etc. Requirements to control work processes will include the following.

- Line management will ensure that personnel working under their supervision are knowledgeable of work requirements and criteria for acceptable work performance and quality achievement. Line management will ensure personnel are provided necessary training, resources, and administrative controls to accomplish assigned tasks.

- Work will be planned, authorized, and accomplished under controlled conditions using appropriate standards, instructions, procedures, or other appropriate means of detail commensurate with the complexity and risk of each activity.

- Work-related instructions, procedures, and other forms of direction will be developed, validated, and approved by skilled personnel. As applicable, the documented process will be validated.

- A process will be established and implemented to identify, control, and maintain quality affecting items.

- Processes will be established and implemented to control consumable items with limited shelf life, and prevent the use of incorrect items.

- A process will be established and implemented to control the handling, storage, cleaning, and preservation of items to prevent damage, loss, or deterioration.

- Items will be marked and labeled during packaging, shipping, handling, and storage to identify, maintain, and preserve the items' integrity and to indicate any necessary special controls.

- Processes will be established to ensure performance of quality control checks for onsite and offsite transportation of items in compliance with the appropriate regulatory requirements.

- Special protective measures will be specified and provided, when required, to maintain acceptable quality.

- A process will be established to ensure that data generated by environmentally related measurement activities are complete, representative, valid, defensible, comparable, and of known precision and accuracy.

  - The process will describe how the various aspects of data processing, such as collection, validation, storage, transfer, and reduction, are managed and evaluated to maintain the integrity and quality of the data.

  - The process will establish the need for and describe the documents required for defining data quality objectives, sampling procedures, sample chain of custody, analytical procedures, internal quality control checks, data reporting, etc.

2C5.3.2.6 Design. The contractor's quality assurance and quality control program will address the following requirements.

- A process will be established and maintained to ensure that engineering systems are designed using sound engineering and scientific principles and appropriate standards. This process will ensure that design inputs, processes, and outputs are controlled to provide for acceptable, appropriate, and verified translation of design inputs into design outputs suitable for their intended purpose.

- Design interfaces will be identified and controlled, and design efforts will be coordinated among and within participating organizations.

- Design adequacy will be verified through design reviews, alternate calculations, or qualification testing by qualified individual(s) other than those who performed the original design. The extent of verification will be based on the complexity, risk, and uniqueness of the design.

- Changes to final designs will be subjected to design control measures commensurate with the original design and approved by the original design organization or a qualified designate.

2C5.3.2.7 Procurement. The contractor's quality assurance and quality control program will address the following requirements.

- A process will be established and implemented to ensure that purchased items and services meet established requirements and perform as expected.

- Applicable technical and administrative requirements will be invoked for procurement of items and services.

- Appropriate controls for the selection, determination of suitability, evaluation, and receipt of commercial grade items will be imposed to ensure that commercial grade items perform as expected.

- Prospective suppliers will be evaluated to ensure that only qualified suppliers are selected.

- Subsequent to award of a contract, suppliers and, as necessary, sub-tier suppliers will be monitored periodically to ensure that acceptable items and services continue to be supplied.

- Purchased items and services will be accepted using specified methods.

2C5.3.2.8 Inspection and Acceptance Testing. The contractor's quality assurance and quality control program will address the following requirements.

- A process will be established and implemented to specify when and what type of inspections will be required. Administrative controls and status indicators will be used to preclude inadvertent bypassing of required inspections and to prevent inadvertent operation of an item or process.

- The level of inspection and degree of independence of inspection personnel will be based on risk.

- Inspection activities will be planned. Planning will identify item characteristics and processes to be inspected, inspection techniques, acceptance criteria, hold points, and the organization responsible for performing inspection.

- When acceptance criteria are not met, deficiencies will be reported, resolved, and reinspected as necessary.

- A testing program will be established and implemented to demonstrate that items and processes will perform as intended.

- Test procedures will be developed and will include items, such as the following:

  - test objectives
  - characteristics to be tested
  - test methods to be employed
  - safety requirements
  - acceptance limits including precision and accuracy
  - training and personnel qualification requirements
  - performance instructions
  - test prerequisites
  - measuring and test equipment requirements
  - documentation requirements.

- Test results will be documented and validated and/or evaluated by technically competent personnel not directly involved in the performance of the test.

- Test procedures will be developed and implemented to demonstrate compliance with applicable regulatory requirements including permitted conditions. The procedures will be approved before implementation.

2C5.3.2.9 Measuring and Test Equipment. The contractor's quality assurance and quality control program will address the following requirements.

- A process will be established and implemented to control calibration, maintenance, and use of equipment.

- The types of equipment to be controlled will be defined.

- Measuring and test equipment will be calibrated at specified intervals on the basis of factors such as the accuracy of the equipment, intended use, frequency of use, stability characteristics, and manufacturer's guidelines.

- Measuring and test equipment will be calibrated against standards having accuracy that will ensure that equipment being calibrated is within required tolerances.

- Measuring and test equipment will be labeled, tagged, or otherwise controlled to indicate status and ensure traceability to calibration test data.

- Measuring and test equipment found out-of-calibration or out-of-tolerance will be segregated or identified until the equipment is successfully recalibrated. The acceptability of items or processes measured, tested, or inspected with out-of-calibration and/or tolerance equipment will be evaluated.

2C5.3.2.10 Assessment. The contractor's quality assurance and quality control program will address the following requirements.

- A process of planned and periodic independent assessments will be established and implemented.

- Personnel performing independent assessments will be knowledgeable technically and will not have direct responsibilities in the area they are assessing.

- Assessment results will be documented, and reported to a level of management having authority to effect corrective action. Implementation of the corrective action will be verified.

Work activity	Quality assurance and quality control control elements									
	Quality assurance and quality control program	Training and qualification	Nonconformance control	Documents and records	Work processes	Design	Procurement	Inspection and acceptance testing	Measuring and test equipment	Assessment
1. Design and construction										
a. Process controlled from start to finish by quality assurance program	X	X	X	X	X	X	X	X	X	X
b. Only testing controlled by quality assurance program	X	X	X	X			X	X	X	X
2. Waste characterization and laboratory analysis	X	X	X	X	X		X		X	X
3. Maintenance, operation, and closure	X	X	X	X	X		X	X	X	X
4. Postclosure	X	X	X	X	X		X	X	X	X
5. Transportation	X	X	X	X	X		X	X	X	X

Figure 2C-1. Quality Assurance and Quality Control Applicability Matrix.

APPENDIX 2D

DESCRIPTIONS OF PROCEDURES

This appendix will contain descriptions of environmental investigation instructions and other procedures that have common, Hanford Facility-wide usage. These descriptions will be completed by February 28, 1992.

APPENDIX 6A

HANFORD FACILITY GENERAL INSPECTION PLAN

RESOURCE CONSERVATION AND RECOVERY ACT/DANGEROUS WASTE REGULATIONS

APPENDIX 6A

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APPENDIX 6A

HANFORD FACILITY GENERAL INSPECTION PLAN

RESOURCE CONSERVATION AND RECOVERY ACT/DANGEROUS WASTE REGULATIONS

This plan provides for the general inspection (WAC 173-303-320) of the Hanford Facility, excluding TSD units already covered by unit-specific plans. The requirements of WAC 173-303-320, General Inspection, are incorporated as final facility standards via WAC 173-303-600.

6A1.0 SCOPE

This plan addresses inspection of those areas of the Hanford Facility not under the direct control of a responsible organization. This inspection plan does not specifically provide for the inspection of monitoring equipment; safety and emergency equipment; security devices; operating and structural equipment that help prevent, detect, or respond to hazards; nor does it preclude such observations. The aforementioned items will be inspected in accordance with unit-specific inspection plans.

6A2.0 PURPOSE

The purpose of this plan is to identify malfunctions and deterioration, operator errors, and discharges that might cause or lead to the release of dangerous waste constituents to the environment or pose a threat to human health.

6A3.0 INSPECTIONS

The inspection schedule, scope of inspections, items to be inspected, and inspection records are discussed in the following sections.

6A3.1 INSPECTION SCHEDULE

Inspections will be conducted on a frequency that allows for all areas subject to this plan to be inspected once every 2 years. Inspections will be initiated 6 months after approval of the initial Hanford Facility Permit. As required to meet the purpose of this plan, and consistent with inspection findings, the inspection frequency could be adjusted at the discretion of the owner/operator, and/or by modification of the Hanford Facility Permit.

6A3.2 INSPECTION SCOPE

The scope of any one inspection could vary as long as all areas are inspected consistent with the schedule set forth in Section 6A3.1.

Specific areas that have been inspected will be identified on maps or in writing in sufficient detail to document inspection of these areas in accordance with Section 6A3.1, or to allow for reinspection at a later date.

6A3.3 ITEMS TO BE INSPECTED

The inspection will focus on the identification of the following items or conditions to ensure proper waste handling and to carry out the purpose of this plan:

- Solid waste disposal sites not previously identified for remedial action
- Uncontrolled waste containers (e.g., orphan drums)
- Temporary activities that could generate an uncontrolled waste form
- Unpermitted waste discharges
- Any damage to, or condition of, that could lead to the impairment of monitoring equipment, safety and emergency equipment, security devices, and operating or structural equipment that help prevent, detect, or respond to hazards to the public health or the environment.

6A3.4 INSPECTION RECORDS

This inspection plan will be maintained onsite by the contractor organization responsible for conduct of the inspection.

Inspection results will be recorded as an inspection summary or log that includes, at a minimum, the following information:

- Date and time of the inspection
- Printed name and the handwritten signature of the inspector
- Notation of the observations made
- Account of spills or discharges in accordance with WAC 173-303-145
- Date and nature of any repairs or remedial actions taken to remedy observations.

The inspection log will be maintained in the Hanford Facility Regulatory File for at least 5 years from the date of the inspection.

APPENDIX 7A

HAZARDOUS MATERIALS RESPONSE PLAN

APPENDIX 7A

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HAZARDOUS MATERIALS RESPONSE PLAN

7A1.0 PURPOSE

The purpose of this Hazardous Materials Response Plan is to mitigate hazardous material incidents within the boundaries of the Hanford Facility. Contractors could develop and implement a response procedure(s) based on this plan.

7A2.0 SCOPE

This plan provides direction to all personnel in response to a nonradiological hazardous materials or mixed waste spill or release at locations not covered by existing contingency plans. This includes spills or releases as a result of transportation activities, movement of materials, packaging, and storage of hazardous materials.

7A3.0 HAZARDOUS MATERIALS INCIDENT CLASSIFICATION

There are three levels of hazardous materials incident classification. The following is the basis used for determining the level of a hazardous materials incident:

- Level of technical expertise required to abate the incident
- Extent of company, federal, state, and local agency involvement
- Extent of evacuation
- Extent of injury and/or deaths
- Extent of involvement of decontamination procedures.

7A3.1 LEVEL I INCIDENT

The following is a description of the Level I hazardous materials incident classification.

- Spills, leaks, ruptures, and/or fires involving hazardous materials that can be contained, extinguished, and/or abated using equipment, supplies, and resources immediately available to the responders.
- Hazardous materials incidents that do not require evacuation of personnel.

- Personnel trained to the operational level (29 CFR 1910.120) can respond to this level of event.

- This event would normally be categorized as an unusual occurrence (U.S. Department of Energy Order 5000.3A).

7A3.2 LEVEL II INCIDENT

The following is a description of the Level II hazardous materials incident classification.

- Hazardous materials incidents that can only be identified, tested, sampled, contained, extinguished, and/or abated using the resources of the city of Richland and/or Hanford Fire Departments; or a hazardous materials incident that requires the use of chemical protective clothing and specialized equipment.

- Hazardous materials incidents that require evacuation of personnel from a building.

- Fires involving hazardous materials that are permitted to burn for a period of time or are allowed to consume themselves.

- Personnel trained to the technician level (29 CFR 1910.120) can respond to this level of event.

- This event would normally be categorized as an unusual occurrence (U.S. Department of Energy 5000.3A).

7A3.3 LEVEL III INCIDENT

The following is a description of the Level III hazardous materials incident classification.

- Spills, leaks, and/or ruptures that only can be contained and/or abated using the highly specialized equipment and supplies available to environmental or industrial response personnel.

- Fires involving hazardous materials that are allowed to burn because of the ineffectiveness or dangers of the use of extinguishing agents or the unavailability of water; and/or there is a real threat of large container failure; and/or an explosion, detonation, boiling liquid expanding vapor explosion (BLEVE), or container failure has occurred.

- Hazardous materials incidents that require evacuation of personnel from more than one building; and/or there are serious personnel injuries and/or deaths as a result of the hazardous materials incident.

- Hazardous materials incidents that require at least second shift hazardous materials team response (Hazmat); and/or decontamination of fire department personnel is required on the scene.

- Personnel trained to the specialist level (29 CFR 1910.120) can respond to this level of event.

- This event normally would be categorized as an emergency and would fall into the category of either an Alert, Site Area Emergency, or a General Emergency, depending on the amount of material released and its potential to exceed 'protective action guides for hazardous nonradiological material' (U.S. Department of Energy Order 5000.3A).

7A4.0 RESPONSIBILITIES

All U.S. Department of Energy and contractor personnel are responsible for implementation of this plan during response to hazardous materials spills or releases occurring at locations not covered by a contingency plan.

7A5.0 OUTLINE OF RESPONSE

This outline is intended to be a guide for use by those individuals responding to a hazardous materials incident at the U.S. Department of Energy Hanford Facility. The plan is general in nature to allow the incident commander flexibility to respond to all incident types and conditions possible on the Hanford Facility. The incident commander is designated as the Hanford Fire Department as described in the DOE-RL emergency plan. Also specified in the DOE-RL emergency plan are locations on the Hanford Facility where dual incident commanders may be used (e.g., PUREX).

7A5.1 RECOMMENDED ACTIONS ON SCENE

The first responder or discoverer of a hazardous materials spill or release should initiate the following response actions:

1. Determine nature of incident:

    - Hazardous material spill with fire

    - Hazardous material spill without fire

    - Accident involving hazardous material, no evidence of spill or fire

    - Accident involving hazardous material, definitely no spill or fire.

2. Call for assistance from the Hanford Fire Department, as needed (811):

   - Hazardous material team (Hazmat)
   - Ambulances
   - Hanford Patrol
   - Heavy equipment.

Note: Notify the Hanford Fire Department of all spills of hazardous materials regardless of the need for assistance.

3. Isolate from employees:

   - Cordon off access
   - Place apparatus to block roadways
   - Use of Hanford Patrol roadblocks
   - Building/vehicle public address systems
   - Area crash alarms.

4. Determine type of hazardous materials involved:

   - Occupancy/location
   - Container shapes
   - Markings and colors
   - Placards and labels
   - Shipping papers
   - Use of senses (sight, smell, touch)
   - Consult reference materials (U.S. Department of Transportation, *National Institute of Occupational Safety and Health Pocket Guide to Chemical Hazards*)
   - Facility managers/employees.

5. Notify the appropriate manager of the incident and ensure that the incident is reported in accordance with applicable procedures.

6. Establish command post in accordance with applicable procedures, upwind and uphill of the incident, at least 500 feet (142.4 meters) away:

- Ensure command post is located so as to preclude the need for relocation

- Direct incoming units to a safe staging area

- Coordinate tasks with other responders.

Note: Steps 4 and 5 will initiate the notification process and subsequent activations of necessary emergency support centers. This notification will occur in conjunction with other established procedures for activation of required emergency centers, and the Unified Dose Assessment Center and other offsite emergency centers as are deemed necessary. Radiological and nonradiological field teams also will be dispatched as necessary to help define and locate the plume.

7. If properly trained personnel are present, initiate rescue/evacuation, as required. Ensure that all personnel who enter the site are equipped with proper protective clothing and respiratory protection:

   - Rescue should <u>only</u> be attempted when the risks are known

   - If the risks are unknown, wait for the Hazmat team.

Note: The following steps normally will be conducted/directed by a Hazmat team leader, or other authorized and fully trained individual:

8. Complete other actions necessary to effect control of the scene:

   - Secure the scene

   - Use absorbants

   - Use covering (blankets, polyethylene, etc.)

   - Overpack

   - Plug/patch

   - Transfer to new container

   - Venting/vapor suppression.

9. Initiate those measures within the first responder's capabilities. These could include, but are not limited to:

   - Establish placement of hose streams and unmanned monitors

   - Establish confinement dikes to prevent run-off

   - Perform first aid.

10. Obtain additional information:

    - Who is in charge (driver, plant manager, building emergency director, or emergency duty officer)
    - What and how much hazardous materials are involved
    - Manufacturer, shipper, receiver
    - Weather conditions.

11. Set up resource areas:

    - Command post location
    - Logistics area
    - Triage area
    - Decontamination area (personnel and equipment)
    - Staging Area
    - Planning.

12. Reevaluate evacuation boundaries and identify containment zones as follows:

    - Red Zone: Immediate danger area/spill or affected area
    - Yellow Zone: Probable danger area/buffer zone, limited access area
    - Green Zone: Worst case danger area/safe area

13. Additional actions to be taken to mitigate the incident include the following:

    - Cooling tanks involved in a fire or exposed to heat to reduce the potential for explosion
    - Removing all available ignition sources
    - Diverting liquid and run-off water to prevent contamination spread
    - Diking and retaining liquids from a leak or spill
    - Limiting property damage as much as possible
    - Provide on scene emergency medical services.

14. Document the response to the incident and provide report to appropriate/responsible management.

7A5.2 DECONTAMINATION

Establish decontamination stations for equipment and personnel in accordance with established procedures for appropriate decontamination techniques.

Materials to consider when establishing a decontamination station are as follows:

- Water supplies
- Containment/catch basins and/or systems
- Manpower necessary to accomplish proper decontamination
- Protective clothing
- Decontamination supplies (buckets, brushes, soap, chemicals as needed)
- Consider risk to personnel
- Weather conditions [i.e., severe heat, cold (current and forecasted)]
- Toxicity of material
- Porosity of equipment to be deconned
- Disposal requirements of decontamination rinse
- Use of controlled zones to maintain contamination control.

7A5.3 PREVENTION OF RECURRENCE OR SPREAD OF FIRES, EXPLOSIONS, OR RELEASES

Following an emergency incident and upon completion of the emergency response to that incident, the building emergency director/incident commander is responsible for analyzing the events that lead to the incident and for conducting a critique, including cause(s), impacts, and lessons learned from the incident. The requirements of U.S. Department of Energy Order 5484.1 must be followed to ensure that all appropriate parties are aware of, and participate in decisions on the best course(s) of action to take to prevent or minimize the possibility of future occurrences.

Specific steps that might be taken for a particular incident could include the following:

- Isolating the site of the initial incident by shutting off power, closing off ventilation systems, etc., to minimize the spread of a release and/or the potential for a fire or explosion
- Inspecting containment structures for cracks or leaks

- Removing released material and waste remaining inside of containment structures as soon as possible

- Containing and isolating residual waste material using dikes and absorbents

- Covering or otherwise stabilizing areas where residual released materials remain to prevent migration or spread from wind or precipitation run-off

- Installation of new structures, systems, or equipment to enable better management of hazardous or dangerous waste or materials.

7A5.4 TERMINATION OF EMERGENCY

Normally, it is a function of the building emergency director/incident commander to declare the termination of an emergency. However, once the emergency organization is activated, only the highest activated level of the emergency response organization will declare that an emergency has ended. If the U.S. Department of Energy Field Office, Richland-Emergency Action Coordination Team is activated, only the U.S. Department of Energy Field Office, Richland Director will officially terminate the emergency. In all cases, however, the incident commander must be consulted before reentry is initiated.

7A5.5 ACCIDENT RECOVERY

The recovery phase of the accident is not handled under emergency criteria, but rather according to a recovery plan developed for the specific event. Thus, the responsible manager will create an emergency organization encompassing all required aspects of engineering, operations, maintenance, and functional support, with direction provided by the appropriate contractor organizations (i.e., Hazardous Waste Unit or the Occupational Health and Safety). This will include making proper notifications to official agencies (i.e., U.S. Department of Energy, U.S. Environmental Protection Agency, or Washington State Department of Ecology). Recapture (where possible), store, and dispose of any material that is released, and store and dispose of any contaminated soil or surface water, or any other material that results from a spill, toxic fume generation, fire or explosion.

No waste that might be incompatible with the released material will be treated, stored, or disposed of until cleanup is completed.

All emergency equipment will be cleaned and fit for its intended use immediately following an emergency. Further information on accident recovery is contained within the DOE-RL Emergency Plan.

7A5.6 POSTEVENT ANALYSIS

Damage assessments should be made at the conclusion of the emergency phase and the results of these assessments must be communicated to the responsible manager and/or the emergency centers. The incident commander should designate a recovery manager who will determine necessary steps to return the area to an operational status. The following items should be considered:

1. Building structures (walls, ceilings, systems, etc.)

2. Utilities:

   - Electricity
   - Water
   - Gas
   - Steam
   - Telephone.

3. Hazardous materials/processes:

   - Radioactive systems or equipment
   - Chemical system
   - Toxic
   - Reactive
   - Corrosive
   - Explosive
   - Pressure systems
   - Compressed gas lines
   - Pressure vessels.

4. Waste systems:

   - Process sewer line
   - Process water line
   - Sanitary water line
   - Fire sprinklers

- Liquid metal
- Cryogenic.

5. Heating ventilation and air conditioning

6. Safety eyewash/safety shower:

- Fire alarm
- Crash alarms
- Sirens and alarms.

7A5.7 POSTEVENT REPORTING REQUIREMENTS

Incidents involving the shutdown of an operation as a result of a hazardous materials spill must be reported to the U.S. Department of Energy Field Office, Richland, and the Washington State Department of Ecology before restart of the operation. The responsible manager will notify the Occurrence Notification Center in accordance with applicable procedures and/or operation-specific notification procedures when the operation has been returned to its pre-incident condition and is ready for restart.

APPENDIX 9A

ZONING AND LAND USE MAP FOR BENTON COUNTY

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APPENDIX 11A

PART B PERMIT APPLICATION CLOSURE AND POSTCLOSURE PLAN OUTLINE

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APPENDIX 11A

PART B PERMIT APPLICATION CLOSURE/POSTCLOSURE PLAN OUTLINE

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FINAL STATUS POSTCLOSURE PERMIT APPLICATION OUTLINE

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APPENDIX 11C

CHARACTERIZATION AND USE OF SOIL AND GROUNDWATER BACKGROUND

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WHC-MR-0246

Characterization and Use of Soil and Groundwater Background for the Hanford Site

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EXECUTIVE SUMMARY

The determination of representative background is one of the most important activities for environmental restoration and waste management at the Hanford Site because background is used in defining contamination and establishing cleanup levels. Appropriate use of soil and groundwater background, therefore, requires data that are representative of the range of compositions that exist naturally. The present approach is to establish a background for each waste management unit. This approach has resulted in different definitions of background resulting in varying definitions of contamination and remediation goals, even for adjacent or superimposed units.

This document provides justification for a Site-wide approach to the determination and use of background as an alternative to the use of unit backgrounds in environmental restoration activities on the Hanford Site. One of the main reasons for the use of a Site-wide approach is that all waste management units impact a single vadose zone and a single regional unconfined aquifer. Existing data on the characteristics of the soil and groundwater show that the compositions of most vadose zone sediments can be considered together as a single compositional series and the natural variation in the composition of groundwater and of sediments exists on the scale of the entire Hanford Site.

It is concluded that the Site-wide approach to the characterization and use of background is preferred for environmental restoration because the Site-wide approach more accurately represents the range of natural variability in soil and groundwater composition on the Hanford Site. The Site-wide approach to background characterization also is desirable because this approach provides a more consistent and credible basis for evaluating contamination, and is more efficient.

Results from a preliminary evaluation of soil background data support the concept that the composition of soil and sediments in the vadose zone across the Hanford Site should be viewed and handled together as a single compositional unit. A preliminary set of soil background threshold values has been generated from these data and is included in this report. A plan for systematic sampling and analysis of the vadose zone during fiscal year 1991 also is described. The soil sampling effort and evaluations of existing groundwater data in the context of a Site-wide approach to background are intended to provide additional technical support for the Site-wide approach to the characterization of soil and groundwater background at the Hanford Site.

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ABSTRACT

This document provides justification for and describes a Site-wide approach to the determination and use of soil and groundwater background for environmental restoration activities at the Hanford Site as an alternative to the existing practice of determining unit-specific background. The determination of representative background is important because it is used as a basis for defining contamination and cleanup levels, and in assessing risk.

The present approach to background characterization at the Hanford Site is to establish a background for each waste management unit, which yields different definitions of contamination and remediation goals for these common media, and is inefficient and costly. A Site-wide approach to the characterization and use of natural soil and groundwater background yields more representative information on the range of natural compositions. The Site-wide approach provides for greater consistency and technical validity in environmental restoration and closure activities on the Hanford Site.

The Site-wide approach to background characterization has important implications for environmental restoration and closure activities because only media contaminated above the levels of Site-wide background need to be considered for remediation. The Site-wide approach is more efficient because this approach minimizes the misidentification of uncontaminated samples as contaminated, as well as minimizes the allocation of resources for remediation of contamination within the range of natural background that poses no increased risk to human health and the environment.

The Site-wide approach to background characterization is based on preliminary evaluations of soil and groundwater at the Hanford Site, which indicate that (1) the vadose zone can be regarded as a single compositional population, (2) the natural compositional variability of groundwater in the unconfined aquifer and in the soil and sediment of the vadose zone exists on the scale of the Hanford Site, and (3) the composition of both soil and groundwater has finite upper concentration limits. Models for what soil and sediment and groundwater background compositions represent, the nature and scale of compositional variability, and the processes responsible for the variability have been developed.

The key element of the soil background model is that the compositions of most vadose zone sediments are related because the sediments have common origins, sources, and modes of deposition associated with cataclysmic flooding during the Ice Age. The principal compositional components in these sediments are quartz-feldspar silt-sand and basaltic sand. Lateral and vertical compositional variability is attributable to differences in the proportion of these two components. These differences are related to the manner in which the sediments were deposited during and between flooding episodes. Windblown deposits that locally veneer these sediments were derived from the flood deposits and also are compositionally related to the sediments.

The principal concepts in the groundwater background model are that (1) groundwater composition in the unconfined aquifer is influenced by natural recharge, communication with the underlying confined aquifers, and water-rock-air reactions; and (2) the groundwater compositions evolve along reaction paths that converge toward common equilibrium or steady state maximum levels. The largest concentrations of dissolved solids in the unconfined aquifer generally are expected to occur in areas of the most highly evolved groundwater, because of the water-rock-air reactions or communication with the underlying confined aquifer

The results of preliminary evaluations of soil background data support the Site-wide soil background population model. A preliminary set of soil background threshold values has been generated from these data. A plan for systematic sampling and analysis of the vadose zone during fiscal year 1991 is described. This effort will provide data to improve the technical and statistical basis for the Site-wide soil background approach and threshold values. Efforts also are underway to evaluate existing groundwater data from the unconfined aquifer in the context of the groundwater background model.

GLOSSARY

ABBREVIATIONS, ACRONYMS, AND INITIALISMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
DQO	data quality objectives
Ecology	Washington State Department of Ecology, charged with enforcement of the *Model Toxics Control Act Cleanup Regulations*, as amended, and the *Dangerous Waste Regulations*
Eh	A measure of the oxidation-reduction potential (volts); the difference in potential measured in a cell having both oxidized and reduced forms of an element (measured) and the standard hydrogen electrode potential.[1] (Eh also can be expressed as pE, which is defined as the negative logarithm of the electron activity.)
EPA	U.S. Environmental Protection Agency
Km	kilometer
m	meter
MTCA	*Model Toxics Control Act Cleanup Regulations*, as amended, Washington Administrative Code, Chapter 173-340.
pH	negative logarithm of the hydrogen-ion concentration
ppm	parts per million
RCRA	*Resource Conservation and Recovery Act of 1976*
WAC	Washington Administrative Code
WMU	Waste management unit. As used in this document, WMU refers collectively to CERCLA operable units and RCRA treatment, storage, and/or disposal facilities.

DEFINITION OF TERMS

Definitions with unidentified sources are based on common usage. Several of the longer definitions have been abridged, as noted at the end of the definition.

Anthropogenic. Involving the impact of man on nature: induced or altered by the presence and activities of man.

Aquifer. A lithologic unit or combination of units that has appreciably greater water transmissibility than adjacent units. An aquifer stores and transmits water commonly recoverable in economic useable quantities.

Area background. The concentrations of hazardous substances that are consistently present in the environment in the vicinity of a site, which concentrations are the result of human activities unrelated to the releases from that site.[2]

Background threshold. Based on a tolerance interval approach, background threshold is the concentration level defining the upper limit of what will be considered as part of the background population. Calculating a threshold requires specifying the cumulative frequency distribution, the percentile level, and the coverage. The WAC 173-340-708(11)(d) specifies the 95 percentile and coverage of 95 percent. Departure from the tolerance interval approach requires approval by Ecology for those WMUs under Ecology jurisdiction.

Basalt. A dark- to medium-dark-colored mafic (iron-magnesium rich) extrusive igneous rock with small grains composed primarily of feldspar (calcic plagioclase), pyroxene, with or without olivine, and varying proportions of glass.[1]

Bulk composition. A complete chemical composition of a sample as performed by a method such as x-ray fluorescence or a spectroscopic analysis on a sample completely dissolved by acid digestion preparation techniques.

Cleanup level. The concentration of a hazardous substance in soil, water, air, or sediment that is determined to be protective of human health and the environment under specified exposure conditions.[2]

Cleanup standards. The standards promulgated under the Revised Code of Washington 70.105D.030(2)(d). Establishing cleanup standards requires specification of the following:

- Hazardous substance concentrations that protect human health and the environment ('cleanup levels')
- The location and site where those cleanup levels must be attained ('points of compliance')
- Additional regulatory requirements that apply to a cleanup action because of the type of action and/or the location of the site.

These requirements are specified in applicable federal and state laws and generally are established following selection of a specific cleanup action.[2]

Conceptual model. A symbolic representation of the essential characteristics of a physical system. The representation can be in language, image, or mathematical form.

Contaminant. Any hazardous substance that does not occur naturally or occurs at greater than natural background levels.[2]

Data quality objectives. These are qualitative and quantitative statements that specify the quality of the data required to support agency (EPA) decisions during remedial response activities. For example, depending on the project phase, sufficient data may have to be collected to characterize the site, evaluate remedial alternatives, determine design criteria, or monitor site conditions and/or remedial action effectiveness (EPA/540/g-7/003).[3]

End member. (a) One of the two or more simple compounds of which an isomorphous (solid solution) series is composed. For example, the end members of the plagioclase feldspar series are albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$). (b) One of the two extremes of a series, e.g., types of sedimentary rock or fossils.[4]

Eolian. (a) Pertaining to the wind; especially said of such deposits as loess and dune sand, of sedimentary structures such as wind formed ripple marks, or of erosion and deposition accomplished by the wind. (b) Said of the active phase of a dune cycle, marked by diminished vegetal control and increased dune growth.[4]

Feldspar. A group of silicate minerals that make up about 60 percent of the outer 15 Km of the Earth's crust; the minerals are silicates of aluminum with the metals potassium, sodium, and calcium, and rarely, barium.[1]

Fluvial. (a) Of or pertaining to a river or rivers. (b) Existing, growing, or living in or about a stream or river. (c) Produced by the action of a stream or river.[4]

Groundwater. Water in a saturated zone or stratum beneath the surface of land or below a surface water[2].

Leachate. The liquid resulting from the partial acid digestion and dissolution of a sample. The material resulting from the acid digestion sample preparation method identified by regulatory protocol (e.g., Method 3050 in EPA's SW-846 guidance).

Local background. Refer to "area background".

Loess. A wide spread, homogenous, fine-grained blanket deposit (generally less than 98.4 feet (30 meters) thick), consisting predominately of silt with subordinate grain sizes ranging from clay to fine sand. Loess is generally buff to light yellow or yellowish brown. Loess now is generally believed to be windblown dust of Pleistocene age, carried from desert surfaces, alluvial valleys, and outwash plains, or from unconsolidated glacial or glaciofluvial deposits. The mineral grains, composed mostly of silica and associated heavy minerals, are fresh and angular and generally are held together by calcareous cement. (abridged)[4]

Natural background. The concentration of a hazardous substance consistently present in the environment that has not been influenced by local human activities. For example, several metals naturally occur in the bedrock and soils of Washington State due to the geologic processes that formed these materials, and the concentration of these metals would be considered natural background. Also, low concentrations of some particularly persistent organic compounds such as polychlorinated biphenols (PCBs) can be found in the surficial soils and sediment throughout much of Washington State because of the global use of these hazardous substances. These low concentrations would be considered natural background. Similarly, concentrations of various radionuclides that are present at low concentrations throughout Washington State because of distribution of global radioactive fallout would be considered natural background.[2]

Nugget effect. The variation in sample concentration levels caused by the presence of a nugget of a mineral or phase that is modally subordinate in the parent material.

Operable unit. A group of contiguous past-practice waste sites related by site characteristics or operations so as to be considered collectively for purposes of environmental restoration under the CERCLA process.

Quartz. (a) Crystalline silica, an important rock-forming mineral: SiO_2. (b) A general term for a variety of noncrystalline or cryptocrystalline minerals having the same chemical composition as that of quartz, such as chalcedony, agate, and opal. (abridged)[4]

Sediment. (a) Solid fragmental material that originates from weathering of rocks and is transported by air, water, or ice, or that accumulates by other natural agents, such as chemical precipitation from solution or secretion by organisms; and that forms in layers on the Earth's surfaces at ordinary temperatures in a loose unconsolidated form; e.g., sand, gravel, silt, mud, till, loess, alluvium. (b) Strictly solid material that has settled from a state of suspension in a liquid. In the singular, the term is usually applied to material held in suspension in water or recently deposited from suspension. In the plural, the term is applied to all kinds of deposits, and refers to essentially unconsolidated materials.[4]

Site background. The natural background of the Hanford site. Includes all contributions from anthropogenic sources unrelated to the Hanford Site operations, e.g., regional agricultural chemicals, nuclear weapons testing fallout, etc.

Soil. A mixture of organic and inorganic solids and biota that exists on the Earth's surface above bedrock.

TSD facility. Treatment, storage, and/or disposal facility. A RCRA designation for a facility that handles hazardous waste.

Unconfined aquifer. An aquifer having a water table; an aquifer containing unconfined groundwater.[4]

Unit background. Refer to "area background".

Vadose zone. Zone of aeration. A subsurface zone containing water under pressure less than that of the atmosphere, including water held by capillarity; and containing air or gases generally under atmospheric pressure. This zone is limited above by the land surface and below by the surface of the 'zone of saturation', i.e., the water table. (abridged)[4]

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[1] *Basalt Waste Isolation Project Glossary*, SD-BWI-PMP-005, Rockwell Hanford Operations, Richland, Washington.

[2] *Model Toxics Control Act Cleanup Regulations*, as amended, WAC Chapter 173-340.

[3] EPA documentation as referenced in each definition.

[4] Bates, R.L., 1990, "Glossary of Geology", J.A. Jackson, ed., American Geological Institute, Falls Church, Virginia.

1.0 INTRODUCTION

A fundamental principle in most environmental regulations is that the natural environment should be used as a baseline for defining contamination and cleanup levels (e.g., EPA 1986; Ecology 1991a,1991b). The implied concepts in these regulations are that (1) concentrations of chemicals that occur in the environment naturally are generally not harmful to human health and the environment and (2) the natural environment should not be remediated because remediation would serve no practical purpose. Determination of the range of naturally occurring chemicals is, therefore, one of the most important activities in the environmental restoration mission at the Hanford Site. The focus of this document is on the determination and use of nonradioactive inorganic constituents in the soil and groundwater background at the Hanford Site.

The term 'background' generally refers to the composition of a medium unimpacted by activities at a waste management unit (WMU). [For purposes of this document, WMU refers to either a *Resource Conservation and Recovery Act of 1976* (RCRA) treatment, storage, and/or disposal (TSD) facility or a *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) operable unit.] Several different definitions of background exist in the regulatory guidelines. The ambient concentration of chemicals present in the environment unimpacted by human activities is defined as natural background by the U.S. Environmental Protection Agency (EPA) (EPA 1989c). The concentration of chemicals consistently present in the environment due to human-made, non-site sources (i.e., agriculture, automobiles) is defined by the EPA as anthropogenic background (EPA 1989c), and as natural background by the Washington State Department of Ecology (Ecology) (Ecology 1991b). The Ecology definition of natural background differs from the EPA definition because the term natural background includes constituents such as agricultural byproducts in the Columbia and Yakima Rivers, and radionuclides distributed globally from atmospheric weapons testing.

The two main types of background discussed here are natural background as defined by Ecology, and 'local' or 'area' background (Ecology 1991b). Local or area background refers to the composition of a medium in the vicinity of an individual WMU before its existence. Local background might or might not correspond to natural background and is used, where possible, to distinguish between contamination from a WMU and contamination attributable to other current or previous activities at the Hanford Site. Local or area background is used synonymously with WMU-background in this document. For the purpose of this document, the analytes included in this definition of natural background are only the inorganic constituents.

Background sampling generally is conducted to distinguish site-related contamination from naturally occurring or other non-site related levels of chemicals in media such as soils and groundwater, and also to establish baseline risk levels for the protection of human health and the environment (EPA 1989c). The background-based definition of contamination, i.e., concentrations larger than those that occur naturally, often supersedes more general standards in environmental restoration efforts because the

concentration levels of natural background vary from region to region (EPA 1989c). In risk assessment activities, the natural range of chemical concentrations in soil and water is used to constrain the levels of human and ecosystem exposure to chemicals that are normal for the site or region. This information is used primarily to provide a lower bound of human and environmental toxicity and other health risks.

The concept of a Site-wide approach for characterizing the natural range of compositions for soil/sediment and groundwater background at the Hanford Site is presented in this report. Discussion of the technical feasibility and utility of a Site-wide approach to background characterization for soil and groundwater begins in Section 2.0 with a comparison of the WMU-based approach and the Site-wide approach of background characterization. The issues of what constitutes representative background, and how background is most appropriately characterized for the purposes of environmental restoration, also are addressed.

The technical validity of the Site-wide approach to the characterization of soil and groundwater background also is discussed in the context of the nature of the media and the factors that influence its composition. A description of the physical and chemical characteristics of the soil/sediment in the vadose zone and the groundwater system in the unconfined aquifer beneath the Hanford Site is provided in terms of geologic, geochemical, and hydrologic information and environmental regulations and protocols in Sections 3.0 and 4.0, respectively. The preliminary results of evaluating the existing WMU-based soil background collectively in a Site-wide context also are presented in Section 3.0. Conclusions regarding the justification for the preferred use of Site-wide background in environmental restoration efforts is provided in Section 5.0.

Additional information on the physical and compositional characteristics of soil/sediment and groundwater at the Hanford Site and the known and expected chemical characteristics are provide in Appendices A and C. Discussions of the statistical and nonstatistical methods used in evaluating the soil background data and statistical evaluation of the validity of the Site-wide approach for characterizing soil background are presented in Appendix B. The systematic sampling and analysis of soil/sediment in the vadose zone and data compilation efforts for Site-wide groundwater background planned for fiscal year 1991 are described in Appendix D. Cost savings analysis information associated with a Site-wide approach to the characterization of soil background is included in Appendix E.

The terms soil and sediment used in this report both describe the unconsolidated earth materials that comprise the vadose zone on the Hanford Site, i.e., the zone from the ground surface to the top of the underlying unconfined water table. These terms have specific meanings in environmental regulations that differ from those used in the scientific and engineering communities. For the purpose of this report, the terms soil and sediment are used interchangeably and refer collectively to these materials in the vadose zone. However, the term sediment is used in the geologic context in describing the geology of the vadose zone materials.

2.0 SITE-WIDE VERSUS UNIT-BASED APPROACH TO BACKGROUND CHARACTERIZATION AND USE

The fundamental requirement for background characterization activities concerns representative sampling of the media. Regulatory protocols require that background samples be representative of the medium of interest in the WMU, and unimpacted by activities in the WMU (EPA 1986). The extent to which the samples are representative, however, also depends on the end use of the data (EPA 1987a). The validity of the Site-wide approach to background characterization, therefore, depends on (1) what constitutes representative background for the purpose of environmental restoration and (2) whether a Site-wide background is more representative of the media impacted by WMUs than a WMU-based background for its intended use.

Over 1,500 locations have been identified on the Hanford Site that potentially require some type of characterization as specified in environmental regulations (e.g., EPA 1980; Ecology 1991a, 1991b) and the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1990). There are presently 62 WMUs identified under the RCRA as TSD units (Ecology et al. 1990). The remaining locations identified under the CERCLA or the RCRA corrective action authority *Hazardous and Solid Waste Amendments of 1984* are grouped into 78 operable units.

The current approach for characterizing these WMUs on the Hanford Site is to establish a local background for each RCRA treatment, storage, and/or disposal unit and each operable unit. The composition of soil and/or groundwater from each WMU is compared to the WMU-background to define contamination and assess risk. This approach has led to inconsistencies in identifying contamination and in the evaluation of restoration and baseline risk levels. Consequently, this approach yields different definitions of contamination and different assessments of remediation goals and risk for each WMU, even those WMUs that are adjacent or superimposed.

An alternative approach is to develop a single Hanford Site background for all the sediments in the vadose zone with the same basic characteristics, and a single background for groundwater in the unconfined aquifer. This approach is based on the fact that all the WMUs share a common sequence of vadose zone sediments and a single unconfined aquifer. In this approach, the range of natural compositions within these media is used to establish the Hanford Site background for soil and for groundwater.

2.1 REPRESENTATIVE CHARACTERIZATION AND USE OF BACKGROUND

A Site-wide approach to the characterization of soil and groundwater background for environmental restoration on the Hanford Site is theoretically a more appropriate method than the WMU-based approach to background characterization for several reasons. These reasons are as follows.

- WMU-based local background may not represent the natural range of soil compositions.

- WMU-based local background may not represent natural background for groundwater.

- Environmental restoration activities typically involve soil and groundwater impacted by more than one WMU.

- Environmental restoration activities are performed on the scale of the impacted medium rather than the scale of individual WMUs.

- The WMU-based approach to background characterization is designed for individual WMUs at unrelated sites or regions that do not share a common vadose zone and unconfined aquifer.

For the purpose of environmental restoration, natural background must represent the natural range of compositions within the medium of concern, e.g., soil and/or groundwater. Local WMU-based background at many WMUs may not represent natural background. This is true for soil background in some areas of extensive past-practice activities (e.g., 300 Area; Figure 2-1). This is especially true for local groundwater background where upgradient wells are influenced by other WMUs. In such cases, the local background, i.e., upgradient well water composition, is not natural background, and cannot be used in determining the natural range of compositions, even for individual WMUs.

The characterization of background also must be performed on the same scale as the environmental restoration activities to accurately represent the range of compositions of known or potential impact. Many of the restoration activities must be evaluated and performed on the scale that considers past and present operations that have influenced the soil and groundwater. In most cases, the scale that should be considered for background characterization in environmental restoration activities is larger than the dimensions of individual WMUs. For example, the extent to which groundwater is impacted by a WMU operation typically is much larger than the lateral dimensions of the WMU itself. In this case, representative background is the natural range of compositions that exist in the impacted part of the aquifer laterally and vertically. In such cases, or where upgradient wells are influenced by other WMUs, it may not be possible to determine an appropriate natural background using a WMU-based approach to the characterization of background.

There is also an important distinction between the purpose and use of background in environmental restoration and monitoring efforts. The objective of environmental restoration is to return the Hanford Site to conditions protective of human health and the environment or to pre-operational conditions; whereas, the main objective of monitoring is to detect contamination and identify sources. The ability to recognize contamination on the scale of individual WMUs is important in monitoring active operations and contaminant plumes, and requires local WMU-background, especially for groundwater. However, the identification of contamination from specific WMUs for the purpose of environmental restoration is subordinate to the identification of contamination levels from all sources that exceed the range of natural background. Moreover, contaminant levels within the range of natural background generally are not distinguishable from background.

One concern regarding the use of a site background is whether levels of contamination within the range of natural background pose a risk to human health or the environment. The regulatory agencies recognize that not all contamination poses a threat to human health or to the environment or warrants remediation. For example, regulatory guidelines indicate that chemicals that are present within the range of naturally occurring levels do not pose a risk to human health or the environment unless the natural background levels themselves pose a risk (EPA 1989c). Concerns regarding ecosystem sensitivities to differences in the level of chemicals within the range of natural soil background also have been considered. However, there is no known ecosystem sensitivity of this type within the Hanford Site region, with the exception of small isolated localities in the Cold Creek Valley and West Lake Basin. At these localities, alkali soils have developed naturally over the past 6,000 years and preclude most vegetation with the exception of those plants that can tolerate high salt environments (e.g., Rickard 1964). Compositional outliers such as this are readily recognizable and are included in the data evaluation process. Similar concerns for groundwater are discussed in Section 4.0.

Perhaps the most important difference between the WMU-based approach and the Site-wide approach to background characterization is in the way that the background characterization impacts evaluations and decisions. Decisions concerning the identification of contamination and/or remediation using individual WMU backgrounds are subject to error because WMU local backgrounds are subsets of the natural range of soil background compositions that exist laterally and vertically throughout the Hanford Site or beneath WMUs. For example, the composition of soil or groundwater that exceeds the local background threshold levels in one area, but that is within the range of the Site-wide natural background, would be interpreted as contaminated using a WMU-based background approach. However, for the purposes of environmental restoration, it is impractical to define background, and consequently contamination and baseline risk levels, differently from one place to another for a common medium. In this regard, the use of a Site-wide background provides a basis for minimizing the misidentification of uncontaminated samples as contaminated, and the potential allocation of resources to remediation efforts that serve no purpose.

Thus, representative characterization of the natural range of soil and groundwater background compositions for the purposes of environmental restoration is best obtained using a Site-wide approach rather than a WMU-based approach. It is not intended that a Site-wide background be used to allow any level of contamination to be introduced into the environment from current or future operations. Rather, Site-wide background is intended for use as one of the most appropriate criterion for distinguishing contamination that practically can be considered for corrective action.

2.2 BENEFITS OF A SITE-WIDE APPROACH

The main benefits of a Site-wide approach to the characterization of background for soil and groundwater include the following:

- Consistent and representative characterization of background
- Consistent definition of contamination and assessment of baseline risk
- Greater efficiency in environmental restoration activities.

Alternatively, the WMU-based approach can result in problems in balancing cost in terms of technical and/or statistical validity. In the case of soil background, a small number of surface soil samples often are inadequate for the level of desired statistical confidence, and generally are inadequate to represent the compositional range of the soil background that actually exists on the scale of the impacted medium. However, the number of samples that may be necessary for statistical purposes, and would be representative of the geology and geochemistry, becomes very costly when performed independently for each WMU. The use of appropriate data accumulated from RCRA or CERCLA activities eliminates most problems associated with small sample number statistics, and is one reason for the improved technical basis of the Site-wide approach.

Cost benefits are realized as a result of using the Site-wide approach to characterization of soil and groundwater background. The Site-wide approach also is more efficient than the WMU-based approach. The primary cost benefit is the reduction in the number of background samples and the analyses that are required. The combined cost savings over a WMU-based program of sampling and analysis for soil background alone is estimated at over $10 million (Appendix E). Similar cost savings are expected for Site-wide characterization of groundwater background.

Cost benefits also are likely to result from the improved ability to evaluate the significance of contamination at any WMU. Allocation of resources for environmental restoration will be more efficient, because the range of compositions that naturally exist in the background media will be known. Knowing the compositional range will minimize occasions where uncontaminated media are designated as being contaminated, resulting in subsequent, unnecessary remediation.

2.3 BACKGROUND CONCEPTUAL MODELS

Conceptual models are integral components of the recommended process for identifying the objectives and quality of data collection efforts (EPA 1987b). For the purpose of background characterization, the development of conceptual models is useful because the models provide the scientific and technical basis for what soil or groundwater background compositions represent, and what the compositional populations are or are expected to be. Conceptual models describe the media in the context of the environment in which the media was formed and presently exists. These models are based on information regarding composition, factors that affect composition, and the processes responsible for the lateral, vertical, and temporal variation in composition. In addition, factors that potentially can affect the composition of the media at any point throughout the sampling or analysis process are identified and used. The conceptual model is revised until an adequate description of the system is

obtained. The adequacy of the model is based on factual content and peer review. New data are obtained and evaluated to improve and refine the model and the description of the natural systems.

Conceptual models for the understanding of soil and groundwater background are based on geologic, hydrologic, and geochemical principles. Data types (parameters) include the following:

- Field information on the geologic relationships and history
- Structure
- Stratigraphy
- Physical properties such as grain size
- Hydrologic physical properties (e.g., flow direction, velocity, etc.)
- Lithologic and mineralogic composition, etc.
- Chemical compositional data (e.g., groundwater and soil leachate).

Verification of the models eventually requires a program of systematic sampling and analysis. These models also include the consideration of WMU operations and histories, and the relationships between the natural processes and the expected or observed range of background compositions.

Background conceptual models for the vadose zone sediments and groundwater in the unconfined aquifer at the Hanford Site are described in Sections 3.0, 4.0, Appendix A, and Appendix C.

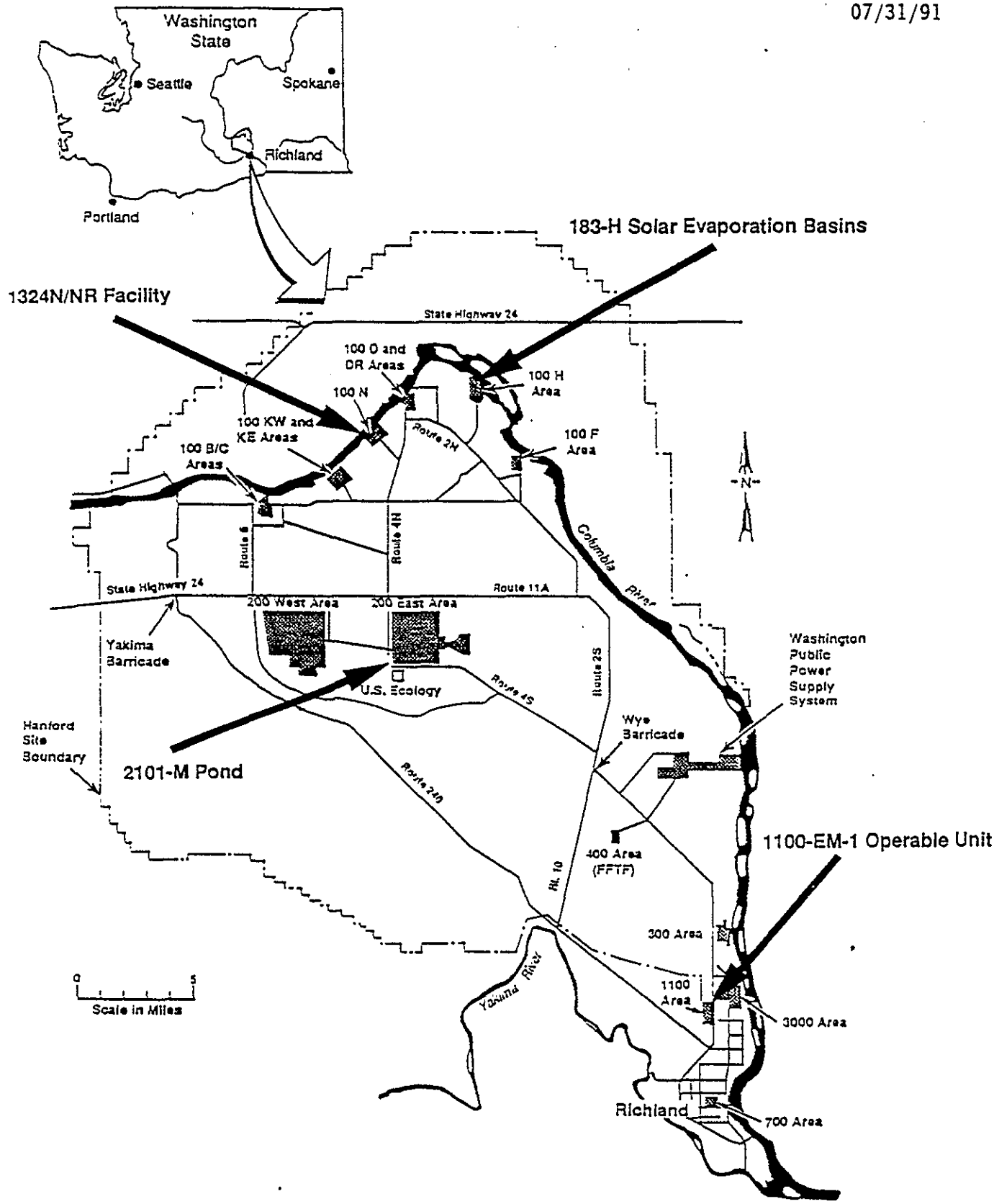

Figure 2-1. Hanford Site.

3.0 SOIL BACKGROUND

The feasibility of a Site-wide approach to characterizing background compositions for soil and sediment in the vadose zone depends on whether these materials can be regarded as having the same basic characteristics (EPA 1989c). The similarities in the basic characteristics of the soil and sediments in the vadose zone are not obvious from the physical appearance of these materials in the field (Appendix A, Figures A-4 to A-6). However, there is a sound geologic and geochemical basis for considering essentially all of the vadose zone together as a single compositional series.

The conceptual model of the vadose zone sediments described in the following sections and in Appendix A contains information on the geology and compositional makeup of the sediments. The purpose of this model is to provide insight regarding the relationships between the physical and compositional characteristics of the vadose zone materials and their compositions, as determined in accordance with regulatory protocols. This soil background conceptual model, therefore, provides a technical basis for characterizing and understanding the characteristics and scale of natural variability in soil background composition within the vadose zone on the Hanford Site.

It is emphasized that the term 'soil' is used in this document only in the regulatory sense and this usage denotes the sediments within the vadose zone, rather than that part of the earth's surface that support plants. Soils in this latter sense have specific properties due to the integrated effects of climate, living matter, parent material, etc. Generally, the uppermost sediments of the Hanford formation and eolian veneer have soil horizons less than a few inches thick (e.g., Appendix A, Figures A-4 to A-6). These soils are considered separately from the vadose zone sediments for the purposes of this report (Appendix A, Sections A5.0 and A6.0). The compositions of the vadose zone materials are dominated by the unaltered components in the sediment.

3.1 SOIL BACKGROUND CONCEPTUAL MODEL

The main element of the soil background conceptual model is that the composition of the vadose zone sediments are related. The relationships are based on the following.

- The finer grained materials in the sediments are composed primarily of varying proportions of two main components.
- Only the finer grained material in these sediments is used in the determination of soil composition, in accordance with regulatory protocols (e.g., EPA 1986).
- There are systematic relationships in the distribution of these two main components laterally and vertically because of the way in which the materials were formed and deposited.

- The compositions of the fine-grained fractions of soil and sediment in the vadose zone primarily reflect the differing proportions of the two main components.

- Compositional ranges attributable to such relationships can be considered as a single group or population of compositions because the range represents a continuous compositional series.

Similarities in the composition of the vadose soils and sediments are expected because of the origin of the sediments. The Hanford formation constitutes a majority of the vadose zone, and is composed primarily of gravel, sand, and silt. Historically, these sediments are related because the sediments have a common origin and were derived from largely common sources. These materials, therefore, have basic similarities in their physical and chemical makeup. The most important similarities are (1) the relationships in physical composition between the fine-grained fractions in the sediments and (2) the chemical relationships in the composition of these materials, as determined by regulatory protocol.

The range of soil compositions within the vadose zone is attributable to the presence of two principal end member components in various proportions. These are: a quartz-feldspar rich end member sediment component and a basalt-rich end member sediment component. The compositions of the sediments are mixtures of the two end members and, thus, have compositions intermediate between those of the two end member components in the following manner:

quartz and feldspar-rich	<---------->	basalt-rich
end member sediment composition	intermediate compositions	end member sediment composition

Both end member components in the sediments originally were deposited as a result of catastrophic floods involving hundreds of cubic miles of water during the most recent Ice Age. The distribution of these materials was controlled by differences in the velocity and energy of the flood waters as the waters flowed through the Pasco Basin. Systematic variations in the velocity and energy of flood waters occurred laterally from the lower energy condition in the bars and banks to the higher energy conditions in the flood channels. The depositional processes associated with these floods resulted in systematic lateral variations in the proportions of the two end member sediment components deposited from individual floods. The flow velocity and energy of the flood waters changed constantly and rapidly throughout the duration of individual floods, and also as the channels shifted from flood to flood. These changes in energy conditions caused differing proportions of the end member sediment to be deposited as the sedimentary sequences accumulated vertically over time.

The scale of compositional variability also is constrained by the origin of the sediments. Vertical variations in composition occur on the scale of the layering (fractions of an inch to tens of feet), and extend throughout the thickness of the vadose zone. The scale of variability laterally corresponds to the cross-sectional dimension of flood waters channeled through this part

of the Pasco Basin. This dimension is about the same as the east-west dimension of the Hanford Site. The scale of longitudinal variability has the dimensions of the entire Pasco Basin. However, the composition of flood deposits south of the Hanford Site also has components originating from the Snake River and Yakima River drainage systems. The potential effects of these factors are not known, however, the efforts do not affect the soil background model for the Hanford Site.

The recent windblown sediments, e.g., sand dunes, that locally veneer the Hanford Site also are expected to be compositionally related to the Hanford formation sediments. These materials are related because the windblown deposits are derived from the flood deposits within the Pasco Basin and adjacent areas by winnowing out the fine-grained material from the flood deposits, and physically fractionating the material by size and density into compositional subsets of the source material. These compositional subsets are composed largely of the same end member sediment components as the flood deposits, but in differing proportions because of the sorting effects of the wind.

This perspective regarding the origin and makeup of the sediments in the vadose zone of the Hanford Site provides a technical basis for regarding the vadose zone as having the same basic characteristics. The soil background conceptual model also identifies the relationship between the physical nature and chemical composition of these sediments. These data also provide a basis for understanding the extent of natural compositional variability in the vadose zone soil and sediments, and the scale on which the variability occurs laterally and vertically. This information, therefore, serves as the technical basis for obtaining a representative characterization of the natural range of soil and sediments in the vadose zone, and in justifying the Site-wide approach to characterization. A more detailed description of the vadose zone model is provided in Appendix A. Analytical factors that influence soil composition, such as the proportions, size, surface area, and solubilities of the constituents in soil samples also are addressed in Appendix A.

3.2 EVALUATION AND STATISTICAL METHODS

The primary way in which soil background compositional data are used in environmental activities is in establishing appropriate baseline concentration levels, which then are used to identify contamination and to assess the risk to human health and the environment. Various statistical techniques and methods can be employed in defining contamination. One of the most common methods employed is to establish a concentration level that is used as the criterion by which samples are considered to be within the natural range of the background levels or are considered to exceed these levels. This background level is referred to as the background threshold (Ecology 1991b). Statistical techniques and methods are used to establish the degree of confidence to be applied to threshold levels. Therefore, the credibility and efficiency of all environmental activities that are based on defining contamination in this way depend on the validity and quality (e.g., representativeness) of the background data.

Corroboration of the feasibility of this concept, however, requires the evaluation of data in the context of the Site-wide approach. The key test is whether the compositions of soil background samples from the vadose zone can be shown to be related in the manner described in Section 3.1. The results of preliminary evaluations on soil background data to test this model are presented in the following section. The statistical and nonstatistical methods employed in the evaluation are discussed in Appendix B.

3.3 SITE-WIDE SOIL BACKGROUND EVALUATIONS: PRELIMINARY RESULTS

One of the main concerns in background characterization efforts is the existence of natural background. A preliminary evaluation of soil background compositional data has been made to determine if contamination of the ground surface is pervasive over the Hanford Site. The soil compositions from samples collected from the surface and from boreholes up to 50 feet deep at background localities in the vicinity of several WMUs were used in the evaluation. The compositions of the samples from all but the upper parts of the boreholes were compared to those at the surface and upper parts of the boreholes. The compositions of the soil samples from the lower parts of the boreholes were regarded as representative of natural background, based on the consideration of potential contaminant source terms, pathways, and mass balance. No preferential patterns of contamination with respect to inorganic constituents were found at or near the surface of the background boreholes at these WMUs. In addition, the surface samples from other WMUs do not appear to indicate any pattern of preferential surface contamination for inorganic constituents. These data indicate that a Site-wide soil background for the vadose zone is possible.

A second consideration regarding the feasibility of the Site-wide approach for soil background is that the soil and sediment in the vadose zone can be regarded as a compositional series in the manner described in Section 3.1. Soil background concentrations from 59 samples at 8 locations in the vicinity of 4 WMUs within the 1100, 100, and 200-E Areas were used in these evaluations (Section 2.0, Figure 2-1). These samples were collected in conjunction with RCRA and CERCLA characterization efforts associated with two surface impoundments--the 2101-M Pond and 1324N/NR Facility; one storage and treatment facility--183-H Solar Evaporation Basins; and one operable unit--1100-EM-1. Data from these samples are the only analyses of soil samples taken for background purposes that have been collected and analyzed according to EPA protocols (e.g., EPA 1986). Although there are some concerns regarding the quality level of these data, these levels are suitable for evaluating the concept of a Site-wide background and establishing preliminary threshold concentrations.

All the samples analyzed to date can be shown to belong to single compositional populations. Cumulative distribution plots for several of the analytes are shown in Appendix B (Figures B-9 and B-10), which illustrate the continuity of the combined data as single populations. It is indicated from these data that the Site-wide approach for soil characterization is feasible.

A tabulation of the provisional soil background threshold values derived from these analyses is provided in Table 3-1. The statistical methods used in the analyses are discussed in Appendix B. Methods for distinguishing differences between anomalously high concentrations that naturally occur in soils and groundwater and contamination also are described in Appendix B, Section B1.2.

Table 3-1. Provisional Hanford Site Soil Background Threshold Values.

Constituent[1]	Concentration threshold[2] (95/95) ppm	Correlation coefficient[3] (r)	Maximum value (nugget effect[4]) ppm	Number of samples[5]
Aluminum	16,573	.994		59
Arsenic	4	.980	8.1	59
Barium	169	.990	229	59
Beryllium	2	.959		43
Cadmium	8	.985		59
Calcium	11,210	.990	14,000	59
Chromium	20	.985	48.3	59
Cobalt	16	.975		43
Copper	21	.959		44
Iron	29,781	.995		59
Potassium	2,740	.990		59
Magnesium	6,480	.990	6,910	59
Manganese	424	.975	533	59
Nickel	18	.985	25.3	59
Lead	10	.992	12.7	52
Strontium	43	.995		38
Vanadium	82	.985		59
Zinc	50	.998	112	59
Ammonium	3	.980		23
Chloride	38	.983		59
Nitrate	<detection limit	--		59
Sulfate	40	.990		38
Fluoride	5	.975		29

[1] Analytes for RCRA analysis per SW-846 6010 plus selected anions.
[2] *Model Toxics Control Act Cleanup Regulations.*
[3] Based on use of the Weibull distribution (Nelson 1982).
[4] Appendix B.
[5] Number of samples differs because of quality control considerations or because some constituents were not analyzed in all data sets.

4.0 GROUNDWATER BACKGROUND

The determination of representative groundwater background provides a basis for defining contamination and cleanup levels in groundwater in the same manner as outlined for soil in Section 3.0. The use of a Site-wide groundwater background in a similar manner as soil background involves determination of representative background on the scale of the medium that has the same basic characteristics (EPA 1989c). For groundwater, this medium is the single unconfined aquifer beneath the Hanford Site. The use of a Site-wide groundwater background in groundwater restoration efforts requires an understanding of the natural variability in composition within the unconfined aquifer rather than on the scale of individual WMUs. The merit of this approach in environmental restoration and closure activities is addressed in this section.

The Site-wide groundwater background approach is recommended because groundwater contamination attributable to individual WMUs typically impacts the aquifer beyond the dimensions of the WMU either laterally or vertically. Thus, for efficient groundwater restoration, remediation, and closure, problems should be addressed on the scale of the aquifer, especially characterization of the natural range of background compositions. Local groundwater background is important and is required for recognizing contamination from individual WMUs. There is no benefit, and great cost, in attempting to remediate parts of the unconfined aquifer beneath the Hanford Site to levels that are within the range of compositions that exist naturally elsewhere in the aquifer and to levels that pose no risk to human health or the environment. Moreover, the relative importance of efforts to distinguish small amounts of contamination below the natural background thresholds for the aquifer serves no purpose in the restoration and closure activities unless the natural background levels themselves pose a risk (EPA 1989c). Groundwater background threshold levels for the Hanford Site are a more appropriate and representative basis for use in groundwater remediation activities.

Determination of Site-wide groundwater background threshold levels requires representative characterization of the range of compositions that occur naturally throughout the unconfined aquifer. However, this type of characterization has not been undertaken previously despite the numerous wells drilled and the many Site-wide studies. Most groundwater characterization and monitoring efforts to date have been conducted to assess the effects of past waste-disposal systems (DOE 1988, pp. 3.9-114) rather than for the purpose of determining the natural range of background compositions for the aquifer. As a result, interpretations regarding Site-wide groundwater background from the groundwater monitoring activities alone must be viewed with caution because the objectives of those activities differed from those required for the determination of the range of natural background compositions.

The main difference is in the type, location, and depth of samples, i.e., representativeness of the data and the basis (e.g., conceptual model) used for interpretation of the data. The basic elements of the groundwater background conceptual model are described in the following section. A more detailed discussion of compositional parameters and their relationship to the

determination of a Site-wide groundwater background are presented in Appendix C. A detailed discussion of evaluation considerations and statistical methods is provided in Appendix C, Section C3.0.

4.1 GROUNDWATER BACKGROUND CONCEPTUAL MODEL

The following are the basic concepts in the groundwater background conceptual model.

- Natural variations exist in the composition of groundwater within the unconfined aquifer beneath the Hanford Site.
- The compositional variability is due to systematic natural processes that control the distribution and range of compositions.
- The natural variability in groundwater composition occurs on the scale of the aquifer both laterally and vertically.

The natural variation in lateral and vertical composition in the aquifer exists because of the influences of recharge, communication with the underlying confined aquifers, and water-rock-air interactions. The trend is for groundwater to become 'harder' as the concentrations of dissolved solids increase by interaction with the aquifer. These reactions do not occur instantaneously, but rather progress with time. The reactions generally approach equilibrium or metastable equilibrium conditions, which effectively buffer the upper concentration limits of groundwater composition for most reaction paths. Thus, there are finite upper concentration limits for most constituents that are controlled by these reactions. The nature of these reactions and processes, as well as the influences of artificial recharge and interaquifer communication, are discussed in detail in Appendix C.

For the purpose of environmental restoration, the upper concentrations within the natural range of groundwater compositions are more important than information concerning the details of how these levels were approached by various reaction paths and influences. It is expected that the highest concentration levels for many constituents are controlled by aquifer-specific reactions between water and the rock-mineral components. Equilibrium controls on 'maximum' concentrations, for example, cause the concentrations to converge toward largely constant levels (Appendix C, Figures C-6 and C-7). In general, groundwater compositions closest to recharge areas have low dissolved solids concentrations, and groundwater with the longest residence time in the aquifer has the highest concentrations of total dissolved solids. The latter is generally the groundwater farthest downgradient from the recharge zones and/or those associated with the parts of the aquifer having low-hydraulic conductivities. These relationships are complicated by the influences of groundwater in the underlying confined aquifer, artificial recharge, and oxidation-reduction, which are addressed in Appendix C.

There could be some concern regarding the potential for small amounts of contamination within the natural range of compositions in the aquifer to compromise the quality of soft water segments of the aquifer, even if there is

no increased risk to human health or the environment. If such levels of contamination can be distinguished from background, the main effect would be for that part of the groundwater system to approach equilibrium by another path, and not to increase reaction path equilibrium levels. In dynamic flow systems, such perturbations also are readily restored to the levels that normally exist (i.e., soft water conditions) for that part of the system. The potential for impacting naturally soft water within the aquifer also is small because the water compositions in the unconfined aquifer already are moderately 'hard' by the time the compositions reach areas impacted by Hanford Site operations, as noted in Appendix C, Section C4.0. There is a significantly greater probability that the naturally hard water in the aquifer has been made artificially softer by the effects of artificial recharge. As noted previously, use of a Site-wide background is intended as the most appropriate criterion for distinguishing contamination that can be practically considered for corrective action, rather than as a level of allowable contamination from current or future operations.

4.2 HANFORD SITE GROUNDWATER BACKGROUND EVALUATIONS: PRELIMINARY RESULTS

The amount of groundwater data that can be used in evaluating the natural range of compositions within the aquifer is under investigation. Groundwater from the unconfined aquifer has been extensively studied by Pacific Northwest Laboratory (DOE-RL 1989) to monitor contaminant movement associated with waste management activities at the Hanford Site (e.g., Raymond et al. 1976; Myers et al. 1976, 1977; Myers 1978; Eddy et al. 1983; Prater et al. 1984, Cline et al. 1985, and Evans et al. 1989). The extent to which these data can be used in the evaluation of natural groundwater background compositions is also under investigation. However, some evaluations have been performed with the data presently available. Qualitative and quantitative evaluations and models of the reactions that take place between groundwater and the dominant solid phases in the unconfined aquifer, and between groundwater and air, have been performed. The results of these evaluations corroborate both the role of air in controlling reactions in the uppermost part of the aquifer and the convergence of unconfined aquifer compositions with those of the confined aquifer groundwater composition (e.g., DOE 1988, pp. 3.9-137 to 143). However, a complete evaluation of the geochemical evolution of the shallow Hanford Site groundwater using a reaction path approach has yet to be performed.

The upper concentration limits within the range of natural groundwater background are of greatest interest for environmental activities, because the limits approach the maximum concentrations that can exist naturally in the aquifer for many components. The groundwaters in the unconfined aquifer with the largest concentrations of dissolved solids have compositions that converge with those in the underlying confined aquifer. This is an expected trend because the basaltic components tend to control the upper concentration levels of the most chemically evolved groundwater for many of the dissolved solids. The compositions of groundwaters from those parts of the unconfined aquifer may, therefore, be appropriate for use as groundwater threshold levels for many constituents. However, the use of these compositional data in establishing a Hanford Site background likely would require corroboration of

reaction path relationships, and additional sampling designed for the measurement of the highest concentration levels in the aquifer. Additional information is provided in Appendix C.

5.0 CONCLUSIONS

The concept of a Site-wide approach to the characterization of soil and groundwater for use in environmental restoration activities at the Hanford Site has a sound scientific and technical basis. The use of a Site-wide approach to the characterization of background is preferred over the present WMU-based approach because the approach provides more accurate and representative information on the natural range of soil and groundwater compositions. The Site-wide approach is regarded as more appropriate for the purpose of environmental restoration activities because: (1) environmental restoration activities are evaluated and performed on the scale of the operational impact to the soil and groundwater, (2) this scale of restoration generally extends beyond the dimensions of individual WMUs, (3) all WMUs share a common vadose zone sequence and groundwater in a single unconfined aquifer, and (4) it is impractical and inefficient to define background differently from one place to another for a common medium.

Preliminary evaluations of available data on soil and groundwater indicate that the Site-wide approach to the characterization of soil and groundwater background is feasible because of the following.

- The compositions of most vadose zone sediments can be considered together as a single compositional series.

- The natural range of variation in the composition of groundwater in the unconfined aquifer and of the sediment in the vadose zone exists on the scale of the entire Hanford Site.

The Site-wide approach to background characterization also is desirable because the approach provides a more consistent and credible basis for evaluating contamination, and is a more efficient method of characterization for the purpose of environmental restoration. The advantages of using a Site-wide approach to the characterization of background include the following:

- Improved efficiency in characterization activities

- Greater consistency in data evaluation and decisions involving environmental restoration

- Improved ability to verify results

- More cost-effective remediation and restoration programs for ensuring protection of human health and the environment.

The Site-wide approach to the characterization and use of soil and groundwater background at the Hanford Site is viable and feasible, and is a technically preferable alternative to the WMU-based approach of background characterization for environmental restoration purposes.

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APPENDICES

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APPENDIX A

VADOSE ZONE BACKGROUND CONCEPTUAL MODEL

APPENDIX A

VADOSE ZONE BACKGROUND CONCEPTUAL MODEL

A1.0 INTRODUCTION

Recent efforts to provide an improved technical basis for characterizing and understanding soil and/or sediment background at the Hanford Site have resulted in the development of a Hanford Site model for the compositional makeup of the vadose zone and controls on compositional variation. This model has been developed by Hanford Site geoscientists, who individually have studied the geology of the Hanford Site and vicinity for as along as 30 years. The development of this model is based on the geological and geochemical characteristics of the vadose zone sediments and experience of the scientific staff.

It is emphasized that the regulatory use of the terms soil and sediment is different from the geologic or soils science usage. The regulatory usage of the term 'soil' refers to essentially any material other than water or air (e.g., Ecology 1991b), and the term 'sediment' is reserved for the material at the bottom of an open body of water, such as a pond or an estuary. Thus, use of the term 'soil' in this report refers to both the unconsolidated rock material (sediments), and materials that support the growth of land plants and biologic activity (soils), except where a distinction is made. It is noted, however, that the vadose zone on the Hanford Site consists primarily of sediments in the geologic sense and should not be confused with soil as used in a soils science context. Soil as a medium for the growth of land plants is largely restricted to the upper few inches of the vadose zone over most of the Hanford Site. This material is considered together with other subordinate components of the vadose zone in Section 3.0.

The conceptual model for soil background is based on the common and relatively unique origin of the majority of the vadose zone sediments on the Hanford Site. This common origin has resulted in specific similarities in the physical and chemical makeup of sediments across the Hanford site. The basis of the model is the following.

- Only the fine-grained fractions of the vadose zone material are analyzed in the determination of soil composition.

- There are fundamental and predictable genetic and compositional relationships among the compositions of the fine-grained fractions comprising the sediments.

- Most of the vadose zone veneer is derived from the fine-grained fraction of these sediments.

The following sections provide a general overview of the Hanford Site geology and geochemistry and identify those specific concepts that have been incorporated into the vadose zone background conceptual model.

A2.0 HANFORD SITE VADOSE ZONE

The vadose zone of the Hanford Site (i.e., that portion of the sedimentary sequence above the regional water table) is the uppermost part of the sedimentary sequence shown in Figure A-1. This sequence consists primarily of mixtures of gravel, sand, and silt that range in thickness from zero to 800 feet, which accumulated in the Pasco Basin of south central Washington over the past 5 million years (DOE 1988). These sediments overlie the 17 to 6 million year old lavas of the Columbia River Basalt Group (McKee et al. 1977, pp. 464-464; Tolan et al., 1989), which are up to 3 miles thick (Orange and Berkman 1985; DOE 1988; Tolan et al. 1989). The suprabasalt sedimentary sequence consist of two main units, the Ringold Formation and the Hanford formation (Brown 1959, p. 6; Routson and Fecht 1979, p. 10; Tallman et al. 1981, pp 1-2; Bjornstad 1984, 1985; DOE 1988, pp. 1.2-115). The basal Ringold Formation consists of moderately consolidated fluvial-lacustrine sediments, and is the principle member for the unconfined aquifers at the Hanford Site. This unit is overlain by younger proglacial flood deposits of the Hanford formation, which constitutes a majority of the volume of the vadose zone. The Hanford formation is locally overlain by eolian dune, loess deposits, and alluvial deposits largely derived from the reworking of the Hanford formation, which blankets much of the east-central Pasco Basin (DOE 1988).

The Hanford formation is locally interbedded with fluvial deposits from the Columbia, Snake, and Yakima Rivers, and alluvial fan deposits flanking the Pasco Basin highlands. Other subordinate components of the vadose zone include volcanic ash, caliche horizons, clastic dikes, and thin root zone horizons in the uppermost soil. Each of these components is discussed in the following sections.

A3.0 HANFORD FORMATION

The most important unit for characterizing background in the vadose zone is the Hanford formation because it constitutes a majority of the Hanford Site vadose zone and is the dominant source of the eolian deposits. The Hanford formation is a sequence of unconsolidated Pleistocene flood deposits that comprise the upper 50 to 300 feet of the vadose zone throughout most of the Hanford Site. These sediments occur at or near the surface, and extend downward to the regional water table except in places where the Ringold Formation is above the water table. Although there is no formalized stratigraphy for the Hanford formation, a preliminary working model developed by the operating contractor staff has proven to be useful in the development of the conceptual model. In general, four subdivisions tentatively have been recognized based on the isotopic age dating (Mullineaux 1986; Srana-Wojcicki et al, 1987 and on the basis of paleomagnetics (unpublished data).

A3.1 ORIGIN

The Hanford formation is a relatively unique sequence of sediments. Its unusual origin is associated with the cataclysmic flooding that occurred between about 6,000 to 1 million years before present (Millineaux et al. 1978; Waitt 1980). These floods were the result of the periodic failure and breaching of ice dams associated with marginal lakes of the continental ice sheet (Bretz 1928, 1969; Atwater 1984; Waitt 1984, 1985). One such ice dam was ancient Lake Missoula, which was located in the vicinity of the Idaho Panhandle northeast of Spokane, Washington (Figure A-2). The breaching of these ice dams allowed the rapid discharge of vast quantities of water that spread across eastern Washington and down the Columbia River to the Pacific Ocean. These cataclysmic floods shaped the landscape of eastern Washington into a rare geographic province known as the channeled scablands (Figure A-2). The material mobilized and eroded by the flood waters subsequently settled out of the flood waters to form the upper sedimentary sequence that blankets much of the Columbia Plateau (e.g., Easterbrook 1979; Waitt 1984, 1985, 1987). Most of what is now the Hanford Site was the site of primary flood channels (Brown 1959; Tallman et al. 1979, pp. 39-49; Routson and Fecht 1979, pp. 20-21; Bjornstad 1984, 1984) (Figure A-3). Those sediments deposited in the Pasco Basin are referred to as the Hanford formation.

A3.2 PHYSICAL CHARACTER AND SPATIAL DISTRIBUTION OF SEDIMENTS

The Hanford formation consists of a sequence of unconsolidated sedimentary deposits ranging in size from boulder gravels to silt and clay (Figures A-4 and A-5). The proportions of these two components vary vertically and laterally throughout the formation, and primarily reflect the local energy regimes of the flood waters at various places and times within the episodes of cataclysmic flooding (Tallman et al. 1979, pp. 39-49; Routson and Fecht 1979, pp. 20-21; Bjornstad 1984, 1984; Waitt 1987). The finer grained sediments were deposited under conditions of slow-moving or slack water during periods of waning floods, at channel margins, and in the distal areas of flooding (Figure A-4). The coarser, denser, and hydraulically less-mobile gravel and basaltic sand were deposited primarily under conditions of faster flow within the primary flood channels and in the early stages of flooding (Figure A-5). Most places within the path of these floods experienced a range of flow conditions that changed rapidly with time, especially areas within the main flood channels. Because much of the Hanford Site is located in those primary flood channels, a succession of alternating and discontinuous layers of very high-energy, coarse-grained gravel deposits to low-energy silt deposits make up the Hanford formation. These relationships are responsible for the lateral and vertical distribution of the fine- and coarse-grained varieties of sediments throughout the Hanford Site (Figures A-4a and A-5b).

A3.3 COMPOSITIONAL IMPLICATIONS

Although the silt, sand, and gravel deposits in the Hanford formation have a common origin, the deposits appear strikingly different in outcrop

(Figures A-4 and A-5). The finer grained components in all these sediments are composed of differing proportions of quartz and feldspar rich sediment and basaltic-rich sediment. The quartz-feldspar rich silt and sand is the dominant fine-grained constituent of the slack water deposits, and the basaltic sand is the dominant fine- to medium-grained component in the higher energy sediments. Thus, the primary difference in physical composition between the smaller particles in the coarse- and fine-grained sediment fractions is in the proportions of basaltic sand and quartz-feldspar-rich sediment. It is evident from field investigations that there is a nearly complete gradation from pure quartz-feldspar to pure basaltic sand in the finer grained components within these flood deposits. Thus, the bulk compositions of the finer grained fraction of these sediments are expected to have compositions that reflect the variable proportions of these constituents. These factors dominate the leachate composition of the soils, as discussed in Appendix C. The compositions of these soils should, therefore, be representable by a mixing line or a curve between quartz-feldspar and basaltic component compositions. The compositions of these samples, should, therefore, constitute a single statistical distribution for each analyte.

A4.0 EOLIAN DEPOSITS

The younger eolian deposits that locally veneer the Hanford formation are windblown deposits derived largely from erosion and winnowing of the unconsolidated Hanford formation (DOE 1988). These deposits are manifest as dunes (Figure A-6a) and/or a sediment veneer (loess) (Figure A-6b) deposited mainly by west-southwesterly winds. The composition of these sediments represent physically fractionated subsets of the Hanford formation. The typically light colored loess and dunes that are dominant on the southern part of the Hanford Site are composed primarily of the remobilized quartz-feldspar rich sand and silt from the slack-water type material. Conversely, the darker colored loess and dunes, which occur on the northern part of the Hanford Site, have a larger component of basaltic sand material. Some of these eolian sediments are the products of two or more episodes of remobilization and eolian fractionation from the Hanford formation and its counterparts in adjacent areas. Consequently, the composition of the eolian cover on the Hanford Site should be chemically indistinguishable from the composition of the Hanford formation.

A5.0 WEATHERING

Both physical and chemical weathering contribute to the breakdown of the sediments in the vadose zone. The importance of chemical weathering in the characterization of soil background depends on the extent to which the composition of the material in the vadose zone is influenced by this process (Leopold et al. 1964, pp. 40-46). Chemical weathering primarily involves reactions between water, air, and rock material. These reactions include hydrolysis, oxidation, and/or the precipitation of calcium carbonate and salts

(Fairbridge 1972). The effects of chemical weathering on soil composition are most important only under certain conditions such as in wet climates or in rocks or soils that have reacted with water for sufficiently long periods. Weathering and soil formation in semiarid zones, however, is generally more mechanical than chemical or organic (Fairbridge 1972).

The Hanford Site is a semiarid region that receives about 6 to 8 inches (15.2 to 20.3 centimeters) of rainfall annually, most of which returns to the atmosphere by evapotranspiration. Soil moisture profiles (Last et al. 1976; Jones 1978) show that soil moisture generally is less than about 5 percent throughout most of the vadose zone, and that moisture is significantly less in the upper 10 to 20 feet (3.05 to 6.1 meters) during the summer months. Consequently, there is only a sparse development of soils over most of the Hanford Site and these soils support plant growth (DOE 1988) that is largely restricted to the upper few inches of the vadose zone.

The influences of chemical weathering and attendant organic processes on the chemistry of the semiarid soils in the Pasco Basin are expected to be minor and subordinate to physical weathering and fractionation processes. These relationships are reflected by the relatively unaltered nature of the mineral constituents in the sediments of the vadose zone, and the sparse development of soils that support plant growth. It also is notable that even where these are developed, primary soils in semiarid regions tend to reflect the composition of the underlying material without much change by leaching or chemical alteration (Fairbridge 1972, p. 548).

The chemistry of most vadose zone sediments is, therefore, expected to be controlled by the distribution and modal proportions of minerals and rock materials in the sediments. This control results from the primary depositional mechanisms and secondary eolian processes. The main exceptions are the subordinate materials in the vadose zone as identified in Section A6.0.

A6.0 SUBORDINATE MEMBERS

The composition of volumetrically subordinate members within the vadose zone includes the recent Columbia River fluvial deposits, volcanic ashes, clastic dikes, soils supporting plant and biologic activity, as well as caliche and salt deposits (e.g., Rickard 1964; DOE 1988). These materials have compositions that differ from those of the majority of sediments in the vadose zone. Thus, one or more of these members could inadvertently be included in a vadose zone soil background and/or WMU sample. Such samples might appear as compositional and statistical outliers. By recognizing that minor, though possibly distinct members exist, the technical basis for evaluating outlier data is improved.

The compositions of most of these members are reasonably well constrained. Caliche, for example, is primarily $CaCO_3$ with small amounts of Sr in solid solution with the Ca. Volcanic ashes deposited during the eruptions of Cascade volcanoes are primarily dacitic to rhyolitic

compositions, and each of these have different trace element characteristics. In most cases, clastic dikes are fluidized fine- to medium-grained sediment from the Hanford formation. The influences of plants and other biologic activities also can cause the composition of some soils to differ from that of the parent sediments.

The composition of the recent Columbia River fluvial deposits may or may not be consistent with the population of Hanford Site soil background compositions. These sediments are not necessarily related to the Hanford formation sediments because they were deposited in a different manner and are younger. The sediments also may have been modified by the effects of weathering. It is possible, however, that these sediments could be indistinguishable from the array of Hanford Site soils.

The precipitation of salts occurs under certain conditions that can, over long periods, produce an appreciable in situ salt content in the upper few feet of the vadose zone. There is one locality in Cold Creek Valley (Appendix C, Figure C-2) where alkali soils have developed naturally over the past 6,000 years in certain places in Cold Creek Valley (Appendix C, Figure F-2), and West Lake Basin. The soils in these localities preclude most vegetation with the exception of those plants that can tolerate high salt environments (Rickard 1964).

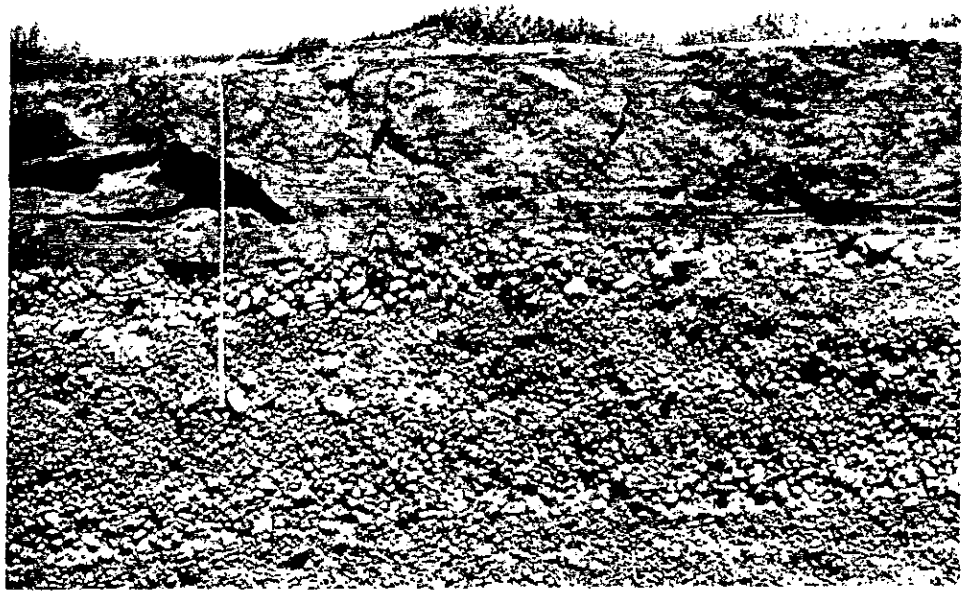
These various types of subordinate members of the vadose zone are included in the soil background model and data evaluation process for completeness, and also to provide a basis for identifying natural compositional outliers. All of these subordinate components are visually distinguishable from the Hanford formation, and thus can be avoided during field sampling, where appropriate, to reduce the impact of outlier data. Extreme compositions associated with these subordinate parts of the vadose zone are to be regarded as separate subsets of natural background, and considered separately from the primary vadose zone soil population.

A7.0 SUMMARY

The essential points of the vadose zone background conceptual model described are the following.

- The Hanford formation is a mixture of quartz-feldspar and basaltic silts and sands plus larger fractions of both types of materials.
- The proportion of quartz-feldspar sands and silts to basaltic sands is the primary factor governing the composition of an individual field sample.
- The occurrence of volumetrically minor components must be accounted for in the interpretation of statistical outliers.

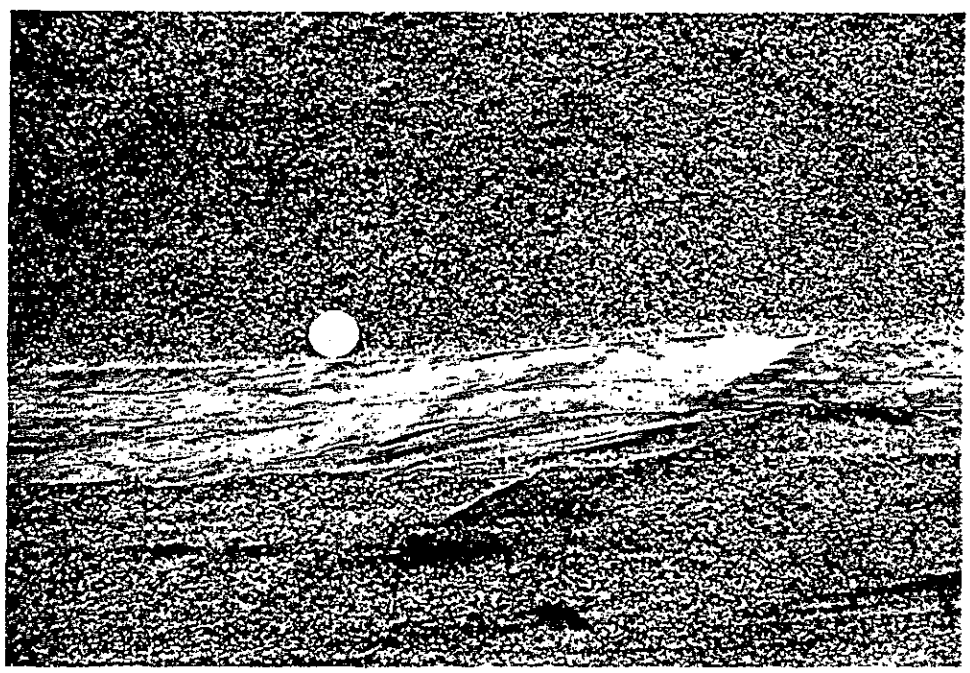
(a) Eolian dunes that veneer parts of the Hanford Site. Note that most of these sands are light-colored (rich in quartz and feldspar). Deflation has locally generated a thin veneer of darker basaltic sand.



(b) Loess deposits that locally veneer the Hanford Site, overlying coarse-grained sediments of the Hanford formation.

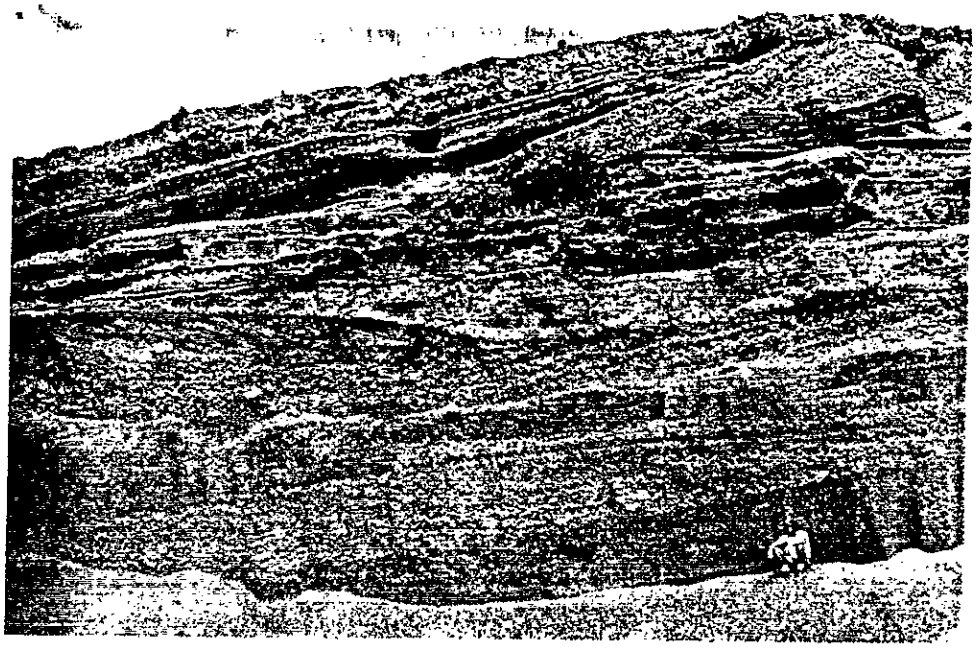
Figure A-6. Eolian Deposits on the Hanford Site.

(a) Size-graded sequence of gravels ranging from cobble to sand. Ruler is shown for scale.

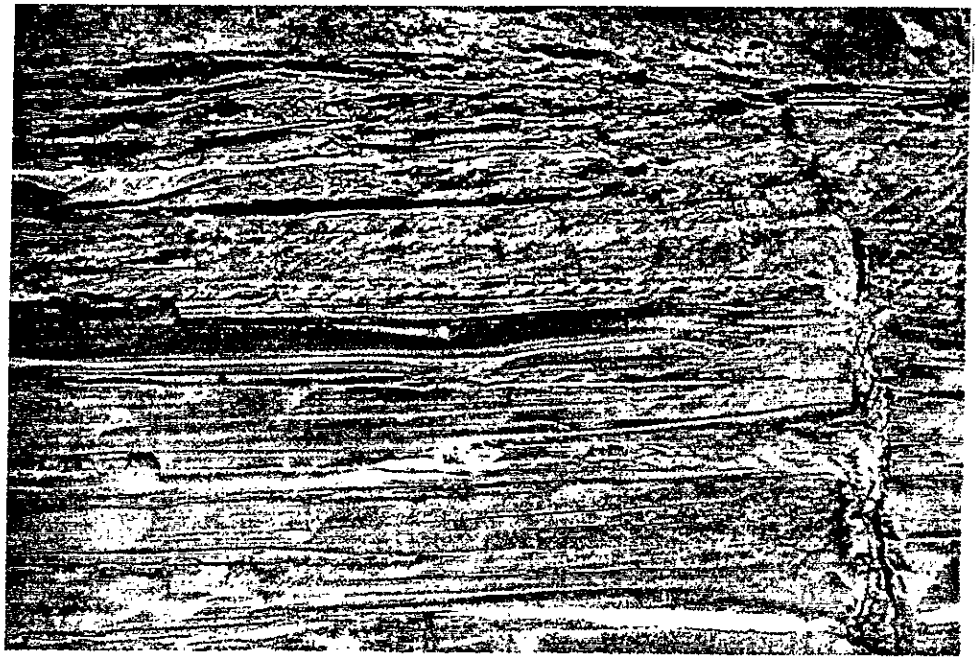


(b) Dark colored, medium-grained Hanford formation deposits rich in basaltic sand with an interbed of fine-grained slackwater sand rich in quartz and feldspar.

Figure A-5. Coarse-Grained Hanford formation Gravels in Outcrop.



(a) The sequence of Hanford formation sediments in this outcrop represent channel gravels deposited in one flood episode (lower gravel unit) overlain by finer grained sediments subsequently deposited from slower moving water. Also, note the intercalation of coarse- and fine-grained layers in the uppermost part of the outcrop, indicative of a rapidly changing depositional environment.



(b) A thick sequence of fine-grained Hanford formation exposed in the U.S. Ecology pit on the Hanford Site represents slackwater bar deposits that occur in the 200 Areas, formed from slowly moving flood waters. Also, note the vertical clastic dike cross-cutting the horizontally layered sediments.

Figure A-4. Fine-grained Sediments and Vertical Variability of the Hanford formation.

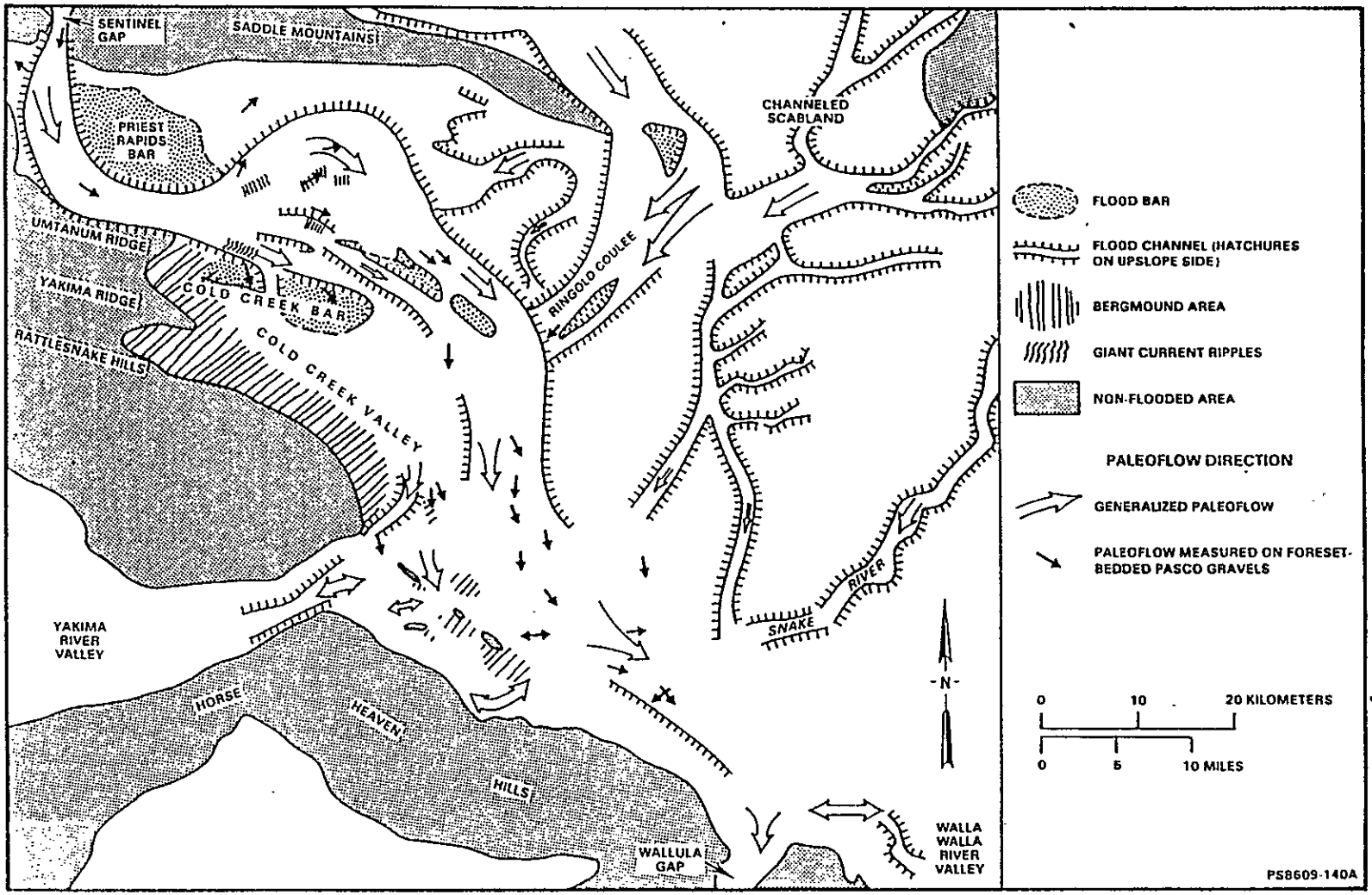


Figure A-3. Generalized Flow Paths of Cataclysmic Ice Age Floods.

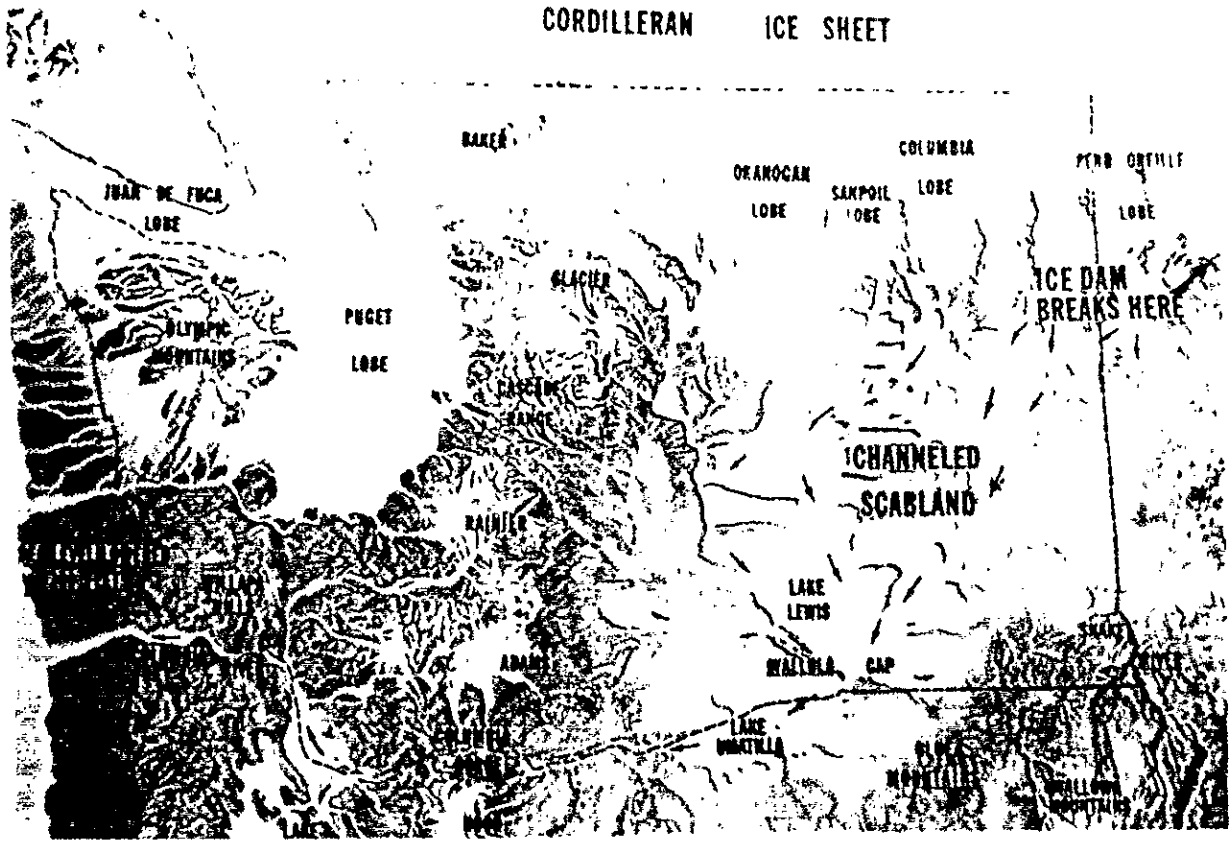


Figure A-2. Physiographic Map of the Washington Area Near the Close of the Ice Age (shows the extent of the Cordilleran Ice Sheet, the site of ice dam failure in Idaho, the general path of cataclysmic flooding and the channeled scablands province in central Washington).

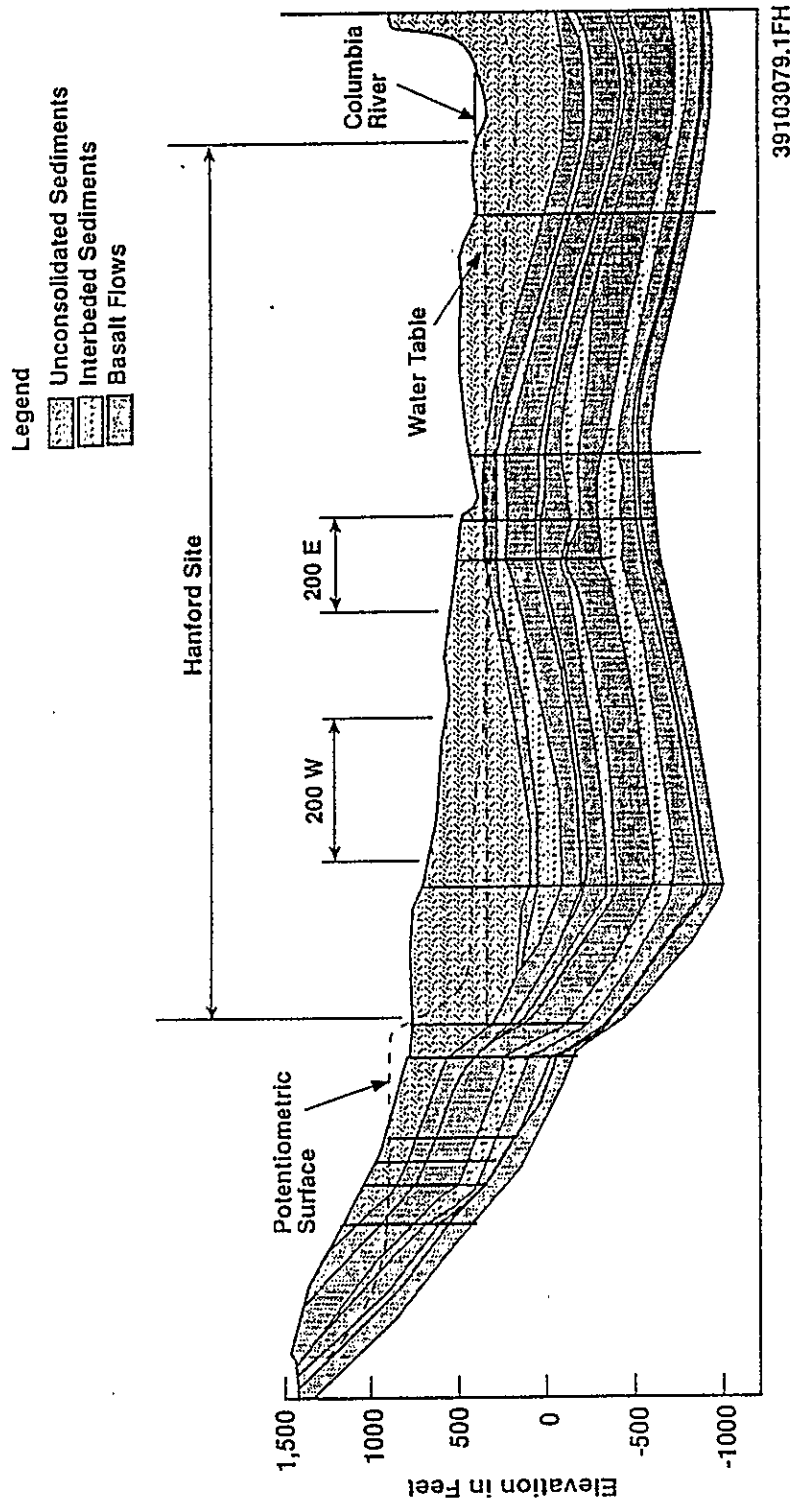


Figure A-1. Schematic Geologic Cross Section Across the Western Pasco Basin (shows the stratigraphic relationships between the Hanford formation, Ringold Formation, and Columbia River Basalts, and also shows the type and lateral extent of variation within the Hanford formation. Vertical exaggeration 52X).

APPENDIX B

EVALUATION AND STATISTICAL METHODS

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APPENDIX B

EVALUATION AND STATISTICAL METHODS

B1.0 INTRODUCTION

Statistical and non-statistical methods are used in evaluating the feasibility of the Site-wide background approach and in obtaining background concentration levels for use in identifying contamination and assessing risk. The evaluation of background data begins with the data collection efforts. The development of data quality objectives (DQOs) in these efforts are designed to ensure that the sample population is representative for the intended purposes. The DQOs also are designed to ensure that the appropriate statistical methods are used in the evaluation of the data (EPA 1987b). The conceptual models such as those developed here for soil and groundwater background also are integral components of the DQO development process, providing a basis for construction of sample populations and data interpretations in the data evaluation process (Figure B-1). Special knowledge or potentially mitigating factors that affect the interpretation of the data also must be included in the analysis process.

It is important that statistical methods not override scientific and technical criteria regarding systematic compositional relationships intrinsic to the medium or the compositional distribution, or which may be associated with the analytical processes themselves. The preferred approach for background characterization efforts is to use the conceptual models to guide the statistical interpretation of analytical results. One of the most important aspects of these models is the identification of factors that control the intrinsic and measured composition of soil and groundwater. These factors include the following:

- Mineral composition constraints on soil and groundwater composition
- The effects of the methods of chemical analysis on soil composition
- The implications of naturally buffered groundwater compositions
- The effects of natural difference in composition spatially
- Fractionation processes (e.g., sorption, natural sedimentary processes, and sampling).

Identification of these factors and an understanding of their effects on composition provide insight regarding the evaluation of the compositional data and statistical distributions. For example, the behavior of several of the natural processes identified previously are logarithmic or exponential in nature (e.g., fractionation). This type of insight is a fundamental element of the conceptual model for justifying expected correlations in the composition of materials related by their origin or other natural processes.

Yet, these factors generally are omitted from statistical evaluations in waste management activities.

The data evaluation process also requires decisions regarding the type of comparisons to be made, the type of statistics to be used, and how background threshold levels are to be determined. A background threshold level is an upper limit of the concentration range for the medium (e.g., soil, groundwater, etc.) below which concentrations are considered to be indistinguishable from those in the background population (Section 3.2). These are analogous, and in some cases, equivalent to tolerance interval levels. In general, the manner in which threshold levels are established depends on the statistical method used and the extent to which other pertinent criteria are considered in the evaluation process. The key aspects of the evaluation process for soil background data, in the context of the conceptual model, are summarized in the following sections.

B1.1 ANALYTICAL FACTORS IN SOIL COMPOSITION

The Hanford Site sediments have been analyzed by a variety of methods. The two most common types of chemical compositions are bulk compositions and leachate compositions. Bulk compositions refer to the total composition of a sample. Leachate compositions, which are prescribed by the regulatory agencies (e.g., EPA 1986; EPA 1989d), are partial compositions resulting from partial dissolution, usually in acid. Most data obtained on the chemical composition of geologic materials before or external to environmental compliance activities have been bulk compositions. Thus, there are less data on soil compositions that have been collected from the Hanford Site using the acid leaching methods. At present, there is no basis for correlating data from one method to another for purposes of comparison.

B1.1.1 Bulk Composition

The bulk composition of soil generally is measured by nondestructive methods such as x-ray fluorescence or by the complete dissolution of samples in acid, and analysis by emission and/or absorption spectroscopy methods. These analysis processes do not involve size or chemical fractionation samples.

The bulk compositions of soil end member components, such as those identified in Section 3.1, reflect the proportions and compositions of the constituent minerals and rock in the sample. The chemical compositions of the quartz-feldspar-rich and the basalt-rich end member components of the Hanford vadose zone sediments have not yet been sampled or analyzed. However, the bulk compositions of these materials can be approximated.

The quartz-feldspar-rich sediments are primarily mixtures of quartz, feldspar, and clay minerals having compositions dominated by Si, Al, Ca, and the alkalies Na, and K, with minor Fe, Mg, Mn, and related metals (e.g., Table B-1). Conversely, the basaltic sediments primarily are mixtures of basalt grains from the Columbia River Basalt Group of the Columbia Plateau and

should have compositions that closely mimic those of the parent basalts. These basalts are typically rich in iron with somewhat lower concentrations of Si, Al, and alkalies that are the quartz-feldspar components. The compositions of quartz, some end member feldspars, a typical clay, and a range for Columbia River Basalts are provided in Table B-1 for reference and comparison.

B1.1.2 Leachate Composition

Soil compositions determined in accordance with regulatory protocols (EPA 1986; EPA 1989d) represent the leachate composition of the fine-grained fractions of a sample only, rather than bulk compositions. The process of size fractionation and partial dissolution for determining composition is used as a conservative measure of the mobile constituent concentrations in solids for the purpose of environmental activities.

It is important to recognize, however, that the grain size of the sample strongly influences the composition of the leachate. The extent to which leaching and/or reaction occurs depends on the effective surface area available for reaction. Thus, samples with identical components and identical bulk compositions but different grain sizes can have different leachate compositions. These effects and those of the physical fractionation resulting from sampling and sample preparation are not accounted for by regulatory protocol, and can seriously bias the analytical results. The variability attributable to this effect is presently not considered in the regulatory process. This factor is identified in the soil background conceptual model, however, because it is expected to be a source of at least as much variability as the precision associated with sampling and analysis. Some regulations (e.g., Ecology 1991b) have begun to incorporate requirements for controlling the grain size of soil samples. However, there is presently no information of the effects of leachate composition on grain size and surface area within a controlled range of sizes. Efforts to quantify these effects are identified in Appendix D.

B1.2 NUGGET EFFECTS

Preliminary evaluation of soil background data indicates that the soil background conceptual model also must include a provision for natural concentrations that may appear as anomalous data. There are two main types of anomalous natural background. One type is from the subordinate materials in the vadose zone identified in Appendix A, Section A6.0, e.g., volcanic ash. The other is from samples that contain a small amount of a phase or a component having a large amount of an analyte that is otherwise regarded as a minor or trace constituent. The latter type is known in the mining industry as the nugget effect (Knudsen and Kim), and implies that although a nugget of a mineral or a metal may occur naturally, it only will be found in a small percentage of samples because the overall proportion of the nugget is small.

This effect is potentially important for constituents that are major components of minerals or amorphous material (basaltic glass), which is

modally subordinate in the soil. Examples are the sulfide minerals that can contain hundreds of thousands of parts per million of constituents such as Cu, Pb, Zn, Hg, Cd, together with sulfur. However, the modal abundance of such minerals in the soils or sediment is typically less than 1 percent. Yet, a single grain of such a mineral could cause the concentration of one or more of the elements listed above to be unusually high in a small percentage of the samples collected. Using a statistical approach alone, the small percentage of samples that contain relatively large concentrations of a constituent would be perceived as outliers and would not belong to the same population as the majority of samples.

Minerals or rock constituents that occur in the Pasco Basin sediments, and that could contribute to the nugget effect include sulfide minerals (Cu, Pb, Zn, Hg, Cd, etc.) and certain heavy minerals that commonly are deposited as placers (e.g., monazite, zircon, apatite, rutile, garnet, epidote, tourmaline). These placers commonly contain large amounts of such elements as uranium, thorium, and zirconium, which all have high charge to ionic radius ratios. Other potentially important contributors to the nugget effect include the basaltic material that constitute significant proportions of some vadose zone sediments. Some of the many basalt flows from which the basaltic components were derived contain as much as 3,000 to 4,000 parts per million of barium, and other flows contain 100 to 200 parts per million of chromium (DOE 1988). Fragments of these basalts can produce an occasional data point that appears erroneous, but is, in fact, part of the natural array of compositions. The nugget effect applies to these basalt components because only a few of the many basalt flows have such extreme compositions, and the probability of such basaltic components occurring in a soil in significant amounts is small, but finite.

The difference between anomalously high concentrations in soil samples and the nugget effect can be distinguished by several methods. The first method is to review the analysis for the presence of elements that could form a candidate nugget mineral (e.g., Cu in a copper sulfide). Correlations between elements within candidate nugget minerals provides a basis for discrimination. A second method is to reanalyze a split of the same sample, or a subsequently collected replicate, for which singularly high concentrations are observed, because this effect stems from a small amount of a specific mineral. In general, a low or less-than detection limit concentration will be found in the split if the apparent anomaly is attributable to the nugget effect. Alternatively, a duplication of high concentrations indicates that the sample from that location is distinctly different from the background population. The probability of encountering two consecutive nugget effect compositions for the same type of nugget (e.g., mineral) is the square of the probability of the initial hit. For the minerals under consideration, their frequency of occurrence is on the order of 1 percent or less. Therefore, the probability of two consecutive hits is on the order of 1 in 10,000 or less.

B1.3 CORRELATION EFFECTS

Variations in soil properties tend to be correlated over space--both vertically and horizontally (Klute 1986). That is, two values taken close together tend to be more alike than two values taken further apart. This correlation is a natural result of the depositional process and is the underlying reason why local area background soil samples may not adequately represent the natural range of compositions on the Hanford Site.

The correlation range is the distance over which the data are correlated. Two data values collected at points further apart than the correlation range are uncorrelated, and meet the usual tests for independence of samples. Accounting for the lack of independence within the correlation range can be performed by two methods. The first method is to apply the methods of geostatistics. This requires extensive sampling over a range of distances and can be expensive. The second method is to estimate the correlation range from available data and ensure that samples are taken at distances greater than the estimate. The latter method allows the data to be processed using the methods of classical statistics based on independence of samples. The soil background sampling effort will use the second method.

B1.4 DATA CONSTRAINTS

The compositions of media such as soil and groundwater are non-negative data. In theory, the minimum value for a particular element may equal zero. In practice, the minimum value will be the assigned detection limit of the method. Virtually all analytical laboratories report data as either a positive real number greater than the detection limit, or as an unspecified value less than the stated detection limit (e.g., <10 ppm).

Geochemical data also are bounded at the upper end by constraints on stoichiometric and phase relationships. Encountering data at the upper bound will in effect require a sample of a pure mineral or phase, or equilibrated groundwater. The upper bound for soils will not be encountered in practice and may be ignored, because the Hanford Site soils are mixtures of many minerals. However, the upper bounds for groundwater concentrations are expected to be encountered. The sampling and analysis methods for a Site-wide groundwater background must incorporate this expectation.

B2.0 STATISTICAL METHODS

Various types of statistical methods can be used in the handling of background data and in evaluating the feasibility of the Site-wide approach to background characterization. The use of statistical methods for both purposes requires decisions concerning the type of distribution (e.g., normal, lognormal, etc.) that best describes the data. The technical basis for the use of a Site-wide approach to background characterization does not depend on

the type of distribution used to represent the data. However, many aspects of the evaluation process either depend on the distribution type or are better performed with an appropriate representation of the data, i.e., choice of distribution type:

Three of the most common criteria for choosing an appropriate distribution are the following:

- Knowledge of how the data are generated
- Prior experience with the data
- Judgement of the analyst.

An example of the first criterion is the data generated by a summation of random variables that converges to the normal distribution as the number of variables increase. Lognormal data are generated by multiplication of random variables. Distributions determined to be appropriate for one data type also can provide a basis for handling similar types of data. The third criterion usually involves a trial-and-error approach to the selection of the distribution that best represents the data. The best representation of the data is the primary basis for deciding which distribution is used.

The EPA guidance (EPA 1989b) typically describes a simple decision process involving normal and lognormal distributions for the data. If neither distribution is determined to adequately represent the data, either a nonparametric approach is used, and/or advice from a professional statistician is recommended.

Once a statistical distribution is chosen various statistical methods can be used to evaluate the data provided that method serves the intended purpose (e.g., EPA 1986, 1989a, 1989b; 40 CFR 264). The use of background data involves the comparison of individual sample concentrations to a background threshold. The regulatory agencies typically require this type of comparison to ensure that contamination is not disguised as non-contamination by averaging. This type of comparison (EPA 1989b) defines an upper limit beyond which a sample will be suspected to be contaminated.

B2.1 FREQUENCY DISTRIBUTIONS

A frequency distribution describes how data are distributed over the domain of possible values. There are two types of distributions, a Probability Density Function (PDF) and a Cumulative Density Function (CDF). Both PDFs and CDFs either can be discrete or continuous functions. For the purposes of limiting this discussion to the most relevant topics, only the continuous functions will be considered (Knudsen and Kim 1978).

A PDF is defined by two requirements. The first requirement is that the probability of occurrence of any datum be non-negative over the domain of the

data. The second requirement is that the sum of all the probabilities over the domain equal one. Mathematically this is expressed as:

$$1)\quad f(x) \geq 0$$
$$2)\quad \int_{-\infty}^{+\infty} f(x)\,dx = 1 \qquad (1)$$

For those distributions with a limited domain (e.g., x > 0), then f(x) is defined equal to zero for all x outside that domain. A continuous PDF describes the probability that a particular datum lies between two specified values. For example, consider the uniform distribution on the interval 0 to 1. The probability of a datum occurring between .2 and .4 is:

$$f(x) = 1, \quad 0 \leq x \leq 1$$
$$p(.2 \leq x \leq .4) = \int_{x_1}^{x_2} f(x)\,dx = \int_{.2}^{.4} 1\,dx = x\Big|_{.2}^{.4} = .4 - .2 = .2 \qquad (2)$$

A cumulative distribution function describes the probability that a datum is less than x and is defined by four requirements:

- The CDF lies between 0 and 1 inclusive for all x
- The CDF is non-decreasing as x increases
- The CDF is the integral of the PDF from minus infinity to the value of x
- The minimum value is zero and the maximum value is 1.0.

Expressed mathematically, these requirements are:

$$1)\quad 0 \leq F(x) \leq 1 \quad \textit{for all } x$$
$$2)\quad \frac{dF(x)}{dx} \geq 0$$
$$3)\quad F(x_0) = \int_{-\infty}^{x_0} f(x)\,dx \qquad (3)$$
$$4)\quad F(-\infty) = 0, \quad \textit{and} \quad F(\infty) = 1$$

When x has a limited domain, then the CDF is defined as either 0 or 1 for all x outside the specified domain as per the fourth requirement. For the uniform distribution described previously, the probability of x less than x_o is:

$$F(x) = P(x \le x_0) = \int_0^{x_0} f(x)\,dx = \int_0^{x_0} 1\,dx = x\Big|_0^{x_0} = x_0 \qquad (4)$$

Distributions typically contain constants that are adjusted to fit the distribution to the data. These parameters are used to establish the location, scale and, when necessary, the shape of the distribution. The location parameter establishes where the distribution lies along the x axis. For the normal distribution, the mean is a location parameter. The scale parameter determines the spread or width of the distribution. Again, for a normal distribution, the standard deviation is a scale parameter. The shape parameter is used for asymmetrical distributions and describes how skewed the distribution is to one side or the other of center. Whether or not a particular parameter is used in a distribution depends primarily on the mathematical form of the equation and occasionally on the degree of accuracy required by the analyst.

B2.2 WEIBULL DISTRIBUTION

The Weibull distribution is identified here as an alternative for other types of distributions because the distribution either includes or approximates all other distribution types used in environmental activities. The advantages in the use of the Weibull distribution are that it provides a more efficient way of evaluating soil and groundwater data that is actually equivalent or superior to using, e.g., normal or lognormal distributions. The use of this distribution also simplifies the laborious trial-and-error method of determining whether the data are normally or lognormally distributed, or nonparametric, for each analyte in each sample, which is required for properly evaluating the data. It also reduces the use of arbitrary assumptions regarding the distribution type. Provisions for use of alternative statistical methods, where appropriate and justifiable, also exist in the regulatory guidelines (e.g., Ecology 1991b). The following is a description of the utility of the Weibull distribution in evaluating background data.

The Weibull distribution has found considerable utility in many industries concerned with reliability issues. This application marks the first known use for environmental work at the Hanford Site. Comparisons to the more common distributions are made so that the reader can see that the Weibull distribution is a more versatile tool for data analysis.

B2.2.1 Weibull Equations

The PDF for the 2-parameter Weibull distribution is given by Nelson (1982):

$$f(x) = \left(\frac{\beta}{\eta^{\beta}}\right)x^{\beta-1}\exp\left(-\left(\frac{x}{\eta}\right)^{\beta}\right), \quad x > 0$$

$$x = \textit{data value} \tag{5}$$

$$\eta = \textit{scale parameter}$$

$$\beta = \textit{shape parameter}$$

The CDF is formed by integrating equation (1) and results in a much simpler expression:

$$F(x) = 1 - \exp\left(-\left(\frac{x}{\eta}\right)^{\beta}\right), \quad x > 0 \tag{6}$$

The domain of x is all real numbers greater than zero. The range for both the PDF and CDF are 0 to 1 inclusive. Equation 2 describes a 2-parameter Weibull distribution, so called because two constants (eta, beta) are required to completely specify the distribution. The 2-parameter Weibull distribution can be extended easily to a 3-parameter Weibull distribution by subtracting a constant value from x. This subtraction process shifts the data, allowing a better representation of the structure of the data set. This gives a 3-parameter CDF of:

$$F(x) = 1 - \exp\left(-\left(\frac{x-t_o}{\eta}\right)^{\beta}\right), \quad x > t_o \tag{7}$$

$$t_o = \textit{location parameter}$$

The parameters of the distribution can be interpreted as follows. The value of eta is the scale parameter and describes the spread of the distribution. It is the 63.2th percentile of the CDF and has the same units as x. Beta is the shape factor and serves the function of a measure of how skewed the distribution is. Beta is in fact the slope of the CDF. Both eta and beta are restricted to real values greater than zero. The value of t_o is not restricted. When a non-zero t_o value is used, the value of eta and beta applies to the shifted data. Recovery of predicted data from the shifted

distribution requires the addition of t_o to any data values determined from the 3-parameter distribution.

B2.2.2 Comparison to Other Forms

The Weibull distribution is a suitable replacement for several distributions. The most direct replacement is achieved by setting the value of beta to 1. This reduces the CDF directly to the exponential form:

$$f(x) = \frac{1}{\eta} e^{\left(-\frac{x-t_o}{\eta}\right)}, \quad x > t_o \tag{8}$$

For beta in the neighborhood of 3-4, the Weibull distribution also provides an excellent approximation to the normal distribution. Figure B-2 is a plot of normally distributed data fitted by the Weibull distribution. The R^2 value of .997 indicates an excellent fit to the data. The number of sample points (500) is very high for this type of comparison (i.e. high power of test).

The Weibull distribution provides an acceptable alternate to the lognormal distribution. This point is demonstrated in Figure B-3. The 500 data points were sampled from a lognormal distribution and fitted with a Weibull distribution. The R^2 value of 0.985 indicates a very good approximation; however, there is an evident lack of fit at the upper end of the distribution. There the data drifts out of the confidence bands towards the high side. This indicates that the threshold values determined from the Weibull distribution are conservative with respect to the lognormal distribution. For this data, the Weibull distribution gives a value of 623 for the 95/95 double-sided threshold versus 828 for the lognormal distribution (Figure B-4). Obviously, the Weibull distribution yields a more conservative value.

B2.3 THRESHOLD CALCULATIONS AND SAMPLE PLOTS

Two examples of the use of the CDF in the evaluation of data populations and the determination of background threshold values are shown in Figure B-5. Note that these examples are similar to the CDF examples identified by the EPA (EPA 1989b) and are not distribution specific. Therefore, the evaluation methods identified here can be used with any appropriate distribution method. A Weibull distribution has been used in the construction of the CDF in these examples.

The CDF for soil background data from the Hanford Site is shown in Figure B-5 with double-side confidence limits. It is indicated from this plot that: (1) there are no outliers as all the data points fall inside the confidence bands, (2) there are no irregular features to the data (i.e. trends above or below the best fit line or skews about the line), and (3) the

correlation is acceptable (e.g., $r^2 > .90$). Once the data have been inspected in this fashion, a single upper confidence interval is applied and the predicted threshold value determined (Figure B-6).

These evaluations have been performed on the basis of the CDF of the data. The Weibull distribution has been used to generate the CDF. Figure B-7a shows the result for aluminum. The data show a definite nonlinear trend, beginning below the regression line, passing above, then dipping below the line again. This type of nonlinearity can be removed by shifting the data, subtracting a constant, optimum amount (t_o) from all of the data points. Figure B-7b shows the result of this shifting. The amount subtracted is shown in the upper left of the plot. The improvement in the representation of the data is immediately obvious. This can be confirmed by comparing the coefficient of variation in the two figures, .87 for the raw data versus .99 for the shifted data. The interpretation of the value of t_o is discussed in Section B2.3.3.

Once a good representation of the data has been developed, the data can be examined. Figure B-8a shows the data with double-sided 95 percent confidence intervals applied to the best fit line. The confidence interval establishes the boundary within which the data are expected to fall. In this instance, the width of the boundary is such that 95 percent of all data is expected to fall within the confidence interval. Data at the upper end of the distribution that is outside of the confidence band are suspected outliers. Outlier data can be examined individually.

When the data set has been examined for good representation, and outlier data treated, the background threshold level can be calculated. The *Model Toxics Control Act Cleanup Regulations* specify that threshold levels will use the 95/95 level. This means that the upper 95th percent confidence band at the 95th percentile level of the data is the threshold level. Figure B-8b shows a single sided confidence interval. Threshold can be determined graphically by starting at the 95 percent level on the vertical axis, moving horizontally to intersect the confidence band, then dropping to the horizontal axis and reading the data value (12,550 parts per million). This value is the threshold level of the shifted data. To recover the unshifted value, the amount of the shift (3,518) is added to the value read from the plot. The final value determined for aluminum is 16,069 parts per million, shown on the second title line of Figure B-8b. The results of preliminary evaluations of available data are presented in Table 3-1 in Section 3.4. Additional plots for zinc, manganese, arsenic, and iron are included in Figures B-9 and B-10.

Additional steps are required in the evaluation where the coefficient of variation is unusually low (e.g., $r^2<0.90$) or the data are clearly not contained within the confidence bands. Alternate distribution forms (e.g., a lognormal fit) can be tested to determine whether another distribution type better describes the data set; data points outside the confidence bands can be further evaluated or the data can be examined in the context of multiple distributions.

B2.3.1 Truncated Data

Data sets having one or more values that are at or below the limits of detection require some special handling. The inclusion of less-than detection limit values are problematic because these are real data that should be included in the evaluation. However, the assignment of a common value to all less-than detection limit data affects the analysis procedure.

Data that represents less than detection limit results are assigned a common value, usually the claimed detection limit. When the data are included in a probability plot, the data appear as a vertical line at the bottom end of the curve, as in Figure B-11a. The vertical line results from each value being assigned a different percentile rank, yet having a common data value. The plotted data are obviously no longer linear, so that the standard linear regression method must be modified. Data values that are less than detection limit are retained for the purposes of establishing the correct rankings of the higher valued data. However, only the highest ranked detection limit datum is included in the regression analysis, as in Figure B-11b. The term 'inspection fit' is applied to this modification of the regression procedure.

When the claimed detection limit is lower than the real detection limit achieved by the laboratory, plots such as Figure B-12 result. In these cases, reevaluation of the laboratory quality control data is required to establish the correct detection limit. This method for screening data results has led to several instances of reevaluation of laboratory performance, adjustment of the detection limits, and also resampling the WMU.

B2.3.2 Example Data and Comparisons

Table B-2 describes the results of a series of comparisons for several species. The data have been collected according to EPA protocols (EPA 1986) in support of WMU closure activities. The distributions compared are the 2-parameter Weibull, 3-parameter Weibull, and lognormal distributions. The coefficient of variation for each attempted fit is shown, as is the number of samples used in the comparison.

As can be seen in Table B-2, the Weibull distribution consistently gives a better fit than the lognormal. In all cases, the number of data points is sufficient to give a reasonable power of discrimination.

B2.3.3 Interpretations of t_o

In reliability analysis, a positive value for t_o is an indication of a minimum service life for a part. A negative value for t_o is interpreted as a an indication of a limited shelf life (i.e. a failure before being put into service). When these concepts are applied to the Hanford Site soil data, slightly different interpretations result.

Positive t-shifts imply that there is a minimum amount of the material present in all samples taken. This can happen only if a constituent is common

to both end members of the Hanford formation and the constituent is present in significant amounts. The minimum concentration in either end member becomes the expected value of the t-shift.

A zero t-shift (2-parameter distribution) implies that the element is either absent in one end member or present only in trace or modally subordinate amounts. There is no guaranteed minimum amount present in all samples.

Negative t-shifts mathematically are allowed. However, a physical interpretation has not yet been developed. With this in mind, negative t-shifts have not been used in the analysis of the soil data for the Hanford Site.

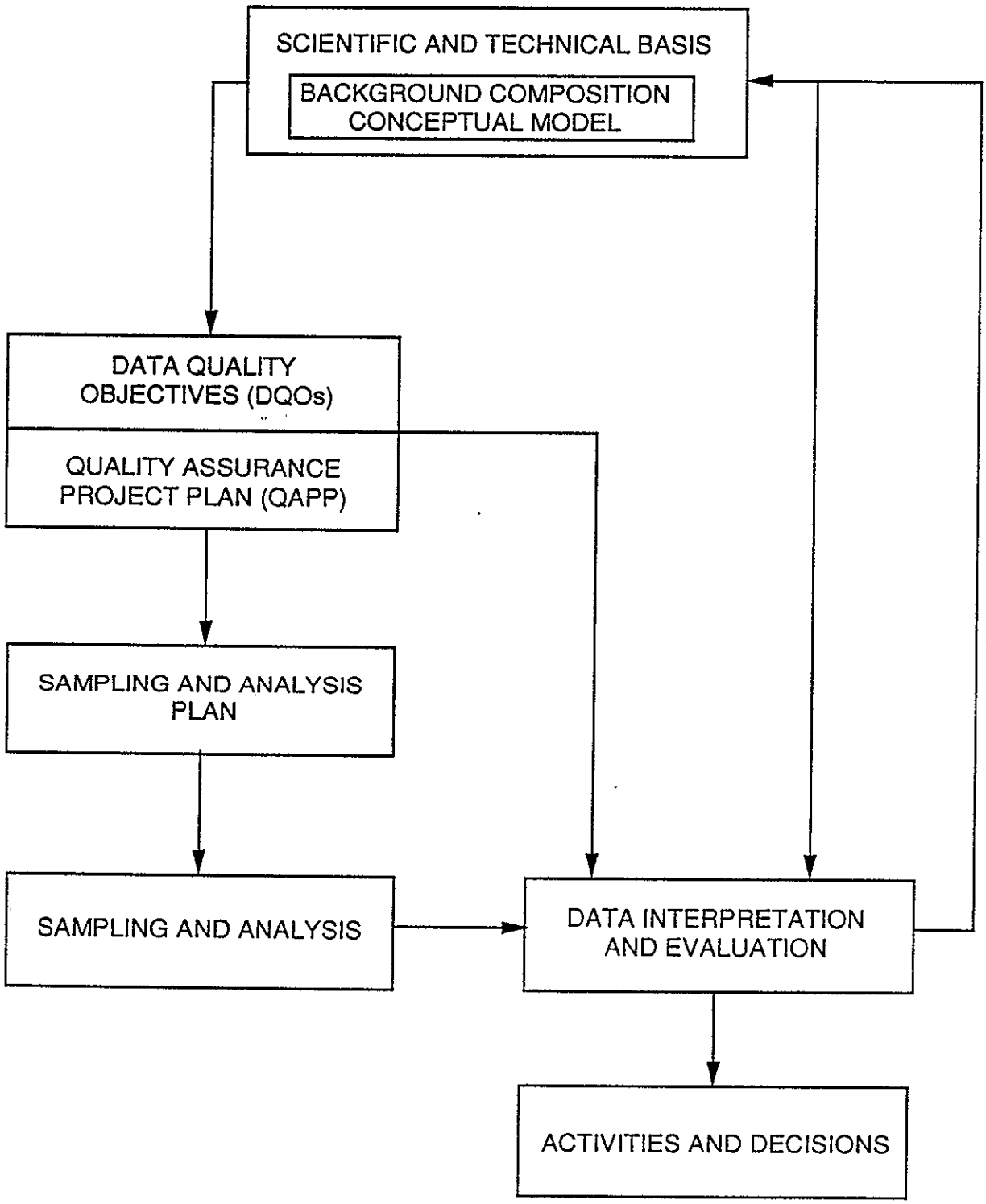


Figure B-1. Role of Scientific and Technical Basis and Background Conceptual Model on Characterization and Evaluation of Background.

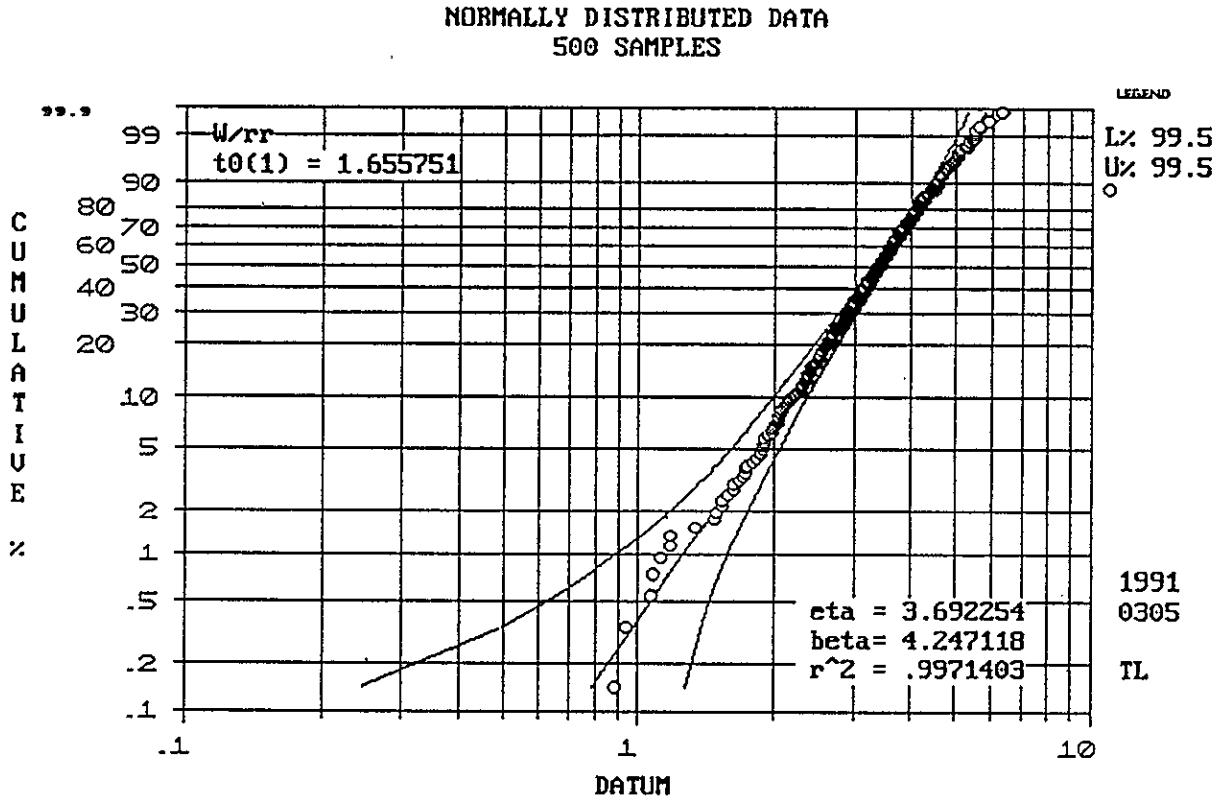


Figure B-2. Normally Distributed Data Fitted by Weibull Distribution.

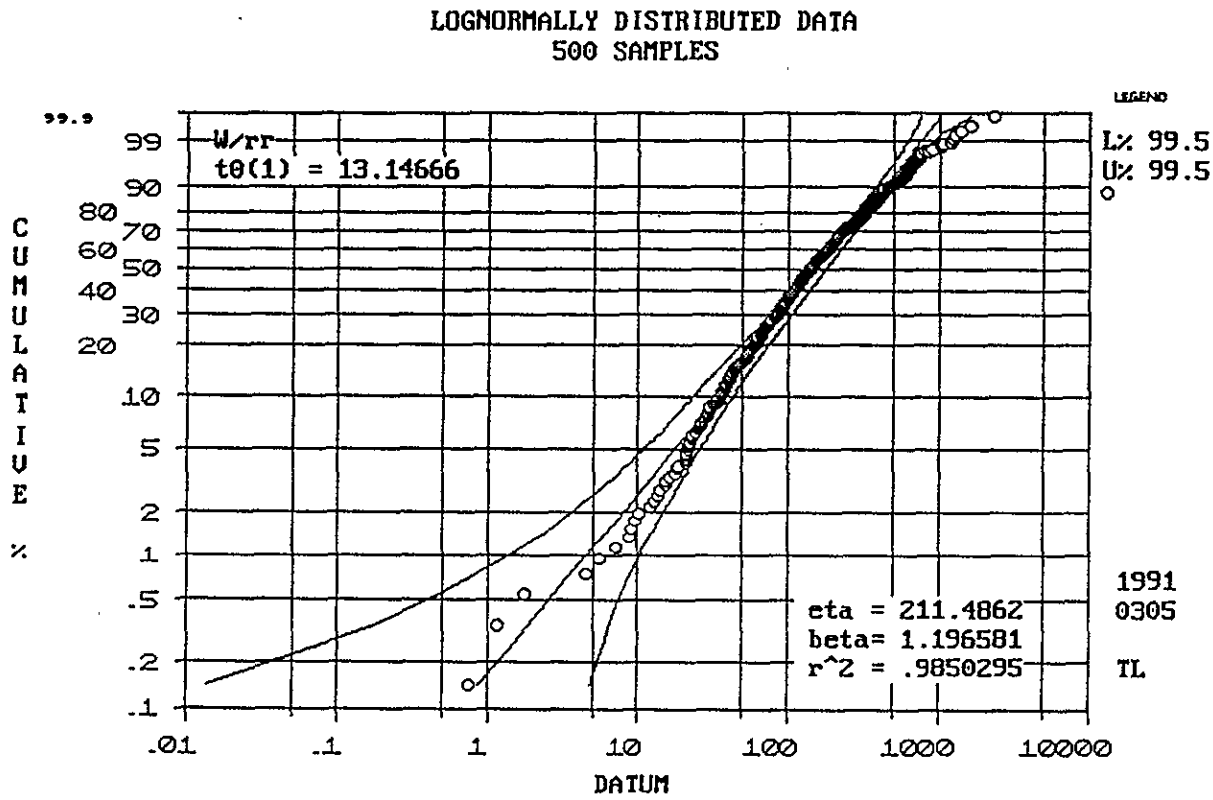


Figure B-3. Lognormally Distributed Data Fitted by Weibull Distribution.

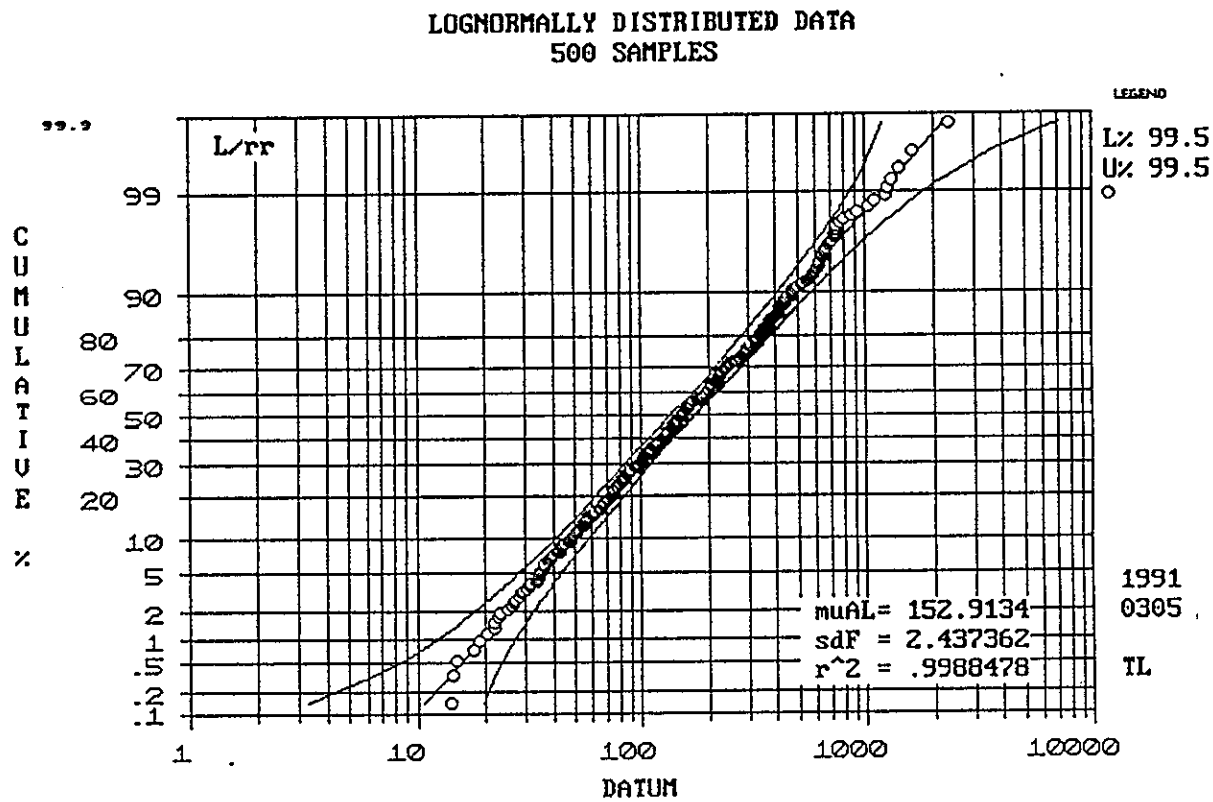


Figure B-4. Lognormally Distributed Data Fitted by Lognormal Distribution.

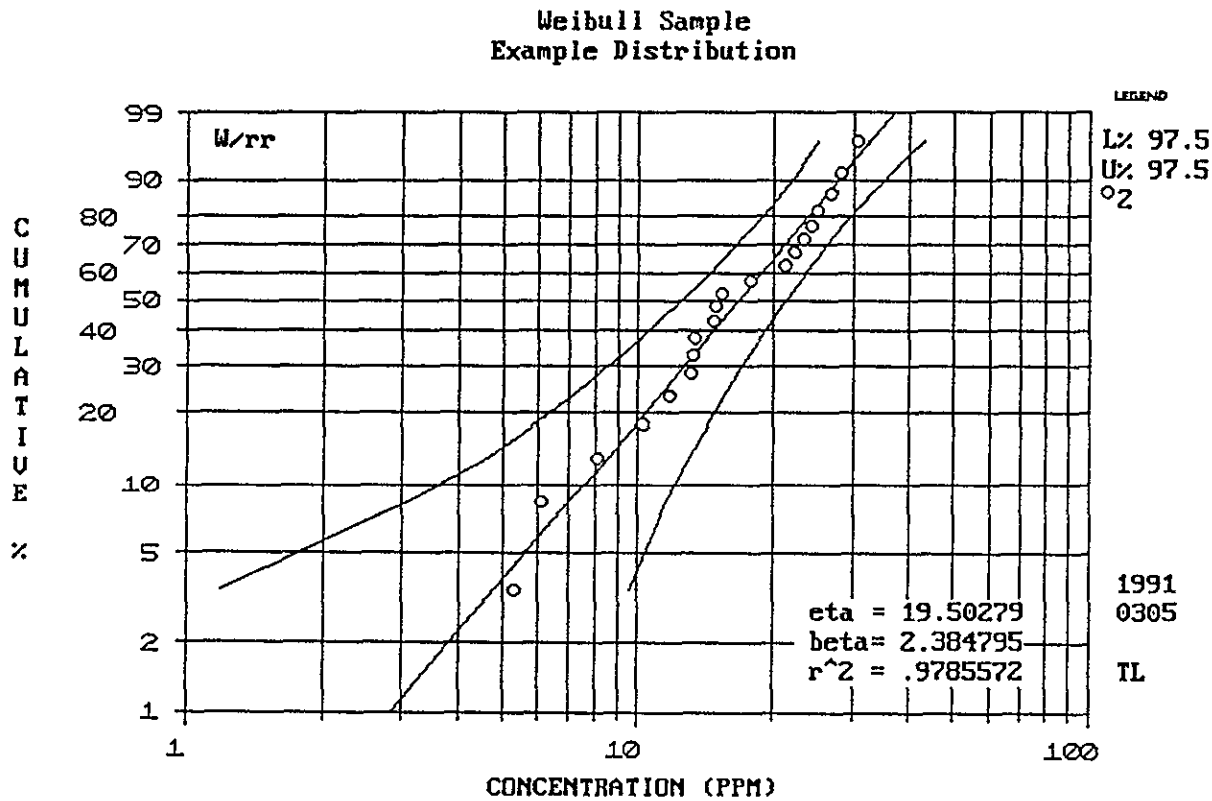


Figure B-5. Example of Data: 2-Sided Confidence Limits.

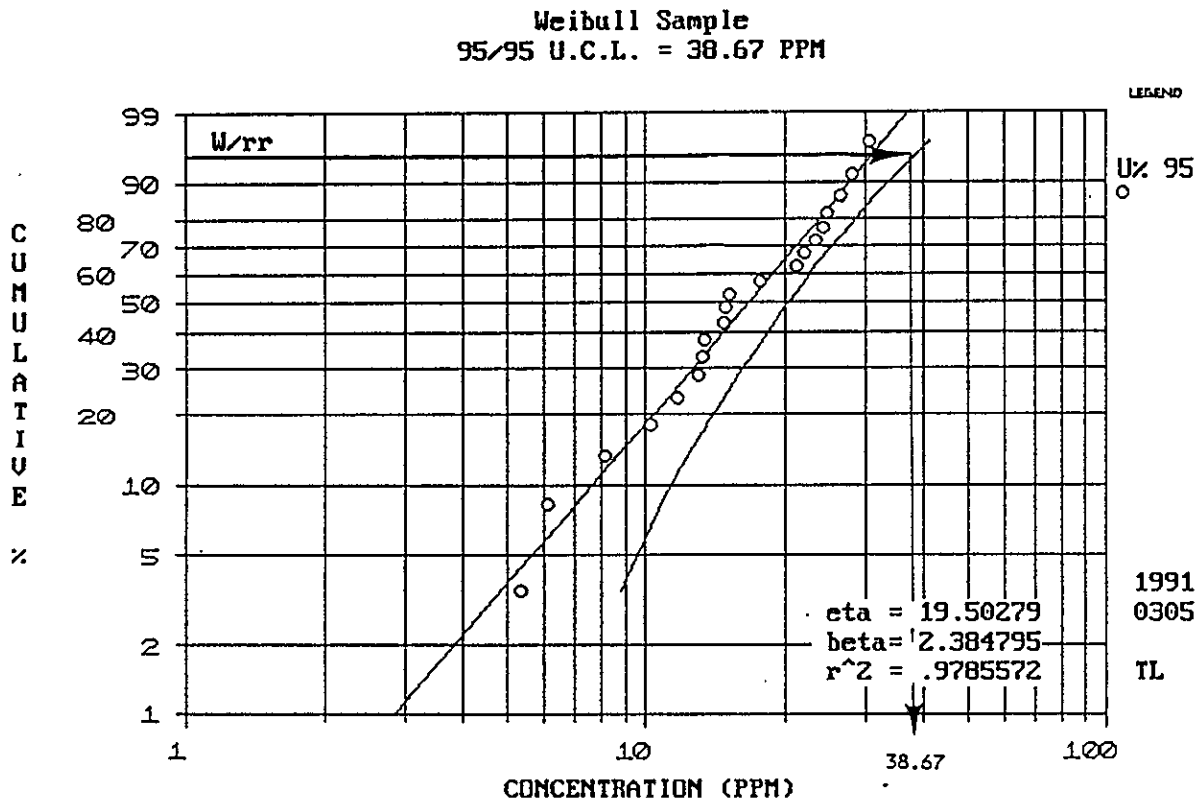
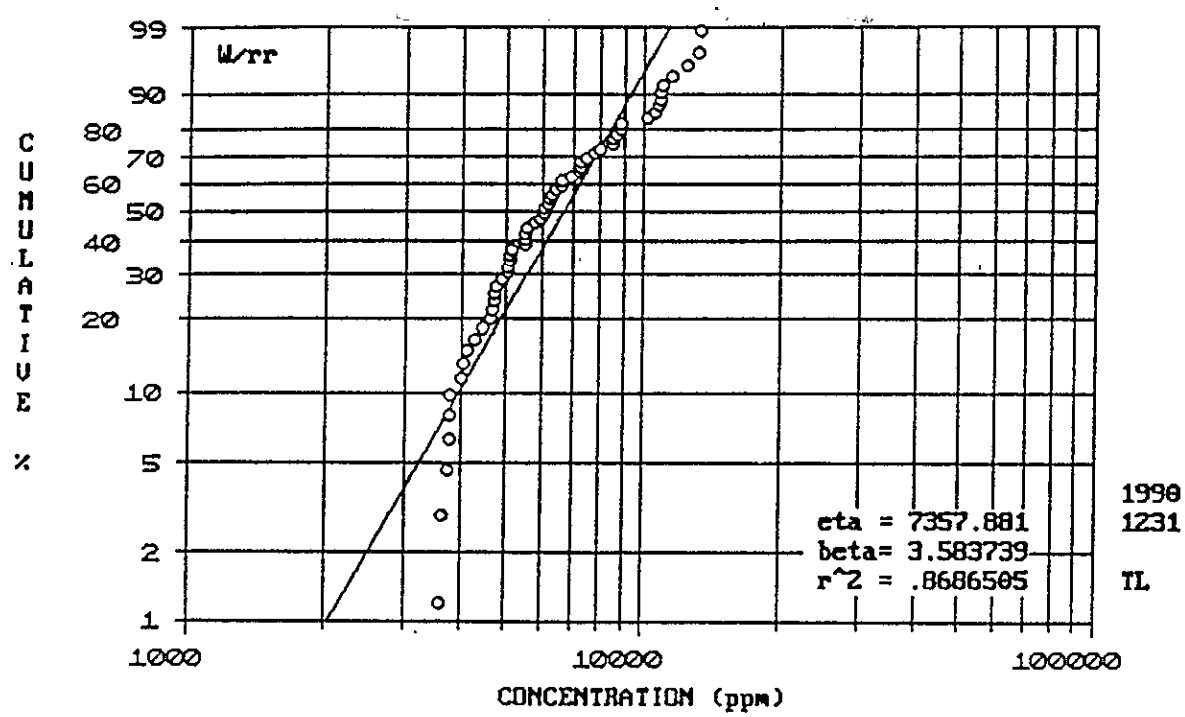


Figure B-6. Example of Data: Threshold Calculation.



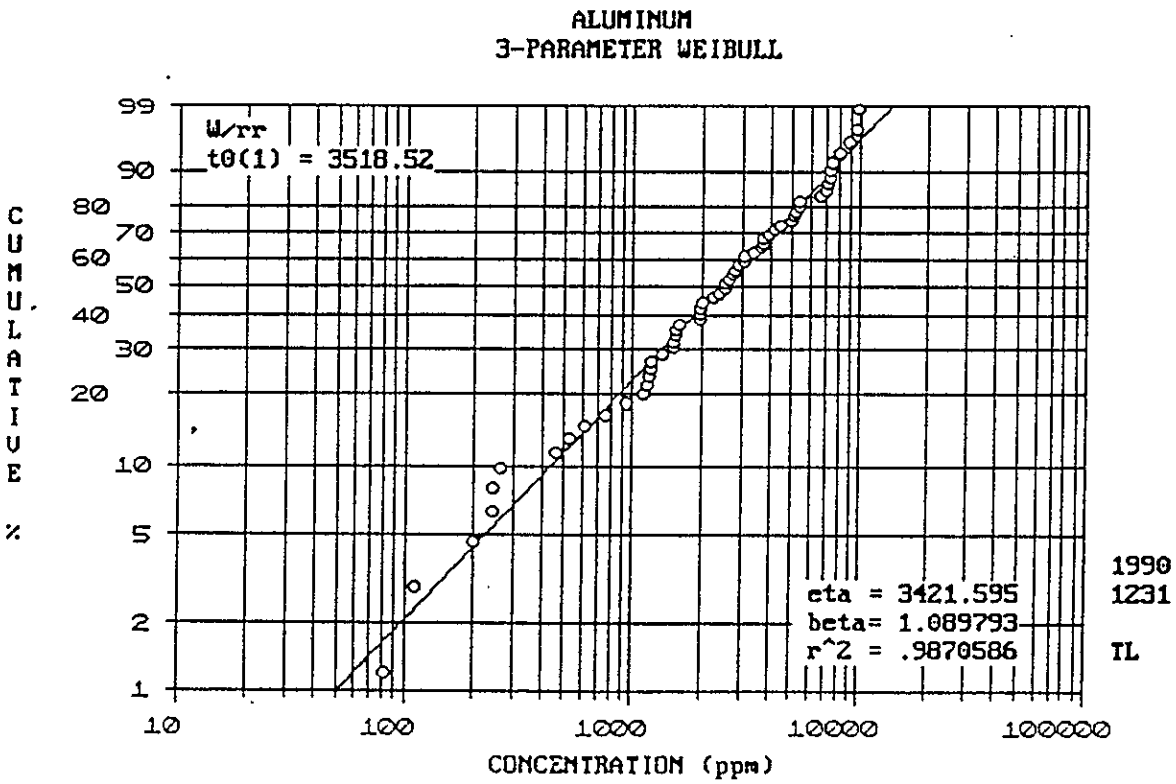
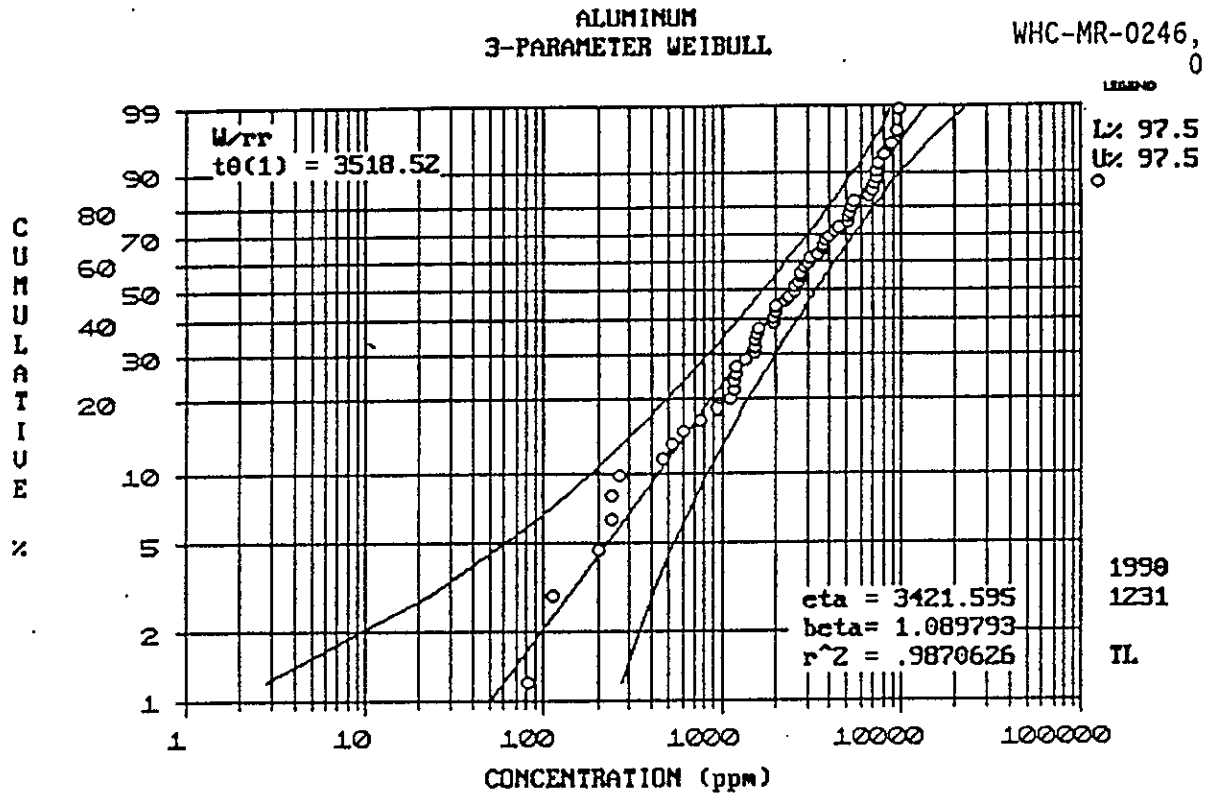


Figure B-7. Cumulative Distribution Plots of Aluminum Concentrations in Site-wide Soil Background.



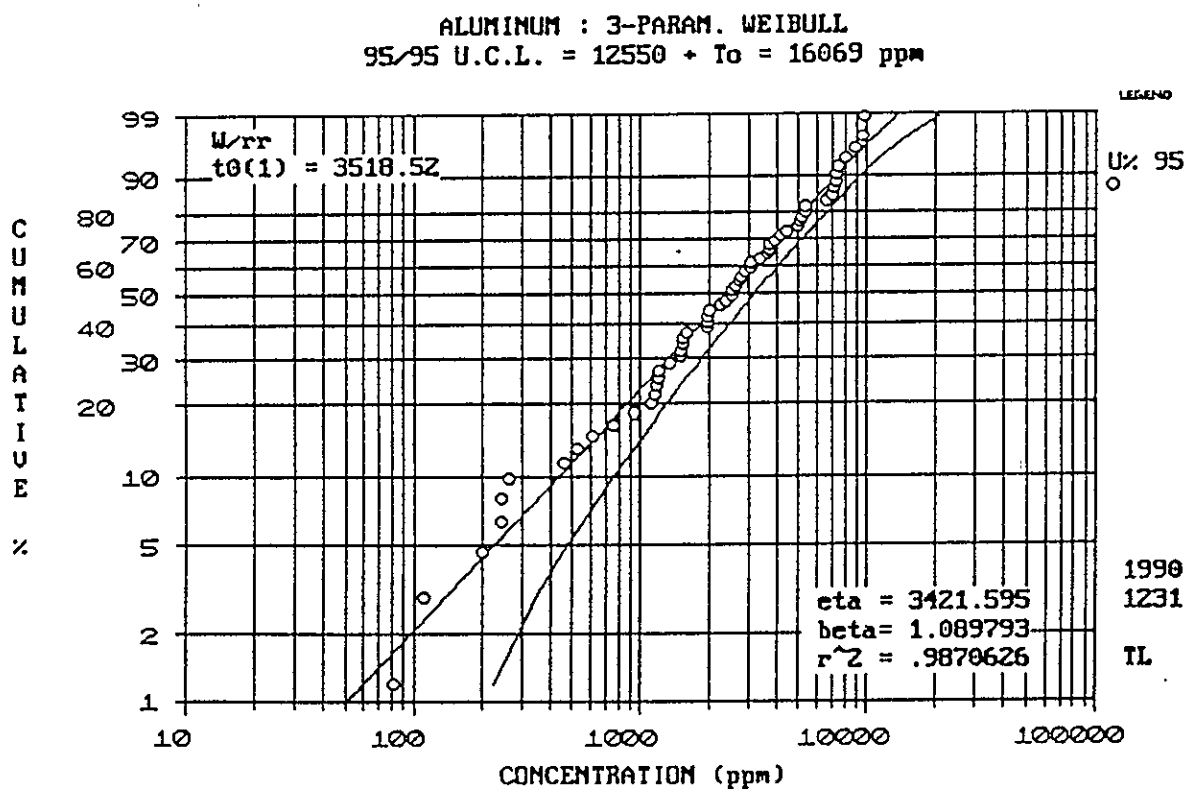
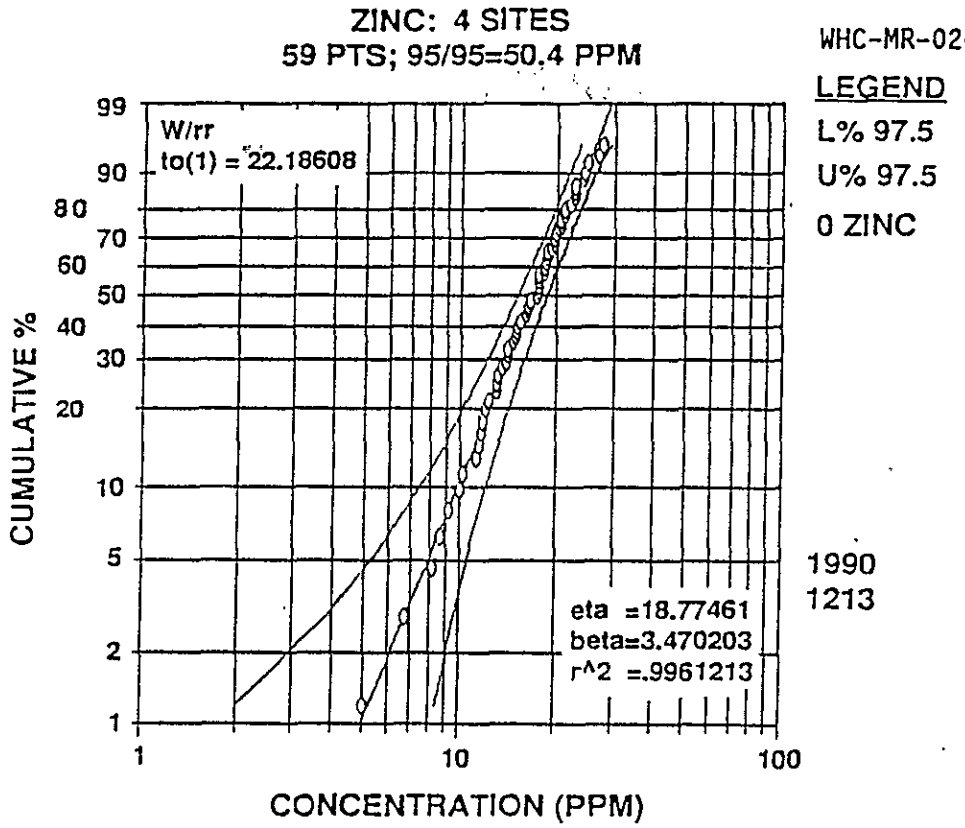


Figure B-8. Cumulative Distribution Plots of Aluminum Concentrations in Site-wide Soil Background.



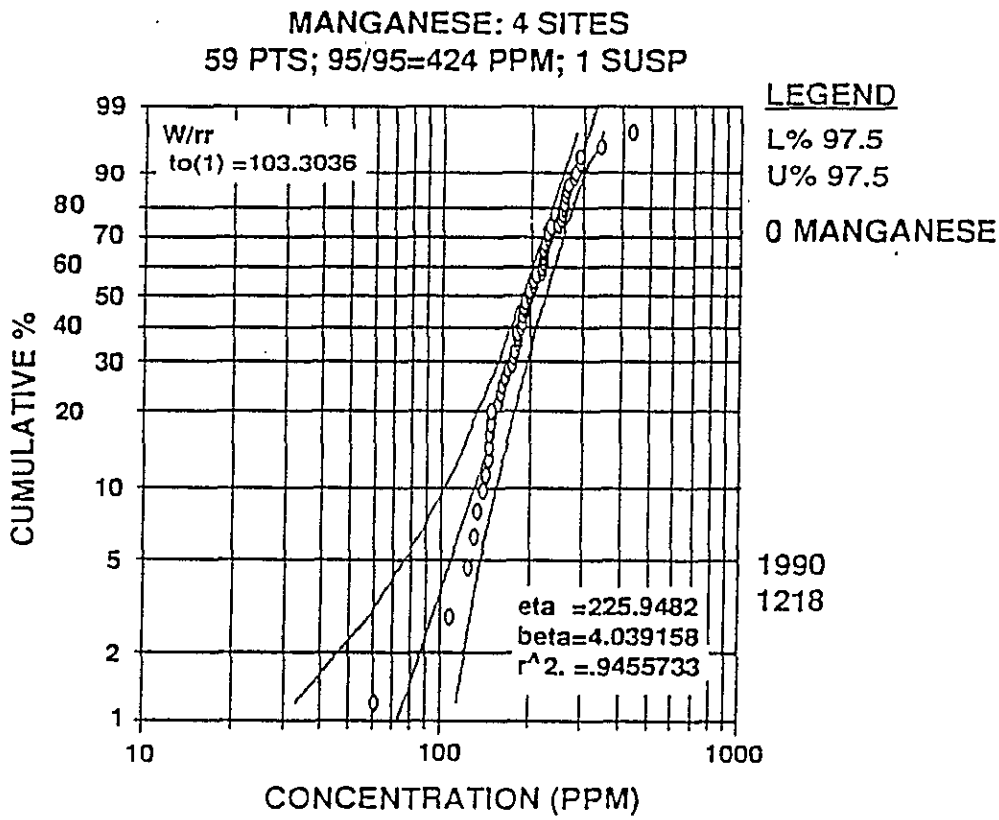
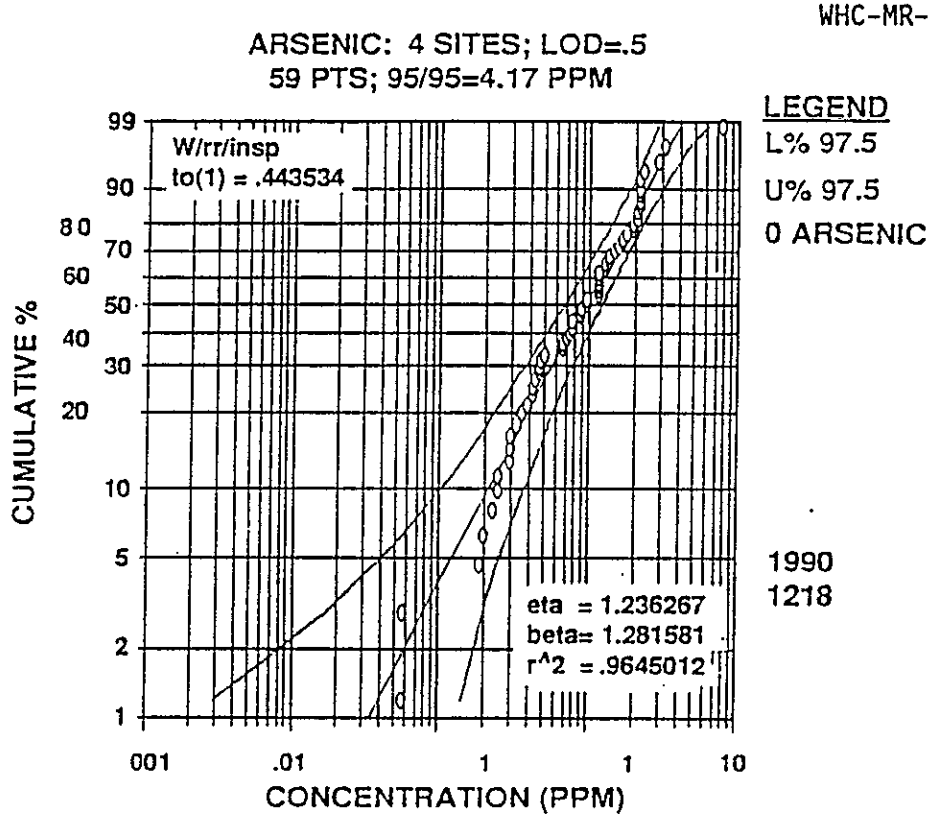


Figure B-9. Cumulative Distribution Plots of Zinc and Manganese Concentrations in Site-wide Soil Background.



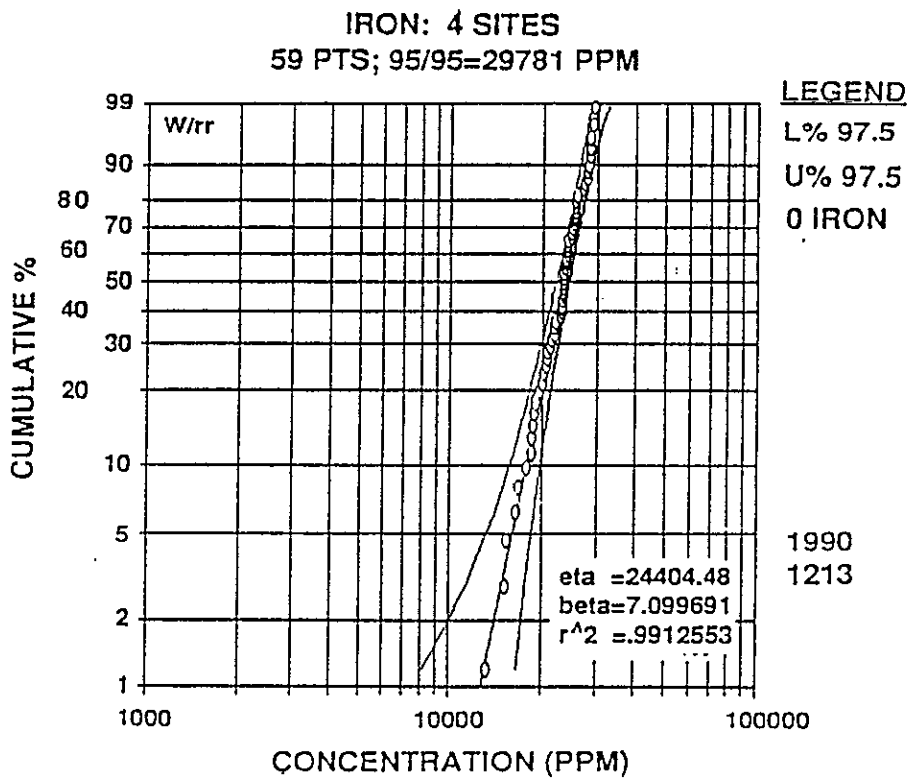
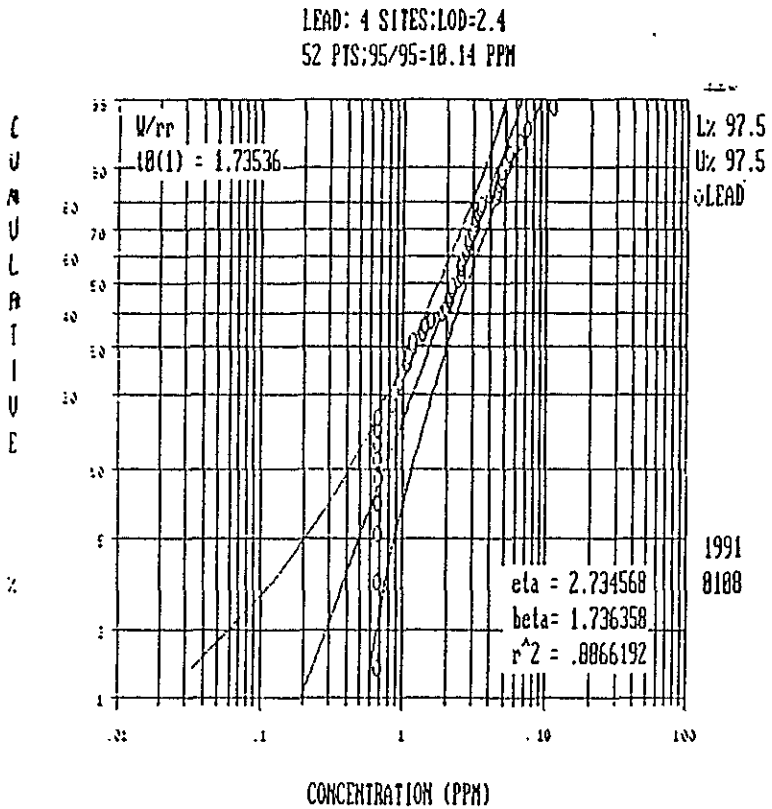
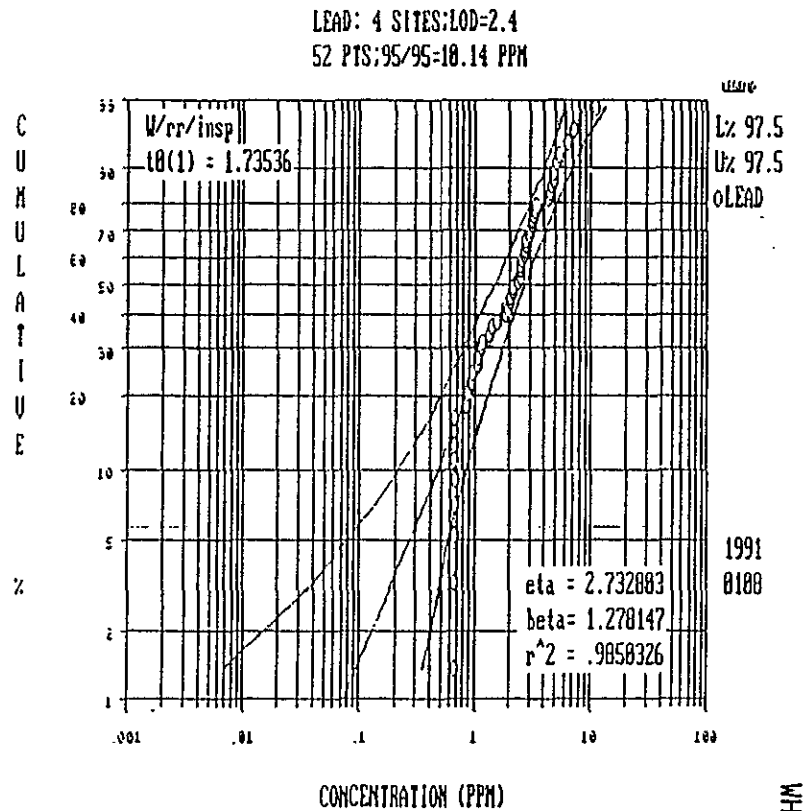


Figure B-10. Cumulative Distribution Plots of Arsenic and Iron Concentrations in Site-wide Soil Background.



Illustrates the effect of less-than-detection limit (<DL) data.



Illustrates the effect of appropriately evaluating the less-than-detection limit (<DL) data.

Figure B-11. Cumulative Distribution Plots of Lead Concentrations in Site-wide Soil Background.

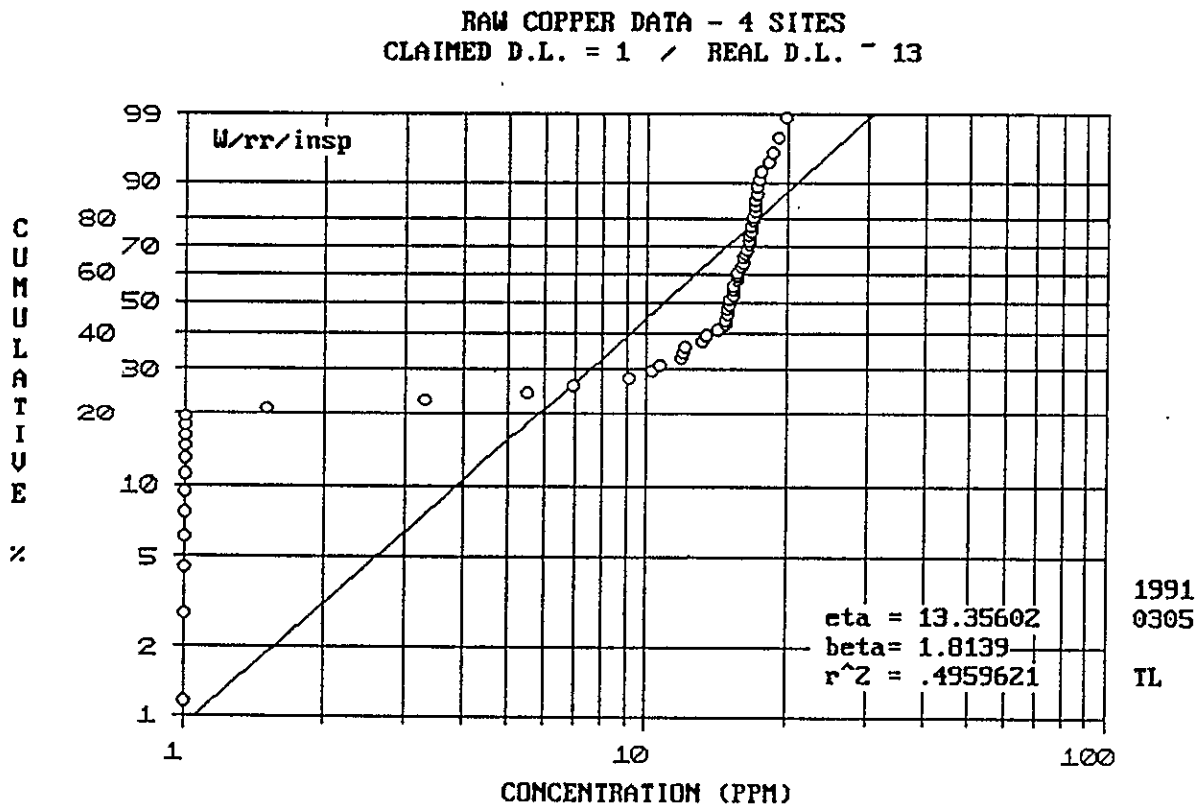


Figure B-12. Raw Plot of Copper Including the 2101-M Pond Data.

Table B-1. Compositional Range of Key Mineral and Rock Constituents in the Hanford Site Vadose Zone.

Constituent	Quartz[1] wt.% (E+04 ppm)	Feldspars[1] wt.% (E+04 ppm)			Pyroxenes[1] wt.% (E+04 ppm)			Basalt[2] wt.% (E+04 ppm)			Glass[2] (in basalt) wt.% (E+04 ppm)			Smectite clay[3] wt.% (E+04 ppm)		
SiO2	100	43.19	-	68.74	59.85	-	45.54	50	-	57	30	-	73	32	-	55
TiO2	-	0		0.08	0		1	0.6	-	3.9	0.6	-	6.4	0.06	-	10
Al2O3	-	18.32	-	36.65	0	-	2	12.8	-	16.5	0.8	-	12	3.1	-	11.4
FeO		0		2.6	0		54.45	10	-	16.6	2	-	47	6.8	-	30
MnO	-	-		-	0		3	0.1	-	0.4	0	-	0.7	0	-	0.64
MgO	-	0		0.15	0		40.15	1.5	-	6.4	0	-	0.8	3.2	-	13.2
CaO	-	0	-	20.16	0	-	25.9	6.2	-	10.5	0.7	-	10	0.6	-	4.5
Na2O	-	0	-	11.82	0	-	0.07	1.1	-	3.8	0	-	2.7	0	-	2.3
K2O	-	0	-	16.92				0.2	-	3.1	0	-	5.7	0.2	-	5

		Feldspars[1] ppm	Pyroxenes[1] ppm	Basalt[3] ppm	Glass[4] (in basalt) ppm	
P2O5	-			2,000 to 4,000	3,200	
SO2	-				600	
U	-			up to 2.5	up to 1.4	
Th				up to 9.2		
Pb	-				up to 12	
Ba	-	up to 15,600		up to 4,000	up to 622	
Zn	-				up to 107	
Cu	-				up to 130	
Ni	-		up to 400		up to 20	
Cr	-		up to 600	up to 200	up to 45	
V	-				up to 475	

[1] Deer et al. 1972
[2] Hoover and Murphy 1989
[3] DOE 1988
[4] Lambert et al. 1989

Table B-2. R^2 Versus Distribution Comparison.

Species	2-Param Weibull	3-Param Weibull	Lognormal	Best fit	ETA BETA t_o	Total samples
Zinc	.972	.996	.963	3-param Weibull	18.8 3.47 22.2	59
Barium	.793	.981	.915	3-param Weibull	34.5 1.09 43.4	59
Copper	.923	---*	.798	2-param Weibull	16.5 6.14 ---	44
Lead	.960	.985	.971	3-param Weibull	2.73 1.28 1.73	52
Chromium	.967	.972	.949	3-param Weibull	8.40 1.83 1.29	59
Iron	.991	---*	.941	2-param Weibull	24400 7.10 ---	59
Arsenic	.889	.965	.962	3-param Weibull	1.24 1.28 .444	59

* The 3-parameter Weibull distribution gives an R^2 of .968 for copper and .993 for iron; however, the value of t_o is negative. Section B2.3.3 presents a discussion of negative t-shifts.

APPENDIX C

GROUNDWATER BACKGROUND CONCEPTUAL MODEL

APPENDIX C

GROUNDWATER BACKGROUND CONCEPTUAL MODEL

C1.0 INTRODUCTION

The model for understanding the known and expected range of groundwater background compositions in the unconfined aquifer at the Hanford Site is based on the principles of hydrology and geochemistry and the characteristics of the aquifer. The primary elements of this model are the following.

- Groundwater background is a range of compositions resulting from natural processes in the unconfined aquifer and underlying confined aquifers.

- Natural processes buffer and control the upper concentration limits of most constituents in groundwater.

The most important factors that potentially influence groundwater background chemistry are: (1) the sources and composition of aquifer recharge, (2) the compositional makeup of the aquifer, (3) internal and chemical controls on groundwater composition within the aquifer (e.g., interaquifer communication, flow rates), and (4) external influences on aquifer composition (e.g., artificial recharge, river water effects). The manner in which these processes are expected to influence and control groundwater composition are described in the following sections.

C2.0 AQUIFERS AND HYDROCHEMICAL FACIES

Differences are expected to exist between the compositions of groundwater from different aquifers or discrete hydrogeologic systems (Figure C-1). Distinct populations of groundwater compositions are referred to as natural background facies (e.g., Freeze and Cherry 1979). At least two hydrochemical facies have been distinguished in the unconfined aquifer on the basis of oxygen isotope characteristics alone (DOE 1988). Although incompletely characterized, there are several hydrogeologic systems beneath the Hanford Site, each with different sources of recharge or influence, and potentially different compositional ranges.

The type and composition of recharge sources are important in understanding and evaluating the chemical evolution and range of natural background compositions. Natural recharge to the unconfined aquifer on the Hanford Site is from rainfall, run-off, springs, and rivers. Natural recharge of the uppermost confined aquifer is primarily from intrabasin highland areas peripheral to the Hanford Site, e.g., Rattlesnake Ridge, Umtanum Ridge, and Yakima Ridge (Figure C-2). Groundwater flow is downgradient from natural recharge areas toward the Columbia River, where groundwater is ultimately discharged. However, the Columbia and Yakima Rivers also contribute locally

and/or seasonally to recharge of the unconfined aquifer (e.g., Newcomb et al. 1972; Graham et al. 1985; Zimmerman et al. 1986).

Artificial recharge from groundwater mounds associated with operations on the Hanford Site has been one of the most important recharge sources to the unconfined aquifer (Newcomb et al. 1972, p. 28). The perturbations of artificial recharge on the hydrologic system composition within the aquifer must, therefore, be included in the model because this source of recharge influences the flow dynamics and chemical evolution within the aquifer. These effects also must be considered in the sampling and evaluation of groundwater data when characterizing background threshold levels (DOE 1988, pp. 3.9-120).

C2.1 CHEMICAL EVOLUTION OF GROUNDWATER: CHEMICAL REACTION PATHS

The fundamental concept in the understanding and valid interpretation of groundwater data is that background composition is not uniform, but varies by an evolutionary process with finite upper limits that are controlled by chemical reactions between the groundwater, aquifer material (i.e., water and rock interactions) and gases (e.g., Freeze and Cherry 1979, pp. 237-297; Brownlow 1979, pp. 177-185; Krauskopf 1979, pp. 532-534; DOE 1988, pp. 3.9-55, 132). These reactions are responsible for such changes as the evolution of soft rain water, which is low in dissolved solids, to hard groundwater containing high concentrations of dissolved solids. This process is a natural consequence of groundwater interaction with the aquifer, which causes the chemistry of groundwater to differ from that of its recharge source(s) in systematic ways that reflect the chemical reaction path of the water and rock system (Figure C-3). The magnitude of these differences can be seen in Table C-1 in which rain water, groundwater, and river water from the Columbia Basin are compared.

The concentrations of most cations and anions in groundwater are associated with water-solid reactions that control the dissolved ion concentration. Examples of two types of chemical reactions between water and solids typically involved in the evolution of groundwater are illustrated in Figures C-4 and C-5. The concentrations of Si, Al, Ca, Na, and K in groundwater are strongly affected by the type of reaction described in Figure C-4 because feldspar is an abundant and ubiquitous mineral in most aquifers, particularly those in the Pasco Basin. Aquifers that contain Fe-bearing minerals affect the groundwater concentrations of Si, Al, Ca, Fe, Mg, and Mn by the type of reaction shown in Figure C-5.

These reactions do not occur instantaneously, but progress with time to approach equilibrium or metastable equilibrium conditions that effectively buffer the groundwater composition. The relationships shown in Figure C-6 illustrate the manner in which reaction between distilled water and several types of minerals are manifest as different reaction paths. In this figure, the concentration of dissolved silicon in the water is seen to increase with time, asymptotically approaching a constant equilibrium concentration for each type of reaction (i.e., saturation conditions). A similar pattern of evolution occurs for all inorganic constituents that are buffered by

interaction with the aquifer. In nature, groundwater composition is affected by many such reactions and may involve metastable reactions as the chemical reaction proceeds toward equilibrium. The specific types of reactions and the extent to which reactions take place depend primarily on the solids (e.g., aquifer minerals) that react with the water and the extent to which these reactions approach completion.

Equilibrium processes buffer the maximum concentration that can exist in the groundwater by solubility controls. Perturbations to the system tend to be minimized by restoration to equilibrium concentrations. These conditions and relationships exist for all constituents buffered by such reactions as long as the buffering capacity of the system is not exhausted (i.e., buffering mineral not completely dissolved). Thus, all reactions theoretically approach equilibrium concentrations either from the lower concentrations, as in the case of surface water introduced into the aquifer, or from higher concentrations, which may occur by the introduction of harder water from an adjacent aquifer or even contaminated water into the system. Unbuffered constituent concentrations increase until the system becomes saturated or oversaturated, at which point a solid phase may precipitate and subsequently buffer the concentration, except where conditions of oversaturation persist.

C2.1.1 Lateral Variations

The most common manifestation of chemical reaction path effects is the lateral variation in groundwater composition downgradient from sources of surface water recharge. In dynamic aquifers like the unconfined aquifer in the Pasco Basin, groundwater compositions are expected to vary systematically with distance from the recharge zone in the manner shown in Figure C-7. The concentration-distance relationships downgradient from areas of surface water recharge, however, are related to the characteristics of the individual hydrogeologic systems. These include recharge composition, physical characteristics of the aquifer, and flow gradients and rates. All of these determine the extent and path of water-rock reactions. A schematic representation of the manner in which the compositional evolution of groundwater varies as a function of flow rate, for example, is illustrated in Figure C-7. The natural reaction path-distance relationships for groundwater composition also can be influenced by seasonal and year-to-year effects on recharge, as implied in Figure C-7.

These effects on groundwater composition result in the lowest dissolved solids concentrations occurring closest to the recharge areas, and the highest total dissolved solids concentrations occurring in groundwater with the longest residence time in the aquifers. This is generally the groundwater that is farthest downgradient from the recharge zones and/or associated with the parts of the aquifer having low-hydraulic conductivities.

Lateral variations associated with mixing of upwelling groundwater from the confined aquifer with surface water from artificial and river recharge sources are discussed in Section C2.2.

C2.1.2 Vertical Variation

Vertical variation in groundwater chemistry of the unconfined aquifer at the Hanford Site is expected to be attributable to the following factors:

- Stratigraphic or structural influences on flow conditions and/or chemical characteristics of the aquifer
- The influences of air on the water-rock reactions in the upper parts of the unconfined aquifer
- The effects of mixing with other aquifers and surface waters.

Vertical variations in the composition of groundwater composition within large sedimentary basins characteristically are manifest as zones that correlate in a general way with lateral variations arising from travel distance and residence time (Domenico 1972). Three main zones are generally recognized:

- An upper zone characterized by active groundwater flushing, with water low in total dissolved solids and HCO_3^- as the dominant anion
- An intermediate zone with less active groundwater circulation and higher total dissolved solids, with sulfate as the normally dominant anion
- A lower zone with very sluggish groundwater flow characterized by high total dissolved solids and high Cl^-.

Significant concentration gradients also are expected to exist vertically within the unconfined aquifer resulting from the influences of air buffered reactions. Reactions between the groundwater and air at the top of the unconfined aquifer in many ways produces the reverse of the normal prograde groundwater evolution path. Groundwater in this part of the aquifer typically has concentrations of dissolved solids that are much lower than those deeper in the aquifer (except for Ca). Air buffered waters also have reduction-oxidation potential (Eh) values as high as +750 mV, whereas the Eh in confined aquifer can decrease to values less than -200 mV (DOE 1988).

The effect of air on groundwater chemistry primarily involves the influences of increased oxygen (oxidation-related reactions) and CO_2 on reactions in the system. These reactions differ significantly from those compositions deeper in the aquifer, because of the amount and source of oxygen available for reaction in the system strongly affects the concentration of total dissolved solids. Reactions that occur under reducing conditions (low oxygen fugacity) permit the concentrations of solids dissolved in the water to be much larger than those that occur under oxidizing (air buffered) conditions (Drever 1982). Water that reacts with air is buffered with respect to oxygen, and consequently is highly oxidized. Groundwater that does not react with air generally is more reducing because the groundwater is buffered internally by reaction with iron (Fe^{2+})- bearing minerals in the aquifer. This is one of the main reason why surface waters have much lower concentrations of total

dissolved solids than groundwater (Table C-1). Conversely, the iron-rich (predominantly Fe^{2+}) basalts in the confined aquifers of the Pasco Basin impose highly reducing conditions and relatively high concentrations of dissolved solids. The effects of CO_2 buffering from air are primarily to increase the concentration of HCO_3^- in the water, which increases dissolved carbonate and elevated levels of associated cations such as Ca and Sr in solution.

Both types of vertical variation in groundwater composition are expected to exist in the unconfined aquifer beneath the Hanford Site. However, the scale on which variations may be manifest in the unconfined aquifer is generally not known. This is largely due to the preponderance of shallow wells in the Hanford Site groundwater monitoring system (DOE 1989), and to the fact that dissolved oxygen content in the groundwater generally has not been included as a data quality objective in groundwater data collection efforts. The results of some Eh measurements on the confined and unconfined aquifers compiled in conjunction with the Basalt Waste Isolation Project efforts are summarized in Section C4.2.

C2.2 MIXING EFFECTS

Variations in the chemistry of the unconfined aquifer due to the effects of mixing with water from the confined aquifer, surface waters from the Columbia and Yakima Rivers, and artificial recharge also are important features of the hydrologic system model. As used here, mixing refers to the variety of interactions resulting from the diffusion across flow lines with different compositions. The most common manifestations of mixing are the existence of discrete hydrochemical regimes and/or the generation of hybrid compositions.

The interaction between the confined and unconfined aquifer at the Hanford Site results from upwelling of groundwater from the underlying confined aquifer into the unconfined aquifer (DOE 1988). The principal effect of this interaction appears to be the generation of distinct hydrochemical regimes. The implications of these regimes on the characterization of natural background for the unconfined aquifer are discussed in Section C3.0.

Where mixing occurs between waters of differing composition, local hybrid groundwater compositions can result in response to a perturbed reaction path. In most cases, mixing causes reactions such as precipitation and/or dissolution to occur, minimizing the effect of the perturbation. Individual constituent concentrations of hybrid groundwater generally are intermediate between that of the parent concentrations. The most important consequence of hybrid groundwater compositions is likely to be the complication of attempts to characterize specific reaction paths. Such complications, however, can be minimized by recognizing the possibility that hybrid compositions exist.

The effects of groundwater-surface water mixing, such as side-bank recharge from the Columbia River, create discrete hydrogeological regimes and hydrochemical facies with compositions that can vary seasonally or as rapidly as changes in river levels. This process is expected to perturb the system

locally by diluting more evolved groundwater with respect to many dissolved solids, and also by modifying the physical conditions (e.g., temperature, Eh, pH, ionic strength) and, consequently, reaction paths. On the scale of the Hanford Site, this type of interaction could be volumetrically minor and subordinate to the large chemical evolution of groundwater in the unconfined aquifer. However, these interactions dominate the local groundwater background at the reactor sites along the Columbia River.

Surface water introduced as artificial recharge from Hanford Site operations largely impacts the unconfined aquifer in the same way as the upwelling of water from the confined aquifer. The main differences in impact are that the groundwater mounds occur at the surface, have chemical compositions that more closely resemble surface (e.g., river) water than groundwater, and also may be contaminated. Thus, the primary influence of artificial recharge is to render parts of the unconfined aquifer unacceptable for the characterization of background. The potential influences of artificial recharge on the ability to determine the natural range of groundwater background composition is discussed in Section C3.0.

C2.3 SAMPLING AND ANALYTICAL CONSIDERATIONS

The processes of sampling and analysis also can influence and/or bias the composition of groundwater samples depending on the manner in which the sampling and analysis are performed. Certain sample modifications are prescribed by regulatory protocols such as filtering and acidifying samples. Although true groundwater composition is the water composition free of suspended solids, suspended particulates in groundwater samples that are not filtered out are subsequently dissolved in the acidification process. Thus, inconsistencies or errors in the filtering process alone can produce erroneous data.

The manner in which the water samples are taken (i.e., pump versus grab samples), and the type and configuration of wells the samples are taken from (e.g., screen length, construction materials, etc.), can seriously impact the composition of a groundwater sample. The effects of reacting a sample of reduced groundwater containing relatively high concentrations of dissolved solids with air in the collection of the sample can rapidly modify the true composition of the sample. The most common modification is the precipitation of amorphous solids, such as ferric hydroxide, and associated sorption of many other dissolved metals. The resulting composition of the sample essentially could be devoid of cations that actually could exist in relatively large concentrations under the reducing conditions within the aquifer. Conversely, chemical reactions between the metallic components of the well can contribute components, especially transition metals, to water samples. Such potential problems have been recognized by the regulatory agencies and have led to the promulgation of sampling protocols and/or material standards. However, these potential influences still must be considered in the screening and interpretation of groundwater data, because such effects are not recognized by statistical methods alone. One example is the recognition that filtered groundwater compositions cannot have larger dissolved solid concentrations

than unfiltered (and acidified) samples. Data of this type that are not identified lead to misinterpretations.

C3.0 EVALUATION AND STATISTICAL METHODS

Many of the statistical methods for evaluating groundwater data are prescribed by regulatory guidelines (EPA 1986; EPA 1989a; EPA 1989b; Ecology 1991b), and different approaches may be prescribed for the various regulatory programs. The same methods used in characterizing and evaluating soil background (Appendix B) in the context of the Site-wide background model also may be used in the evaluation of groundwater background. The main difference between the evaluation of soil and groundwater background is in the nature of the processes that control the range and distribution of compositions as described by the conceptual model.

Individual aquifers and hydrochemical facies constitute discrete compositional populations that generally are discriminated by means of geochemical evaluations. As with soil, background threshold values for groundwater can be determined on the basis of the concentration range of the components and the cumulative distribution. For the natural process of groundwater evolution by rock-water reaction processes, the upper limits of the cumulative distribution should asymptotically approach the equilibrium concentration limits imposed by solubilities, reaction constants, etc. Thus, essentially the same statistical methods used for evaluation of soil background also can be used for evaluating and screening groundwater background, provided that the population is representative of the natural range of compositions. However, the evaluation process should not be limited to a statistical evaluation alone, because the evaluation process can lead to underestimation of the real background levels, especially if the population is not representative of the natural range of compositions.

In general, the true upper limits of the groundwater background compositional range always will be underestimated or misidentified if data with relatively high concentrations cannot be distinguished from contamination. Simple averages, and even values corresponding to an upper confidence or tolerance intervals, are always lower than the concentration levels buffered by equilibrium process because the statistical methods alone have no provisions for factors such as buffered compositions. The present evaluation methods and statistical approaches provide no basis for distinguishing between these two alternatives. Thus, a greater number of groundwater samples alone is of limited benefit to the establishment of background without a conceptual model for understanding the natural distribution and DQOs for sampling and analysis designed specifically for the determination of the natural compositional range.

C4.0 PRELIMINARY RESULTS

The compilation and evaluation of existing data on groundwater in the context of the Site-wide groundwater model have only just begun, and have not progressed as yet to the same extent as have the evaluations of soil background. The compilation and evaluation of existing data and refinement of the conceptual model in context of these evaluations are the primary groundwater background efforts planned for fiscal year 1991. However, preliminary results of these efforts to date appear to generally corroborate the main components of the groundwater background conceptual model. The highlights of these findings pertinent to the evaluation and evolution of the groundwater background conceptual model are summarized in the following sections.

C4.1 LATERAL VARIATIONS

The manifestation of the chemical evolution of groundwater laterally across the Hanford Site previously has not been assessed. It is estimated, however, that the magnitude of compositional changes in groundwater due to reaction path processes should be evident in the groundwater on the scale of the Hanford Site hydrologic system. Information on reaction rates and attendant compositional effects such as that shown in Figure C-7, coupled with groundwater flow velocity, can be used to estimate the importance of this process. For an average flow velocity as fast as 0.6 feet (1.0 meter) per day, it is estimated that groundwater reactions with K-feldspar at 77 °F (25 °C) would approach equilibrium after traveling about 4.35 miles (7 kilometers), and that faster reactions such as those with quartz may approach equilibrium after traveling only about 0.62 mile (1 kilometer). It is estimated that equilibrium would be approached at somewhat greater distances for groundwater at temperatures closer to those of actual aquifer temperatures [52 °F (11 °C)] due to the temperature dependence of reaction constants. The effects of reaction kinetics also would be expected to increase the range of influence for these effects.

These distances are within the range of those from natural recharge areas (e.g., Rattlesnake Ridge, Yakima Ridge) to the Hanford Site. The other notable aspect of these scoping calculations is that for slower flow velocities and/or rapid reactions, the effects of the reaction path process also could be important on the scale of distance between upgradient and downgradient wells at some operable units.

C4.2 VERTICAL VARIATIONS

It is evident that systematic trends in the chemistry of the groundwaters are related to stratigraphic level, based on preliminary geochemical evaluations of the data on groundwater, extending from the upper part of the unconfined aquifer down into the confined aquifers in basalt. Although the extent and nature of vertical chemical variations within the unconfined aquifers are not well constrained, it is indicated from existing data that the

major element compositions of groundwater in the unconfined aquifer converge with those of the confined aquifer groundwater compositions in the Saddle Mountain Basalt (DOE 1988, pp. 3.9-137 to 143). These relationships are not surprising, especially for the parts of the aquifer sediments containing basaltic material. Even small amounts of basaltic material have a great reducing capacity that is controlled by the abundance of and large surface areas of Fe^{2+}-bearing minerals in the basalt (Hoover and Murphy 1989).

Similar conclusions also are indicated by the few measurements of oxidation-reduction potential that have been made in the upper part of the unconfined aquifer (e.g., DOE 1988, pp. 3.9-72). These measurements indicate that reduction-oxidation potentials in the unconfined aquifer range from values of +90 mV, comparable to the oxidizing conditions in surface springs, to values of at least -142 mV, corresponding to reducing conditions, and that these conditions, in turn, overlap with those in the confined basaltic aquifers, which range to Eh values less than -200 mV (DOE 1988, pp. 3.9-72).

The influences of air buffered reactions are expected to be important primarily in the uppermost part of the aquifer. However, the existing population of samples from the unconfined aquifer are so strongly biased to the uppermost part of the aquifer that the monitoring data alone cannot be expected to be representative of the range of natural compositions in the aquifer. Owing to the effects of air buffering, the uppermost parts of the aquifer could be the least representative parts of the overall aquifer chemistry. Because of these effects, the upper part of the aquifer also is expected to have lower dissolved solid concentrations than elsewhere in the aquifer.

C5.0 SUMMARY

A complete evaluation of the geochemical evolution of the shallow Hanford Site groundwater using a reaction path approach has yet to be performed. However, qualitative reaction path evaluations appear to corroborate both the role of air in controlling reactions from the uppermost part of the aquifer as well as the convergence of unconfined aquifer compositions with those of the confined aquifer groundwater composition (DOE 1988, pp. 3.9-137 to 143).

The lower bound of groundwater composition is relatively the soft water from natural surface water recharge. It is possible that the groundwater compositions that most closely approximate the upper concentration limits for most constituents have been measured. Groundwater in the unconfined aquifer with the largest concentrations of dissolved solids are those with compositions that converge with those in the unconfined aquifer. This is an expected trend because the groundwater compositions in the confined aquifer are the most chemically evolved, and have concentrations that more closely approach equilibrium levels. All other naturally occurring compositions are intermediate between these two bounding compositions. The upper limits of this range are of greatest interest to environmental activities, because the upper limits represents the maximum concentrations that would naturally result

in the aquifer. The implications of this upper limit are that Site-wide background threshold levels for constituents expected to approach maximum levels in the more evolved groundwater could be established from these data, but would likely require corroboration involving a sampling effort dedicated to that purpose.

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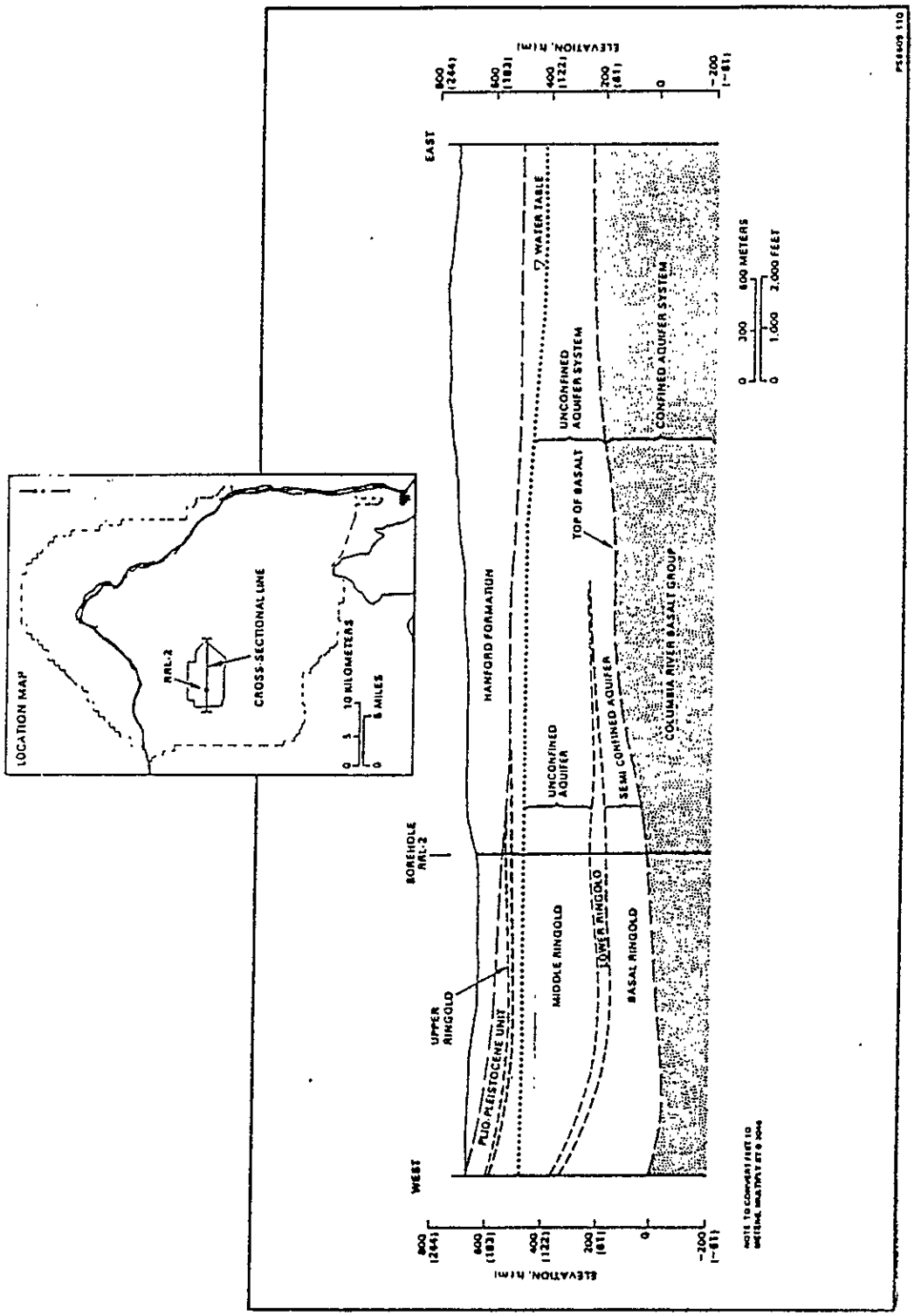

Figure C-1. Geohydrologic Cross Section Across Part of the Hanford Site (shows the relationships between the unconfined and confined aquifers) (vertical exaggerations = 10X) (After Jensen et al. 1986; Landon and Bjornstad 1986).

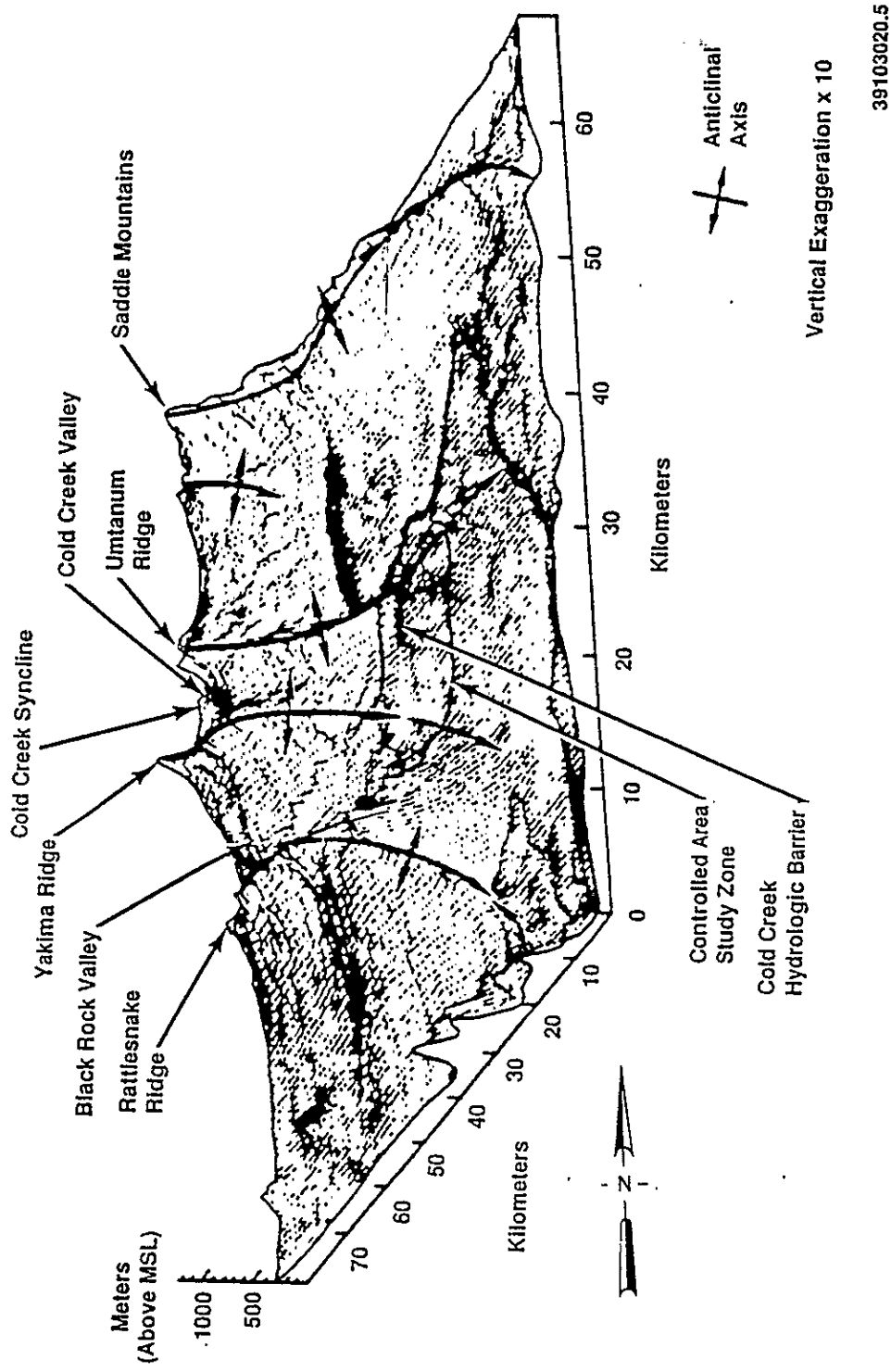

Figure C-2. Land Surface Perspective in the Vicinity of the Hanford Site (shows the main systems of natural recharge to the groundwater on the Hanford Site from rainwater run-off) (vertical exaggeration = 10X).

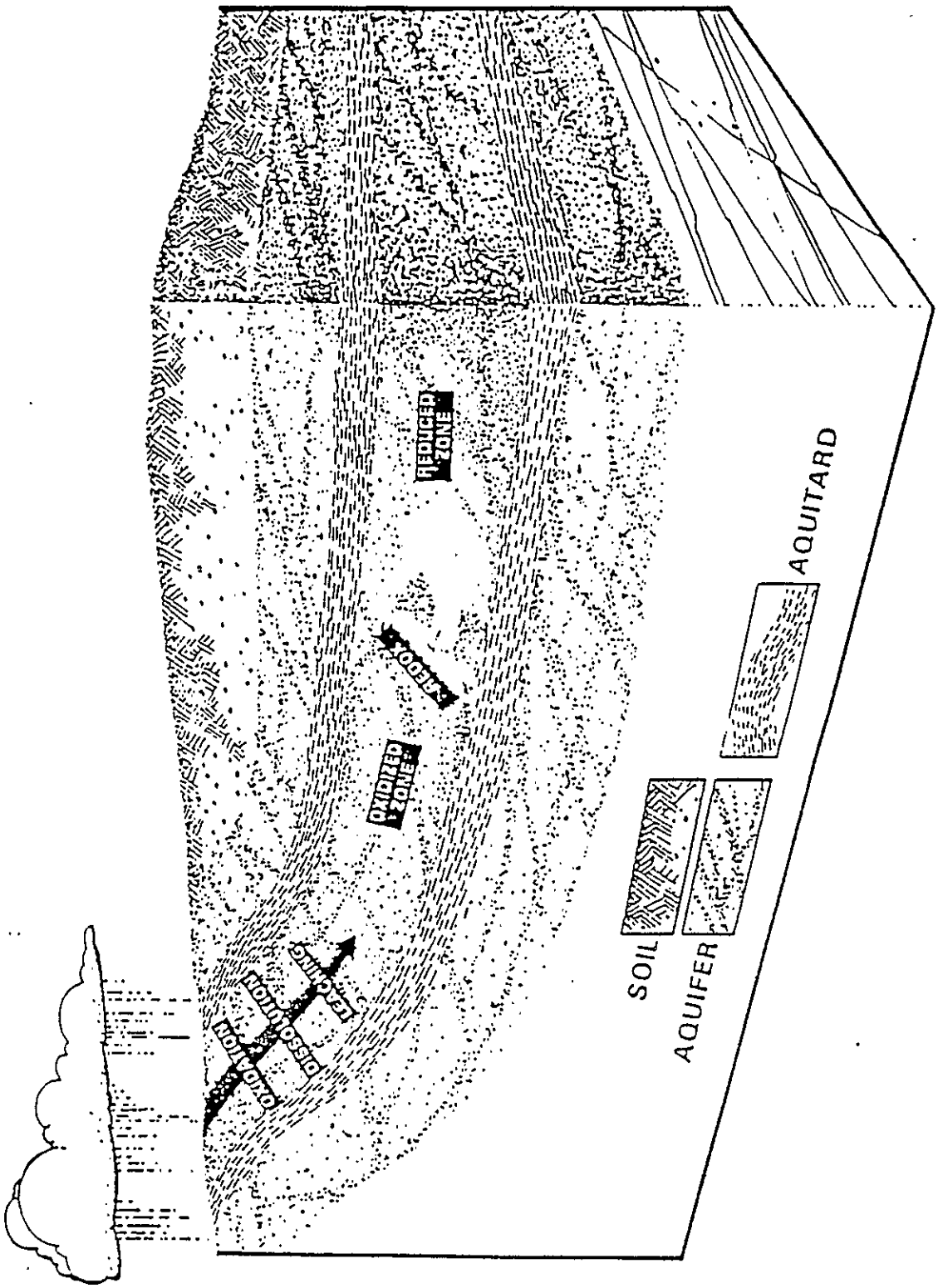

Figure C-3. Schematic Illustration of the Typical Evolutionary Process of 'Soft' Rainwater to 'Hard' Groundwater Along its Flow Path in an Aquifer.

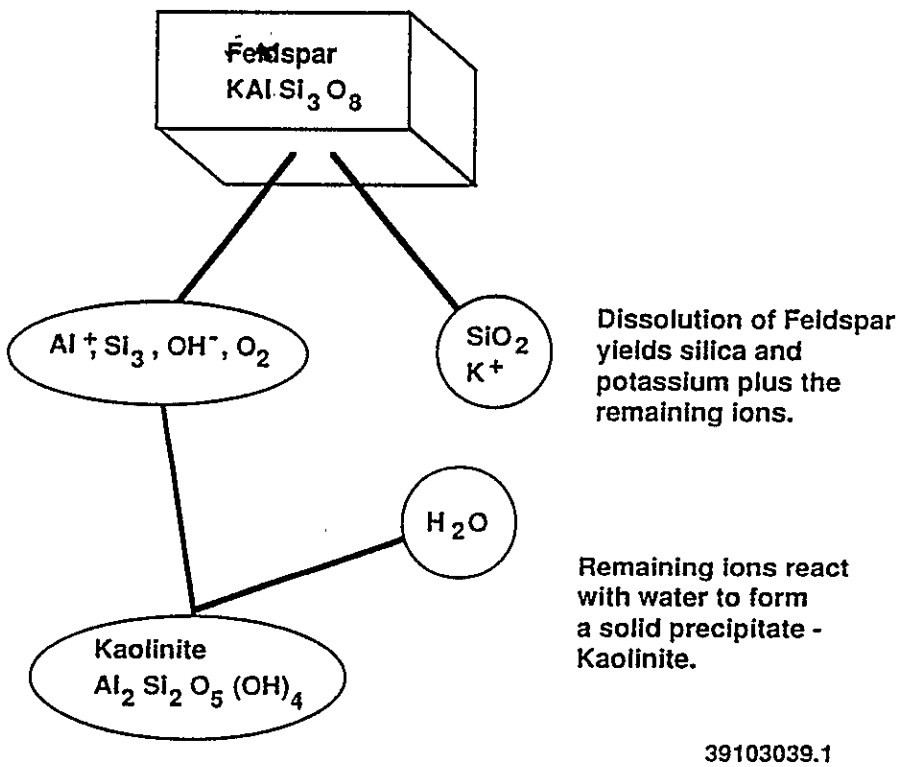

Figure C-4. Reactions Associated with the Alteration of K-feldspar.

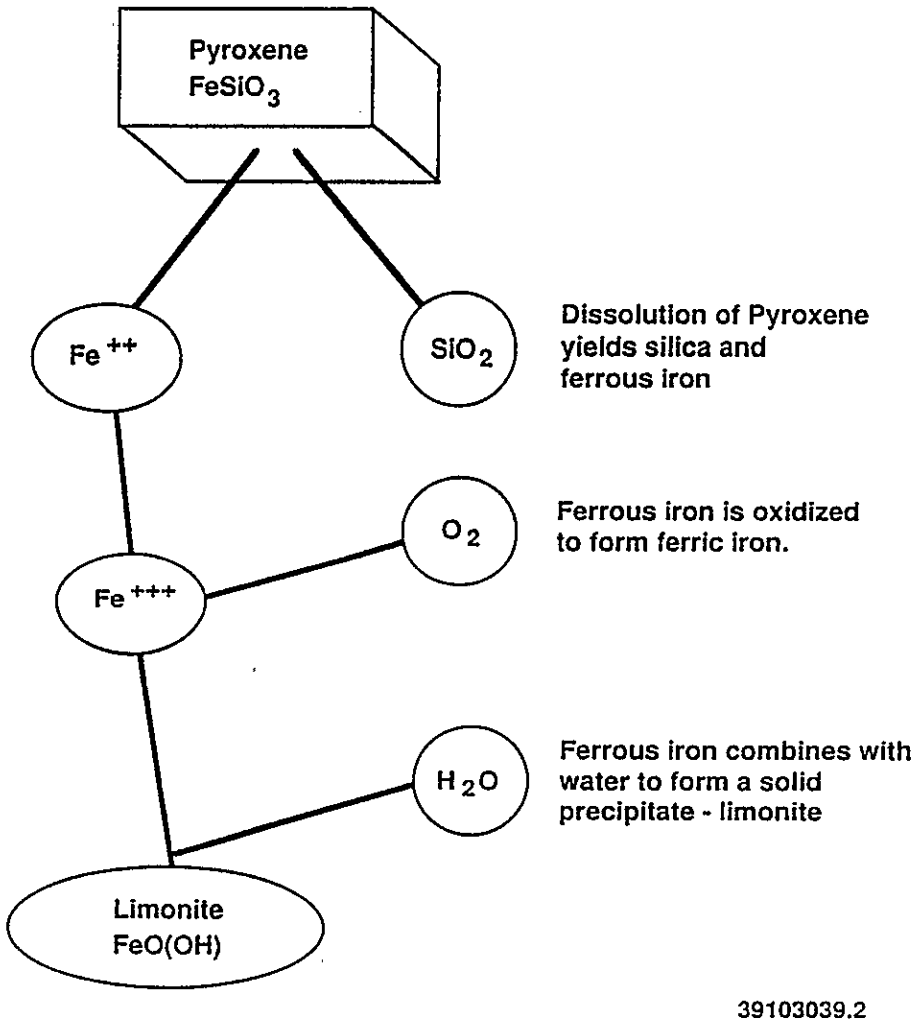

Figure C-5. Reactions Associated with the Alteration of an End Member Fe-pyroxene.

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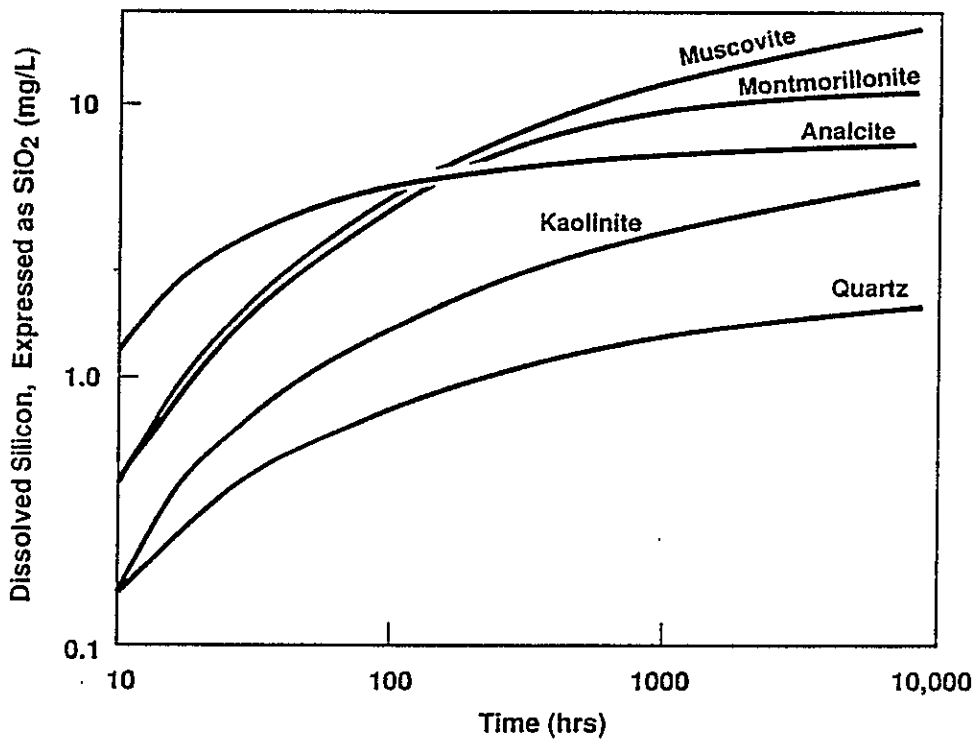

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Figure C-6. Silica Concentration Released During the Dissolution of Silicate Minerals in Distilled Water at 25 °C (Bricker 1967).

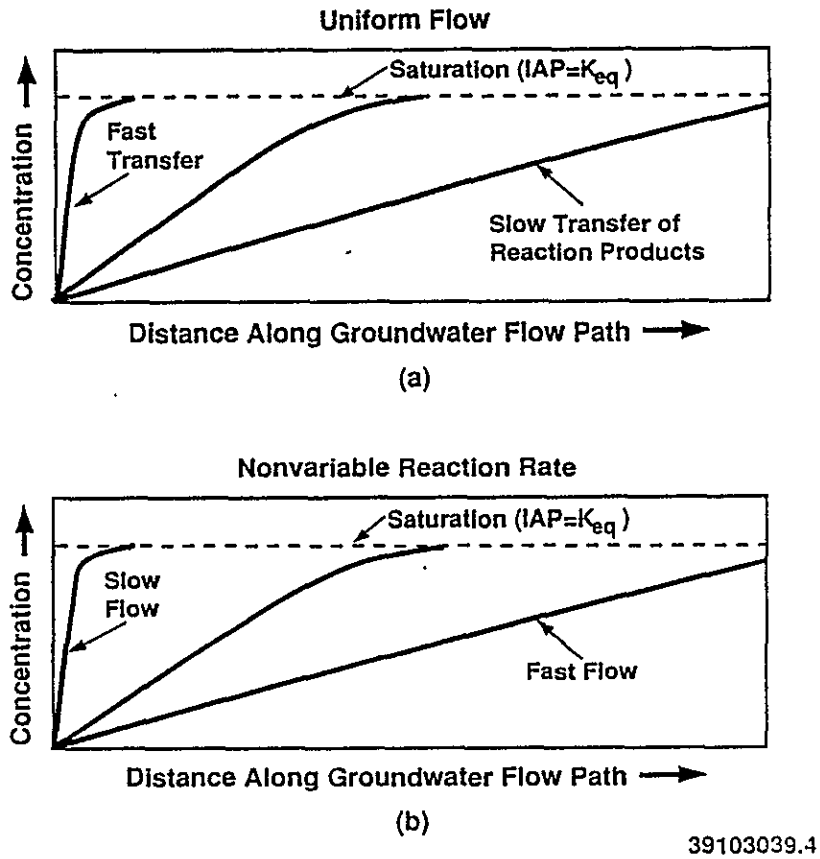

Figure C-7. Concentration Relationships with Distance Along a Groundwater Flow Path for Different Flow Conditions.

Table C-1. Chemical Composition of Waters[1].

Constituent	Sierra Nevada Mountains rain water[2] mg/L	Columbia River maximum 1985-86 mg/L	Yakima River maximum 1985-86 mg/L	Unconfined aquifer maximum through 1987 mg/L	Cold Creek confined aquifer groundwater mg/L
Si	0	2.1	10.7	45	24
Al	0	-	-	-	0.065
Fe	-	<0.03	<0.015	-	.01-.05
Mn	-	<0.01	0.66	-	0.004
Mg	0.2	5.2	0.023	13	13
Ca	0	22.2	30.3	20	31
Na	0.6	2.5	16.3	58	15
K	0.6	0.91	3	48	3
C/HCO3[2]	3[2]	16.3	29.5	25	-
S/SO4[2]	1.6[2]	13.4	17.9	33	14
Cl	0.2	1.1	6.9	78	8
F	-	0.32	0.22	75	0.6
P		0.02			
N		0.3			
Ammonia		0.04			
Ba					0.04-0.07
Cr					0.034
Ni					0.017-0.03
Cu					0.005
Pb					0.2
Co					0.02
As					0.05
Cd					0.009
^{14}C		107.7	120		
^{3}H		29.8	14		
Eh		25-165	73-170	100-450	
pH				7.1-9.5	

[1] DOE 1988 unless otherwise noted.
[2] Feth et al. 1964.

APPENDIX D

PLANNED ACTIVITIES

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APPENDIX D

PLANNED ACTIVITIES

D1.0 INTRODUCTION

The proposed activities for fiscal year 1991 involve two concurrent efforts, (1) a Site-wide effort of soil sampling and analysis for the characterization of soil background and evaluation of the Site-wide conceptual model and (2) an evaluation of existing groundwater background data and models.

The plan for a systematic sampling and analysis of soil on a Site-wide scale has evolved from previous efforts to compile existing soil background data collected according to EPA protocols (EPA 1986), to refine and test conceptual models for soil and groundwater background at the Hanford Site, and to evaluate these data.

The sequence of activities included in this effort are summarized in Figure D-1. The results of previous activities have led to the development and refinement of the soil background conceptual model. The new activities that are to be performed include the following:

- Systematic soil sampling and analysis
- Compilation and determination of supporting geological information
- Other characterization efforts that are important in the evaluation or corroboration of the conceptual model.

The groundwater background efforts for fiscal year 1991 are limited to the compilation and analysis of existing data. These activities are described in Section D3.0.

D2.0 SOIL SAMPLING AND ANALYSIS

A systematic plan of sampling and analysis of background soil and sediment on the Hanford Site will be designed for testing the conceptual model. Data from systematically selected sample locations Site-wide are required to test and corroborate the conceptual model, and will include samples from at least one deep vadose zone borehole. The systematic sampling will be designed for the evaluation of lateral and vertical variability of the vadose zone soil and sediment on the Hanford Site. The data obtained from these samples also will be used to evaluate the extent to which such sampling efforts can be used to represent soil within the confines of the 560 square mile (1,450 square kilometers) Hanford Site area. Data obtained from this effort also will be used to improve the existing database, and used further evaluation and corroboration of the Site-wide background model. Corroboration

of the Site-wide background model will permit the determination of appropriate natural background thresholds from these data, which can be applied to environmental and waste management activities Site-wide.

The criteria to be used in determining sampling locations include the following:

- Sites of no known or suspected contamination and those not in immediate proximity to specific waste sites
- Sites of existing surface excavations where the upper few feet, to tens of feet, of the vadose zone are exposed or can be readily exposed and sampled.
- Locations or sites that are representative of the variety of soil types, including end member types
- Locations or sites that provide reasonable lateral coverage within the context of the previous requirements
- Locations or sites that permit the sampling of the vertical sequence of soil within the vadose zone
- Portions of the vadose zone that most frequently have been impacted by Hanford Site activities (e.g., parts of the stratigraphy most commonly at or near the surface)
- At least one suite of samples from well characterized borehole samples that extend to a greater depth than otherwise available from surface excavations
- Sampling opportunities not otherwise available and that generally meet the aforementioned criteria.

Based on these criteria, the plan for systematic vadose sampling will consist of two phases (1) surface and near surface sampling from existing pits and outcrops and (2) the acquisition of vadose zone samples from boreholes. The surface samples are to be collected from pits and outcrops on the Hanford Site and elsewhere in the Pasco Basin where various parts of the upper vadose zone and vadose zone stratigraphy are freshly exposed and easily sampled. These samples will be used to evaluate lateral variability, lithologic variability (e.g., end member silt and basaltic units), as well as stratigraphic variability (within the limits to which the stratigraphic sequence is exposed in the surface and near surface).

Borehole samples will be samples of opportunity obtained exclusively in conjunction with ongoing drilling efforts in conjunction with CERCLA remedial investigation and feasibility studies, and also Pacific Northwest Laboratory drilling efforts. These vadose zone (and/or groundwater) borehole samples will provide for the systematic sampling of complete vertical sections of the vadose zone at the borehole locations and the evaluation of vertical variation.

Specific sampling and analysis plans will be prepared for each of the two phases of sampling. Most aspects of these two efforts will be similar, and will differ primarily in the differences between sampling methods from boreholes versus surface sites and selected analytes. The analytes of interest in the background sampling effort are the naturally occurring constituents in the soil that are, or could be encountered, in the environmental and/or WMU activities. These primarily include the inorganic cation and anion constituents listed in Table D-1. Some of the cations that are included in Table D-1 are not anticipated to be waste constituents, but are included because the cations are major or minor element components of the soil that are important for correlation and purposes of evaluating the conceptual model.

Many organic constituents also occur naturally in soil and also will be included in the analyte list where appropriate. Most inorganic constituents in background samples are unaffected by the length of the holding time; however, many organic compounds can change with time after the compounds are sampled. Thus, organic constituents could be omitted from the list of constituents for some samples, particularly those samples obtained from boreholes where it is not possible to analyze the samples within EPA holding time limits.

Analysis of the data will include tests for internal consistency and will include the application of professional judgment to aid in distinguishing the possible contamination of a sampling location or particular samples. Description of this aspect of data analysis will be included in the data analysis. Special care also will be exercised in the interpretation of data from samples that might be prone to contaminant retention (e.g., caliche-bearing samples).

D2.1 SUPPORTING INFORMATION AND OTHER CHARACTERIZATION EFFORTS

Supporting geologic information required for the refinement and corroboration of the conceptual model will be obtained from several sources including the Hanford Site, regional personnel, experienced geologic personnel, existing references, and additional field work. This information will be compiled and documented in the summary of results.

Corroboration of the conceptual model also will require some soil characterization efforts that extend beyond those required by EPA or Hanford Site protocols. These characterization efforts involve the identification of the constituent mineral and rock components in the soils and sediments, size fraction measurements, and compositions on a limited number of samples. Bulk chemistry analyses by x-ray fluorescence also will be obtained on a limited number of samples to provide a cross-reference between bulk chemistry and leachate chemistry, and also to provide a basis for the use of x-ray field screening techniques. Some of this additional characterization data will be obtainable from the Pacific Northwest Laboratory database and also from characterization efforts that are planned for some of the borehole samples.

D2.2 ACTIVITY ORGANIZATION

Specific components of the Site-wide soil background characterization activities include the following:

- Description of Hanford Site background working model
- Field reconnaissance and identification of sampling sites
- Preparation of sampling and analysis plans (including DQO and quality assurance project plan)
- Preparation of laboratory analysis work order
- Arrangements for nonprotocol analyses and measurements
- Field sampling
- Laboratory analysis and data generation
- Data validation
- Compilation of new and existing data, data entry, and data screening
- Data interpretation (includes statistical and geochemical analyses)
- Summary and documentation of results.

The organization of these activities and distribution of effort are illustrated in Figure D-2. The sampling and analysis efforts are scheduled to begin with the preparation of sampling and analysis plans, quality assurance project plans, and other required documentation for each of the two phases of sampling. The schedules for these activities depends on the laboratory availability and documentation requirements.

The preliminary breakdown for the distribution of effort in the two main phases of Site-wide soil sampling is summarized as follows:

- Surface and near-surface sampling from outcrops and existing Hanford Site borrow pits (approximately 80 samples)
- Borehole sampling analysis activities (limited to analysis of sample splits)
- Savage Island borehole; eastern Hanford Site boundary borehole (approximately 12 samples)
- Deep microbiology and background borehole; northern Hanford Site boundary, through entire vadose zone (approximately 40 samples)
- CERCLA remedial investigation/feasibility study borehole and groundwater well activities (unscheduled)

- Other borehole activities; e.g., soil column disposal site drilling; 200 East and 200 West Areas (unscheduled).

All borehole sampling and analysis will involve only the acquisition and analysis of sample splits and will involve no drilling costs to this project. Soil background data obtained from borehole and groundwater well activities will yield supplemental data at no cost to the Site-wide background characterization effort.

D3.0 GROUNDWATER

Groundwater background efforts for fiscal year 1991 initially will be limited to the compilation and analysis of existing data, the development and refinement of groundwater background conceptual models, and development of the technical basis for groundwater sampling and analysis.

The activities presently scheduled in fiscal year 1991 include the following:

- The compilation of existing groundwater compositional data
- Development and refinement of groundwater conceptual models for the Hanford Site groundwater background in the context of the hydrologic systems
- Evaluation of geochemical constraints on groundwater-aquifer interaction
- Statistical evaluation of groundwater compositional data
- Limited measurement and sampling at existing well sites.

The organization of these activities is summarized in Figure D-2. The compilation and summary of data include archived water chemistry data from the groundwater monitoring program and other available sources; information on the aquifer components that control chemical reactions and compositions (i.e., phase identification, intensive parameters, phase chemistry); information on the range of intensive parameters within the aquifer regime (e.g., temperature, Eh); and information on the hydrology and geology of the aquifer (e.g., physical and hydrologic properties, flow lines, etc.). The evaluation of these data using statistical, geochemical, and population approaches leads to the development and/or refinement of the conceptual model(s). The results of these activities will be used to identify additional information needs. In the absence of a program of systematic sampling as a follow-on to these activities, it is anticipated that this effort will result only in the identification of additional information needs.

Statistical analysis and population evaluations will be similar to those used for soil, but used for the purpose of discriminating aquifer populations from natural and predicted (e.g., equilibrium) inter-aquifer variation. Data

from other activities, such as the Basalt Waste Isolation Project groundwater data, basalt-water interaction information, and studies on the Hanford and Ringold Formation mineral-rock constituents also will be used to supplement existing data in these evaluations.

Geochemical reaction path modeling also will be initiated. These models will be designed to test the conceptual models for range of groundwater compositions expected in the Hanford Site aquifers as a function of recharge, aquifer type, residence time in the aquifer (water-aquifer reaction time), and other influences (e.g., mixing, external buffering, etc.).

Some measurement from existing groundwater wells for Eh associated with water chemistry could be included in this effort to obtain information not otherwise obtainable from regulatory analyses alone, but that is fundamental to the development, refinement, and corroboration of the conceptual models (e.g., Eh/dissolved oxygen content in groundwater laterally and vertically within the aquifer).

These efforts presumably will culminate in systematic groundwater sampling and analysis activities for the next fiscal year.

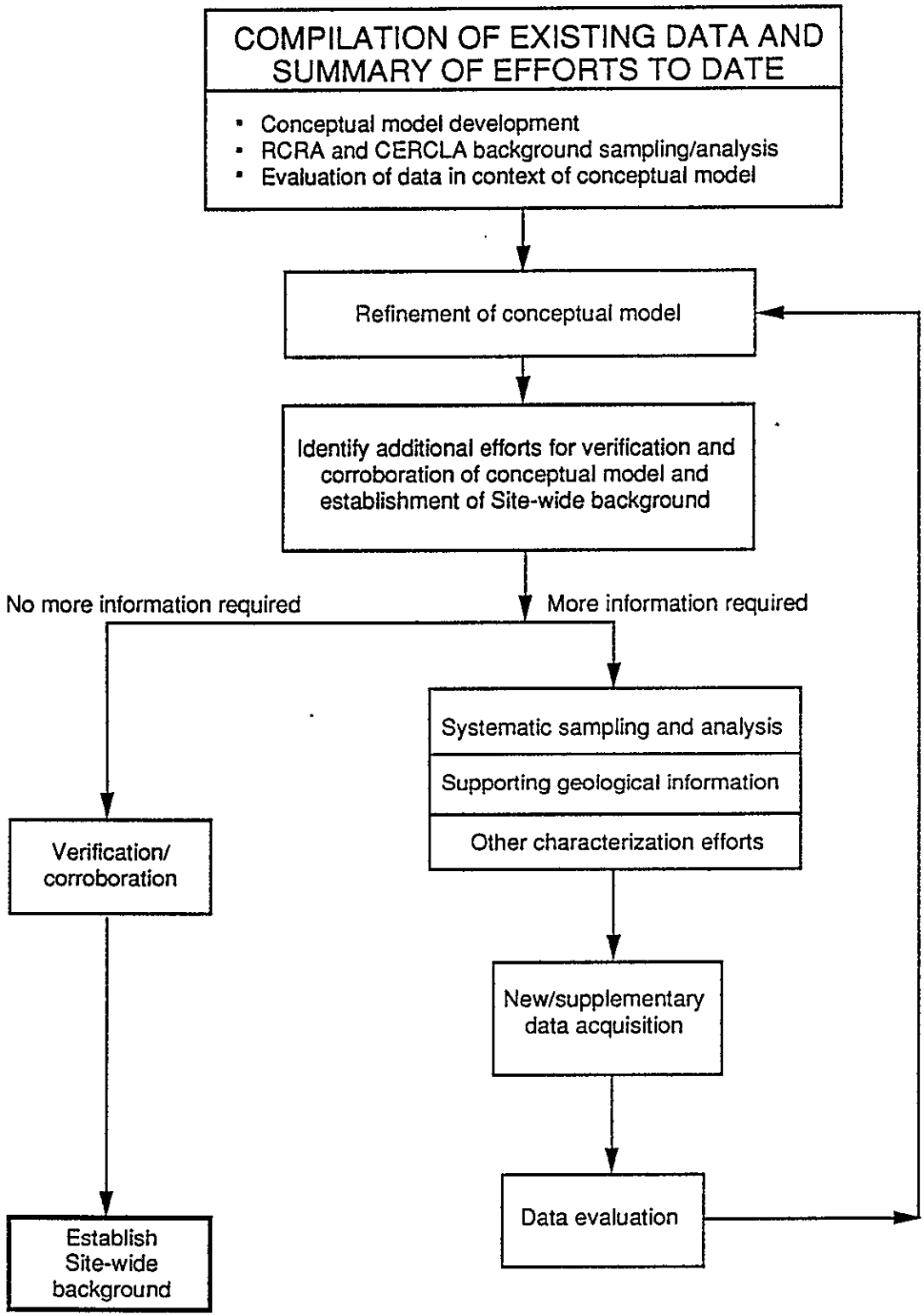

Figure D-1. Site-wide Soil Background Activities.

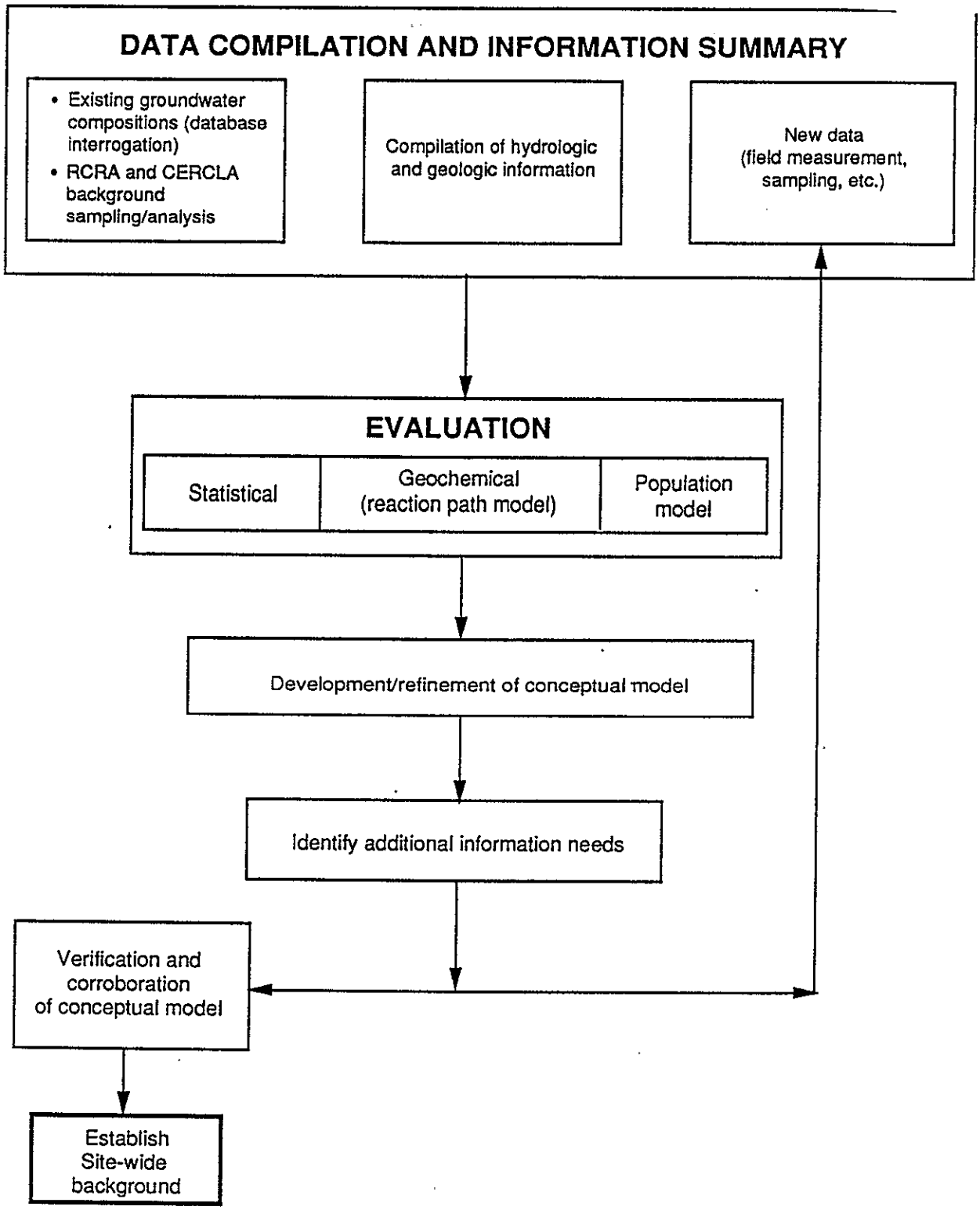

Figure D-2. Site-wide Groundwater Background Activities.

Table D-1. Soil Background Analytes.

Typical EPA Constituents	
Cations	**Anions**
Antimony	Fluoride
Arsenic	Chloride
Barium	Nitrate-nitrite
Beryllium	Phosphate
Cadmium	Sulfate
Chromium	
Cobalt	
Copper	**Others**
Lead	Ammonium
Mercury	Total organic carbon
Nickel	± Semivolatile organics
Selenium	
Silver	
Thallium	
Tin	
Vanadium	
Zinc	
Other Major, Minor, and Indicator Constituents	
Aluminum	Molybdenum
Calcium	Potassium
Iron	Sodium
Lithium	Silicon
Magnesium	Tungsten
Manganese	Titanium

APPENDIX E

SOIL BACKGROUND COST SAVINGS ESTIMATE

APPENDIX E

SOIL BACKGROUND COST SAVINGS ESTIMATE

E1.0 INTRODUCTION

The cost savings that will be realized from implementing a Site-wide soil background program will occur in several areas and forms. The first area of savings is in the area of direct costs associated with the reduced amount of sampling and analysis work to be performed. Associated with this savings is the parallel savings of the reduced amount of documentation to be generated to control the work. The second area of savings is in the benefits to be accrued from consistent application of background levels at all WMUs. Application of a consistent background level at all WMUs will prevent one WMU from being cleaned to a more stringent standard than another, thus ensuring optimum application of cleanup funds. A third area of cost savings will be the intangible costs associated with public and regulatory acceptance of background levels and the reduced amount of effort in the comment resolution process. The discussion in the following sections concerns only the direct cost savings. However, the indirect and intangible cost savings should not be forgotten or ignored.

E2.0 CURRENT DIRECT COSTS

The process of determining a local soil background can be broken down into the following tasks:

Task	Each WMU	All WMUs
Preparation of the field sampling plan	($ 34,400)	$ 4,816,000
Field sampling of the soil	(6,900)	963,000
Laboratory analysis of the soil samples	(33,800)	4,725,000
Data review and validation	(2,800)	398,000
Data analysis	(2,800)	398,000
TOTAL EXISTING BASELINE COST:		**$11,300,000**

The dollar amounts have been computed from both manhour estimates and from examination of cost data for several WMUs on the Hanford Site for which background sampling has been performed. The conversion of manhours to dollars does not include General Services Administration overhead charges (exempt labor = $32.85 per hour, nonexempt = $15.01 per hour).

The number of samples on which the field sampling and analysis costs has been based is 25. This is based on the requirements of the *Model Toxics Control Act* that requires a minimum of 20 samples be collected to establish background. Inclusion of the necessary quality assurance blanks and

duplicates raises the sample number from 20 to 21 or 22. The reject rate determined from contract laboratory program protocol analysis is about one in five samples. This raises the total number of samples required at each site from 21 or 22 to about 25.

E3.0 SITE-WIDE SOIL BACKGROUND COST ESTIMATE

The cost estimate for performing a Site-wide soil background measurement is based on the same type of tasks that are described under Section E2.0, plus additional tasks for identifying the field sampling locations and documenting the new methods. The following cost estimate has been based on a maximum of approximately 170 samples.

Task	Cost
Method documentation	$ 31,000
Identification of field sampling locations	11,000
Preparation of field sampling plan for site background	28,000
Field sampling of soil	47,000
Laboratory analysis of soil samples	230,000
Data review and validation	17,000
Data analysis	17,000
SITE-WIDE SOIL BACKGROUND COST ESTIMATE:	**$381,000**

TOTAL COST SAVINGS

CURRENT DIRECT COSTS	$11,300,000
MINUS SITE-WIDE SOIL BACKGROUND COST	381,000
NET SAVINGS:	**$10,919,000**

Inclusion of the General Services Administration adders into the estimate raises the labor rates by about 50 percent, and adds about 3 million to the estimated savings. The claimed savings of at least $10 million easily is supported by this estimate.

Benton County Planning Department

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