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HAZARD RANKING SYSTEM EVALUATION OF CERCLA INACTIVE WASTE SITES AT HANFORD

Volume 1 - Evaluation Methods and Results

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PREFACE

The purpose of this report is to formally document the individual site Hazard Ranking System (HRS) evaluations conducted as part of the preliminary assessment/site inspection (PA/SI) activities at the U.S. Department of Energy (DOE) Hanford Site. These activities were carried out pursuant to the DOE orders that describe the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program addressing the cleanup of inactive waste sites. These orders incorporate the U.S. Environmental Protection Agency methodology, which is based on the Superfund Amendments and Reauthorization Act of 1986 (SARA). The methodology includes six parts: PA/SI, remedial investigation/feasibility study, record of decision, design and implementation of remedial action, operation and monitoring, and verification monitoring.

Volume 1 of this report discusses the CERCLA inactive waste-site evaluation process, assumptions, and results of the HRS methodology employed.

Volume 2 presents the data on the individual CERCLA engineered-facility sites at Hanford, as contained in the Hanford Inactive Site Surveillance (HISS) Data Base.

Volume 3 presents the data on the individual CERCLA unplanned-release sites at Hanford, as contained in the HISS Data Base.

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EXECUTIVE SUMMARY

This report documents the individual site Hazard Ranking System (HRS) evaluations conducted as part of the preliminary assessment/site inspection (PA/SI) activities performed at the U.S. Department of Energy (DOE) Hanford Site. The following assessment activities were undertaken:

- scoring of 335 engineered-facility sites, using the Hazard Ranking System (HRS) (40 CFR 300) methodology - The Hanford Inactive Site Surveillance (HISS) Data Base (developed for this project) incorporated the HRS scores for these sites. Results were also sent to the managers of the Waste Information Data System (WIDS), which tracks CERCLA and non-CERCLA waste sites.
- identification, investigation, and scoring of 20 newly designated engineered-facility sites - The HRS methodology was used to score these sites, and the scores and site data were entered into the HISS Data Base and sent to the WIDS data base managers.
- identification, investigation, and evaluation of 291 unplanned-release sites - These sites were evaluated using the HRS methodology. The HISS Data Base was updated to include these sites, and the information was sent to the WIDS data base managers.
- aggregation of the Hanford inactive waste sites into four administrative sites and development of HRS evaluation packages for each of the four aggregate sites.

These activities were carried out under the direction of the DOE orders that define the DOE Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program.

The evaluation included a total of 646 individual inactive waste sites at Hanford. Figure S.1 is a categorical breakdown of those waste sites. Also shown in Figure S.1 is a breakdown of the 125 sites that scored greater than 28.5 on the HRS migration route. A listing of the 125 sites that scored greater than 28.5 is presented in Table S.1.

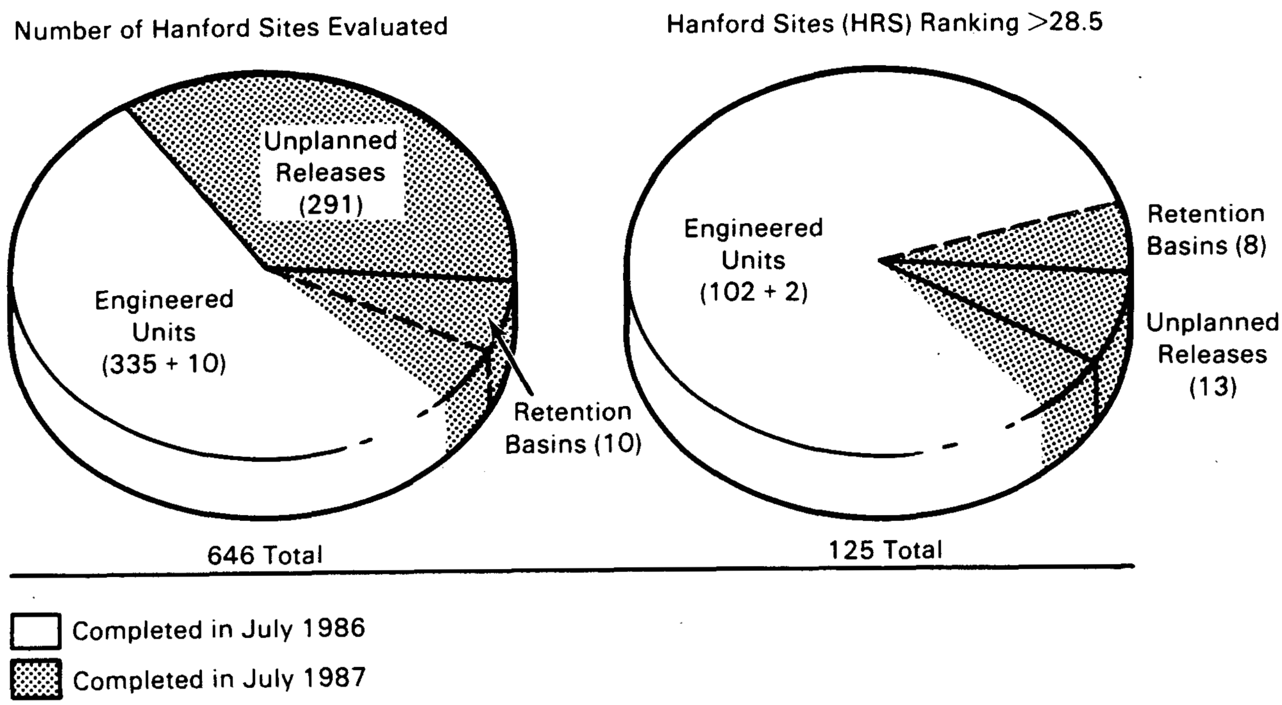

FIGURE S.1. Categorical Breakdown of the 646 Inactive Waste Sites at Hanford and the 125 Waste Sites that Scored Greater than 28.5 on the Hazard Ranking System Migration Route

At the request of the U.S. Environmental Protection Agency, the inactive waste sites (CERCLA Program sites) at Hanford were combined into four administrative aggregate areas. These four areas were then evaluated using the HRS methodology and scoring packages prepared for use in proposing the Hanford Site for listing on the National Priority List. Table S.2 lists the four U.S. DOE Hanford Aggregate-Area sites and their respective scores.

TABLE S.1. Hazard Ranking System (HRS) High-Scoring Sites (Score Greater Than 28.5)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
116-DR-7	100 D/DR	Crib	28.95
216-S-16P	200 West	Pond	32.71
216-U-4	200 West	Reverse Well	32.71
216-A-40	200 East	Trench	32.71
UPR-1100-4	1100	Tank	34.59
White Bluffs Pickling Acid Crib	600	Crib	35.49
1100 Area Battery Acid Pit	1100	Sand Pit	38.54
216-U-11	200 West	Ditches (2)	37.75
116-DR-3	100 D/DR	Trench	40.09
116-KE-1	100 KE/KW	Crib	40.09
116-KW-1	100 KE/KW	Crib	40.09
116-B-2	100 B/C	Trench	40.09
116-B-5	100 B/C	Crib	40.09
100 KW*1	100 KE/KW	Dry Well	40.09
100 KW*2	100 KE/KW	French Drain	40.09
116-F-7	100 F	French Drain	40.93
116-DR-1	100 D/DR	Trench	42.32
116-DR-2	100 D/DR	Trench	42.32
116-H-1	110 H	Trench	42.32
116-H-2	100 H	Trench	42.32
116-H-3	100 H	French Drain	42.32
116-K-1	100 KE/KW	Crib	42.32
116-B-1	100 B/C	Trench	42.32
116-C-1	100 B/C	Trench	42.32
116-C-2	100 B/C	Crib	42.32
116-F-3	100 F	Trench	42.32
116-F-2	100 F	Trench	42.32
116-F-6	100 F	Trench	42.32
116-F-9	100 F	Trenches (2)	42.32
116-F-10	100 F	French Drain	42.32
100 KE*2	100 KE/KW	French Drain	42.32
116-DR-6	100 D/DR	Trench	42.32
100 KE*1	100 KE/KW	Dry Well	42.32
116-D-1B	100 D/DR	Trench	42.32
UPR-300-39	300	Unplanned Release	44.02
UPR-100-N-1	100 N	Unplanned Release	44.37
UPR-100-N-2	100 N	Unplanned Release	44.37
116-B-4	100 B/C	French Drain	44.55
116-F-1	100 F	Trench	44.55
216-Z-1(D)	200 West	Ditch	45.30
216-Z-11	200 West	Ditch	45.30
216-N-2	200 North	Trench	45.30
216-N-3	200 North	Trench	45.30

TABLE S.1. (contd)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
216-N-4	200 North	Pond	45.30
216-N-5	200 North	Trench	
45.30216-N-6	200 North	Pond	45.30
216-N-7	200 North	Trench	45.30
216-B-2-2	200 East	Trench	45.30
216-S-11	200 West	Pond	45.30
216-Z-17	200 West	Trench	45.30
216-U-4B	200 West	French	45.30
216-U-3	200 West	French Drain	47.27
UPR-100-N-9	100 N	Unplanned Release	47.33
216-A-4	200 East	Crib	47.81
216-A-6	200 East	Crib	47.81
216-B-4	200 East	Crib	47.81
216-B-10A	200 East	Crib	47.81
216-B-11A&B	200 East	Reverse Well	47.81
216-C-10	200 East	Crib	47.81
216-S-3	200 West	French Drains (2)	47.81
216-S-4	200 West	French Drain	47.81
216-S-5	200 West	Crib	47.81
216-S-6	200 West	Crib	47.81
216-S-17	200 West	Pond	47.81
216-S-16D	200 West	Ditch	47.81
216-S-21	200 West	Crib	47.81
216-T-8	200 West	Crib	47.81
216-T-28	200 West	Crib	47.81
216-Z-10	200 West	Reverse Well	47.81
216-A-28	200 East	French Drain	47.81
216-U-4A	200 West	French Drain	47.81
116-KE-2	100-KE/KW	Crib	49.00
UPR-100-N-17	100 N	Unplanned Release	50.28
216-A-36A	200 East	Crib	50.33
216-B-6	200 East	Reverse Well	50.33
216-B-50	200 East	Crib	50.33
216-B-57	200 East	Crib	50.33
216-C-1	200 East	Crib	50.33
216-S-9	200 West	Crib	50.33
216-S-20	200 West	Crib	50.33
216-Z-7	200 West	Cribs (2)	50.33
216-T-2	200 West	Reverse Well	50.33
116-K-2	100 KE/KW	Trench	51.23
216-Z-1 & 2	200 West	Crib	52.85
UPR-100-K-1	100 KE/KW	Unplanned Release	53.24
216-S-1 & 2	200 West	Cribs (2)	55.36
216-A-7	200 East	Crib	57.88
216-A-9	200 East	Crib	57.88
216-A-21	200 East	Crib	57.88

TABLE S.1. (contd)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
216-A-24	200 East	Crib	57.88
216-A-27	200 East	Crib	57.88
216-B-43	200 East	Crib	57.88
216-S-7	200 West	Cribs (2)	57.88
216-T-19	200 West	Crib and Tile Field	57.88
UPR-300-13	300	Unplanned Release	59.74
UPR-300-40	300	Unplanned Release	59.74
216-A-5	200 East	Crib	60.40
216-B-5	200 East	Reverse Well	60.40
216-B-44	200 East	Crib	60.40
216-T-3	200 West	Reverse Well	60.40
UPR-300-12	300	Unplanned Release	62.88
UPR-300-38	300	Unplanned Release	62.88
216-B-12	200 East	Cribs (3)	62.92
216-B-16	200 East	Crib	62.92
216-B-45	200 East	Crib	62.92
216-B-46	200 East	Crib	62.92
216-B-48	200 East	Crib	62.92
216-B-49	200 East	Crib	62.92
216-U-1 & 2	200 West	Crib	62.92
216-B-7A&B	200 East	Crib	65.43
216-T-7	200 West	Crib and Tile Field	65.43
UPR-100-N-5	100 N	Unplanned Release	68.03
UPR-100-N-12	100 N	Unplanned Release	70.99
UPR-100-N-3	100 N	Unplanned Release	73.95
107-C	100 B/C	Retention Basin	76.91
107-D	100 D/DR	Retention Basin	76.91
107-DR	100 D/DR	Retention Basin	76.91
107-F	100 F	Retention Basin	76.91
107-H	100 H	Retention Basin	76.91
107-KE	100 KE/KW	Retention Basin	76.91
107-KW	100 KE/KW	Retention Basin	76.91
107-B	100 B/C	Retention Basin	76.91
316-1	300	Pond	79.28
316-2	300	Pond	79.28
316-3	300	Trench	79.28

TABLE S.2. Hazard Ranking System (HRS) Migration Route Scores for the Four U.S. DOE Hanford Aggregate-Area Sites

Aggregate Site Name	Location (Hanford Operational Area)	HRS Migration Score
U.S. DOE Hanford 100 Area	100	46.38
U.S. DOE Hanford 200 Area	200; 600	69.05
U.S. DOE Hanford 300 Area	300; 600	65.23
U.S. DOE Hanford 1100 Area	1100	36.33

REFERENCES

U.S. Code of Federal Regulations, Title 40, Part 300 (40 CFR 300), Appendix A; "Uncontrolled Hazardous Waste Site Ranking System; A Users Manual."

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FIGURES

TABLES

1.0 INTRODUCTION

This report contains the results of the individual site Hazard Ranking System (HRS) evaluations conducted as part of the preliminary assessment/site inspection (PA/SI) activities performed at the U.S. Department of Energy (DOE) Hanford Site. The HRS evaluation of the Hanford Site was conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements of the DOE orders that address the cleanup of inactive waste sites. The DOE orders reflect the Superfund Amendments and Reauthorization Act (SARA), and incorporate the U.S. Environmental Protection Agency (EPA) methodology (EPA 1985).

In addition, near the end of fiscal year 1987, the EPA emphasized placing the Hanford Site on the National Priority List (NPL). As a result, the identified CERCLA sites located on the Hanford Site were combined to form four administrative aggregate sites for consideration for listing on the NPL. These four aggregate sites (Figure 1.1) are called the "U.S. DOE Hanford" sites (i.e., U.S. DOE Hanford 100 Area, U.S. DOE Hanford 200 Area, U.S. DOE Hanford 300 Area, and U.S. DOE Hanford 1100 Area). The aggregation of the Hanford Site into the four U.S. DOE Hanford sites altered the Hanford PA/SI work in that the Hazard Ranking System (HRS) scores produced for the four administrative aggregate sites became the official basis for considering the Hanford Site for listing on the NPL, and the HRS scores previously produced during the evaluation of the individual sites became only supportive information.

A total of 335 engineered-facility sites (i.e., cribs, trenches, and other facilities designed specifically for the disposal of liquid waste) were scored using the HRS (40 CFR 300). The results of the evaluation of these sites are included in this report. Also included are the results from the investigation and evaluation of 20 newly designated engineered-facility sites, and the results from the investigation and evaluation of the 291 pre-1980, unplanned-release sites. The HRS methodology (40 CFR 300) was used in the scoring of these sites. The inclusion of these additional 311 sites raises the total number of pre-1980 CERCLA sites evaluated at Hanford to 646. In addition, the report includes a brief summary of the

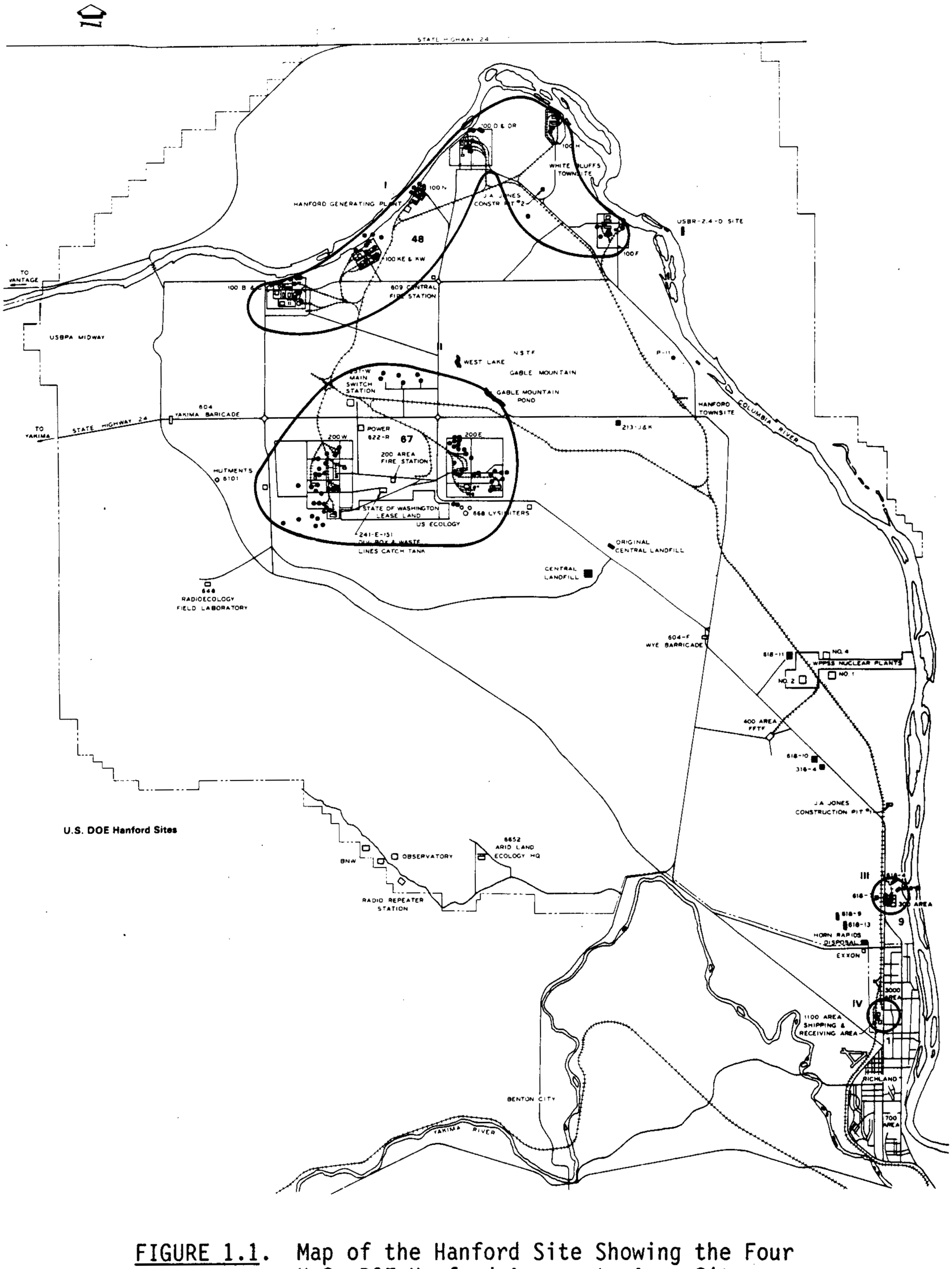

FIGURE 1.1. Map of the Hanford Site Showing the Four U.S. DOE Hanford Aggregate-Area Sites

results associated with the aggregation of the Hanford inactive waste sites into four administrative aggregate sites for the purpose of listing the Hanford Site on the NPL. These four Hanford aggregate sites, evaluated using the HRS methodology and the evaluation process with the HRS scores, were documented in four NPL packages with an exact format and content specified by the EPA. These four NPL packages have been accepted by the EPA as sufficient to satisfy PA/SI reporting requirements.

1.1 BACKGROUND OF THE DOE MISSION AT HANFORD

Established in 1943, the Hanford Site was originally designed, built, and operated to produce plutonium for nuclear weapons using production reactors and chemical reprocessing plants. Since then, waste management, energy research and development, isotope use, and other activities have been added to Hanford operations. The production activity created relatively large volumes of low-level radioactive wastes and solid and liquid chemical wastes, which were disposed of in the soil column.

Historical practices and operational changes of particular interest to this study are as follows:

- substitution of a bismuth phosphate precipitation process with solvent extraction chemical reprocessing in 1956 (and associated replacement of bismuth phosphate first- and second-cycle wastes with solvent wastes)
- segregation of transuranic solid waste, stored for later shipment off site, beginning in 1970 by order of the DOE
- shutdown of the last of eight once-through cooled production reactors (adjacent to the Columbia River) in 1971
- termination of routine liquid discharges containing transuranics to the soil column in 1973
- consolidation of all radioactive solid-waste disposal in all Hanford areas to the 200 Areas and of all nonradioactive trash/chemicals to the Central Landfill (an area near the center of the Site) in 1973.

As a result of these process changes and new DOE requirements, the sites of most interest to this study are those established early in the history of Hanford's waste-management operations. Current disposal practices at Hanford have not resulted in measurable public health impacts (Price et al. 1984, 1985; Cline, Rieger, and Raymond 1985; Price 1986).

1.2 METHODOLOGY

This section presents the methodology used in the evaluation of the individual hazardous waste sites to collect and analyze data, evaluate past operations, estimate whether waste-disposal sites have released contaminants to the environment, and evaluate/score sites.

Basically, the methodology included the following steps:

1. collection of waste-disposal site data through exhaustive literature review, including confirmation of data
2. additional confirmation of data through review of maps and employee interviews
3. visual inspection of all sites, including photographing each site
4. establishment (e.g., decay correct for radionuclides, interpret historical records, apply assumptions, and perform calculational estimates) of a radionuclide and chemical inventory and incorporation into data base
5. review of and comment resolution on data packages
6. application of computerized HRS on individual site data packages
7. performance of quality control and quality assurance functions on individual site scoring packages
8. confirmation/determination of whether sites scoring above 28.5 on the HRS (based on geochemistry, degree of hazard of process stream, and other scientific analysis) were likely to pose a potential risk to the public

9. aggregation of the individual waste site into four administrative aggregate-area sites and scoring of the four administrative aggregate-area sites, which included working with EPA Region X to define the aggregate areas, assembling the input data necessary to score each aggregate area using the HRS, evaluating and producing HRS scores for each aggregate-area site, and developing detailed HRS evaluation documentation packages for each of the four aggregate-area sites

10. documentation of the HRS evaluation activities in the form of a formal report.

1.2.1 Evaluation of Past Operations

Information collected on the waste sites was compiled in the Hanford Inactive Sites Surveillance (HISS) Data Base. The HISS Data Base is a computerized data file documenting past waste-disposal information for inactive waste-disposal sites and unplanned chemical and radiological releases to the environment at Hanford. The HISS Data Base has been established and operated under PNL-MA-70 quality assurance plan number OHE-1C, which is entitled "QA Plan for the Remedial Investigation of Waste Sites Covered by the Inactive Waste Site Surveillance Project." Initially, a thorough literature search was conducted to identify information on the waste management operations, past disposal practices, and unusual occurrence problems (i.e., unplanned releases). Verification activities also included visually inspecting and photographing individual sites and interviewing numerous present and past Hanford Site employees who may have had access to or knowledge of unpublished information sources. This unpublished information was often useful for resolving contradictions in historical documentation.

All information was used as input to the HISS Data Base. The file was then extensively peer-reviewed by other Hanford personnel for accuracy and consistency with other Hanford data (e.g., ERDA 1975; DOE 1987).

1.2.2 Determination of Radiological and Chemical Inventories

Radiological inventories were obtained from existing Hanford data bases and other official records. In some cases, those data bases and records were updated by information gathered by the CERCLA program, based on comments received by the authors concerning the HISS Data Base.

Chemical inventories of inactive waste-disposal sites were obtained in four steps, described below:

1. Identification of Hanford Site activities generating chemical waste.

Hanford Site activities generating chemical or process wastes at each inactive waste-disposal site were most often identified using information from one or more of several documents, including Radiological Characterization of the Retired 100 Areas (Dorian and Richards 1978) and Handbook of 200 Area Waste Sites (Maxfield 1979). These references usually included a description of the source of the waste received by the site as well as an inventory of the radionuclides received by the site. The primary limitation of these references was their singular focus on radioactively contaminated sites. This limitation was minor, however, because relatively few of the inactive disposal sites at Hanford contained chemical contamination only. Sources of wastes for the chemically contaminated sites were usually identified by site employees.

2. Determination of data characterizing chemical composition of waste streams.

The chemical composition of waste streams was estimated from an analysis of process descriptions. For those processes that were not thoroughly described, major waste constituents were estimated based on knowledge of the chemicals used in the process. The chemical characteristics of a few waste streams (e.g., laboratory wastes, decontamination wastes) were estimated based on information supplied by personnel with knowledge of the process and/or waste produced. A few waste streams were well characterized in documentation related to waste disposal.

3. Determination of data characterizing waste quantities.

The quantities of most liquid wastes and some solid wastes are included in Dorian and Richards (1978) and Maxfield (1979) as well as in periodic reports on radioactive discharges and in correspondence files. If waste quantities were not otherwise documented, estimates were obtained from employees familiar with the sites and Hanford operations. Frequently, it was necessary to estimate waste volumes based on specific site descriptive information (e.g., site volume, size, radiological survey measurement, production information, etc.).

4. Determination of data estimating chemical inventories.

Inventories of chemicals associated with liquid-waste streams were usually obtained from records of waste composition and quantity (i.e., from concentration and volume). In some cases, chemical inventories for liquid wastes were obtained directly from chemical usage estimates provided by employees. Occasionally, employees would acknowledge the disposal of certain chemicals to waste streams but could not recall any information on quantities. Inventories of chemicals associated with solid wastes and unplanned releases were generally more difficult to obtain. Employees were usually able to indicate, however, whether a solid-waste disposal site received any chemical wastes. According to disposal records, the vast majority of solid-waste disposal sites at Hanford primarily received wastes contaminated with radionuclides. Frequently, only brief descriptions of unplanned releases were available and inventories had to be estimated using the descriptive information provided and general knowledge of the process(es) involved in the unplanned release.

1.2.3 Ranking Waste-Disposal Sites Using the HRS

The HRS methodology for ranking hazardous waste sites was developed for the EPA for the purpose of identifying the nation's inactive waste sites warranting the highest priority for remedial action. The HRS system evaluates sites on the basis of relative risk or danger, taking into account the population at risk, the hazard potential of the substances at the facility, the potential for contamination of the environment (i.e, ground water, surface water, and air), the potential risk of fire and explosion, and the potential for injury associated with humans or animals coming in contact with the substances contained at the site (40 CFR 300). Pacific Northwest Laboratory (PNL) developed a computerized system for performing HRS evaluations (Stenner, Peloquin, and Hawley 1986). This computerized system was used to perform the evaluations of the sites presented in this report. Site data and HRS scores were managed by the HISS Data Base, which was developed by PNL for this project.

To facilitate the evaluation of this large number of sites, investigators initially grouped the sites by operations area. Preliminary assessment of the data indicated that, in addition to waste-disposal site locations, a critical factor in determining the overall HRS score was the classification of the waste-disposal site as having an "observed release"[a] or "no observed release."

The classification of waste-disposal sites as having observed releases to ground or surface waters was a crucial factor in determining the overall site score. Because of the importance of this classification, the term "observed release" was applied to sites where either direct evidence (e.g., scintillation-log data) or strong circumstantial evidence (e.g., volumes of process water in excess of soil capacity) indicated a release of contaminants to ground or surface water. The second category, "no observed release," was applied to sites where neither direct nor strong circumstantial evidence of release was found.

As a result of this classification, the sites in the 100 and 200 Areas were further subdivided in preparation for scoring. These divisions were as follows:

(a) The observed release classification is in reference to discharge of material to the ground or surface water. No evidence of the sites having observed atmospheric releases was found; consequently, this route was scored as "0" in accordance with the procedures specified for the HRS methodology.

- 100 Area Sites
  - Liquid-Waste Disposal Sites - no observed release
  - Liquid-Waste Disposal Sites - observed
  - Solid-Waste/Miscellaneous Disposal Sites
- 200 Area Sites
  - Liquid-Waste Disposal Sites - no observed release
  - Liquid-Waste Disposal Sites - observed release
  - Solid-Waste/Miscellaneous Disposal Sites.

In the 100 and 200 Areas, as shown above, only some of the liquid-waste disposal sites were scored as having observed releases. None of the solid-waste disposal sites had any evidence (direct or circumstantial) of release. Because of the limited number of sites, the 300 and 600 Areas were not further subdivided. (The 400 Area is where the Fast Flux Test Facility is located; it has no inactive waste-disposal sites.)

Waste-disposal sites were assigned to one or the other of the observed release/no observed release categories only after 1) available monitoring data were evaluated and 2) processing information was reviewed, if monitoring data were ambiguous or lacking. This two-step approach is examined in more detail below.

1.2.3.1 Approach to Classifying Waste-Disposal Sites

The HRS requires that sites with evidence of release of contaminants to the air, ground water, or surface water be so classified for scoring. The HRS manuals (40 CFR 300) state that contaminants in ground water or in a well near the facility constitute analytical evidence of a release. However, they also state that such existing conditions as an oily or otherwise objectionable taste or smell in well water must be confirmed to be a direct result of a release at the facility. Price et al. (1985) documented that the aquifer underlying the Hanford Site has received radioactive and chemical discharges from past operations and from sites not considered as "inactive." Consequently, most of the inactive waste-disposal sites are situated above an aquifer that contains "contaminants" and so could be construed as having an observed release. However, Hanford has ground-water monitoring wells located adjacent to some of its inactive waste-disposal sites, and these wells provide evidence that particular sites have not released contaminants to the ground water. The ambiguity in the HRS scoring instructions is indicated by the two options for scoring these sites: 1) all waste-disposal sites situated over the contaminated aquifer would be rated as having had observed releases, or 2) only waste-disposal sites with direct evidence of release (e.g., that obtained from monitoring wells in or near the waste sites) would be so classified.

Option 1 would have resulted in uniformly high scores for most sites; conversely, option 2 would have yielded low scores. Neither of these choices would be helpful for discriminating between sites that might or might not pose a risk. Therefore, an intermediate option was chosen. Sites with direct (e.g., monitoring well) evidence were classified as having had observed releases. Sites with strong circumstantial evidence of release (explained below) were similarly classified. The remaining sites, despite their location above a contaminated aquifer, were classified as having no observed release to the environment.

1.2.3.2 Data Used in Classifying Waste Sites

Scintillation-log data (Fecht et al. 1977) were used initially to classify waste-disposal sites as having had either an observed release or no observed release. Scintillation-log data describe the distribution of radioactivity that penetrates the vadose zone to the water table. This distribution corresponds to the movement of radionuclides downward through the soil column. The advantages of this approach include direct observation of contaminant movement in the vadose zone and minimal interference from other nearby disposal sites. One disadvantage is that results are limited to the migration of radionuclides only. However, the movement of nonradioactive contaminants was inferred from the migration of radionuclides having similar transport properties. For example, ruthenium-106, which is poorly attenuated by soil, was considered a good indicator of the movement of poorly attenuated chemical species such as nitrate ion (EPA 1978).

Well-logging data were also used to help classify sites. Density-type well-logging data provide a comparative analysis of moisture profiles and can identify the presence of a wetting front in the soil column. This front is associated with downward migration of liquid wastes. Contaminants such as ruthenium-106 and nitrate ions, which are not attenuated by the soil but rather move at the same speed as water, were assumed to be present in the wetting front. The effectiveness of this approach to classification was limited by the difficulty of accurately interpreting moisture-log data and the necessity of inferring rather than measuring the contamination.

There was no direct evidence available to allow classification of a majority of sites. For these sites, classification was based on strong circumstantial evidence, such as whether the volume of process water disposed of to the site exceeded the retention capacity of the soil. Other factors considered included the moisture- and contaminant-retention properties of waste-disposal sites with a specific retention design. The retention capacity of the soil column below a site was determined in the following way. The area the site was multiplied by the distance from the bottom of the site to the ground water to obtain the total soil-column volume. It was assumed that only 10% of this volume was void space and therefore available to hold liquid waste. If this available volume was less than the volume of waste disposed to the soil column, it was assumed that there was an observed release. Monitoring of the waste volume disposed at sites with specific-retention designs indicated that the long-lived radionuclides[a] were attenuated because of factors such as the favorable ion-exchange qualities of the soil column. The evidence of the retention of large inventories of long-lived radionuclides by Hanford's inactive waste-disposal sites with specific-retention design is confirmed by the limited quantity of the same long-lived radionuclides found in ground water (Price et al. 1984, 1985; Cline et al. 1985; Price 1986).

Data on the moisture- and contaminant-retention properties of the soil were used to define the minimum volume of the disposed liquid effluent necessary to reach the water table. These data included the amount of lateral spreading that occurred in the vadose zone, moisture losses caused by evaporation and transpiration, the difference between the in situ moisture content of the soil before disposal and the available moisture content of the

(a) Radionuclides with a half-life of more than 1 year, excluding tritium.

soil (field capacity), the frequency and timing of waste applications, and waste characteristics that would influence water movement (e.g., retention of moisture by high-salt wastes). The concept of specific retention was not as effectively applied to nonradioactive species disposed of along with radioactive species in mixed-waste sites, because many chemical species were poorly attenuated and did not decay. (For more explanation of specific-retention design on a site-specific basis, see Brown and Ruppert 1948; Clukey 1956; and Heid 1956).

Most of the inactive sites used for liquid disposal at Hanford were not designed for specific retention of radionuclides. These sites were designed to dispose of small to large volumes of aqueous wastes that contained relatively dilute quantities of chemicals and radionuclides. In almost all cases, the volume disposed of to these sites is recorded (see Volumes 2 and 3, the HISS Data Base). It was therefore possible, within certain limits and based on known quantities of waste disposed of and the operating history of the site, to determine if the volume of waste water disposed of was sufficient to cause the wetting front to reach the unconfined aquifer.

2.0 DESCRIPTION OF THE HANFORD SITE

This section summarizes environmental conditions at the Hanford Site and briefly discusses the Site's purpose and history. It also describes specific environmental features and the process history of each operational area (i.e., the Hanford 100, 200, 300, 400, and 600 Areas).

2.1 ENVIRONMENTAL SUMMARY

The semiarid Hanford Site, operated by the U.S. Department of Energy (DOE), occupies about 1450 km^2 (560 mi^2) of the southeastern part of Washington State north of where the Yakima River flows into the Columbia (see Figure 2.1). The Site lies about 322 km (200 mi) east of Portland, Oregon; 274 km (170 mi) southeast of Seattle, Washington; and 201 km (125 mi) southwest of Spokane, Washington.

Environmental conditions common to all areas at Hanford are summarized below. Descriptions of these environmental aspects are based on several reports (ERDA 1975; Yandon 1977; Sommer, Rau, and Robinson 1981; DOE 1984).

2.1.1 Geology and Soils

The Hanford Site lies in the Pasco Basin, a structural and topographic basin of eastern Washington lying within the Columbia Plateau. The region is underlain by three geologic units. In ascending order, these are: 1) the sequential beds of basaltic lavas and interbed sediments of the Columbia River Basalt Group; 2) the Pliocene-aged Ringold Formation (lacustrine formation), consisting of well-rounded pebbles and cobbles with interstitial spaces filled with medium sand; and 3) the Hanford formation, consisting of the Pasco (glaciofluvial) gravels and associated sediments of late Pleistocene age.

The surface geology of the Site is characterized by a surface layer of light brown, fine, slightly silty, wind-deposited sand, sparsely covered by vegetation. Although the surface soil is fertile, it has little agricultural value without irrigation. Underlying the surface sands is a mixture of sand and gravel extending to a depth of about 60 m (200 ft). Basaltic rock starts at that depth and extends downward over 3,000 m (1.9 mi).

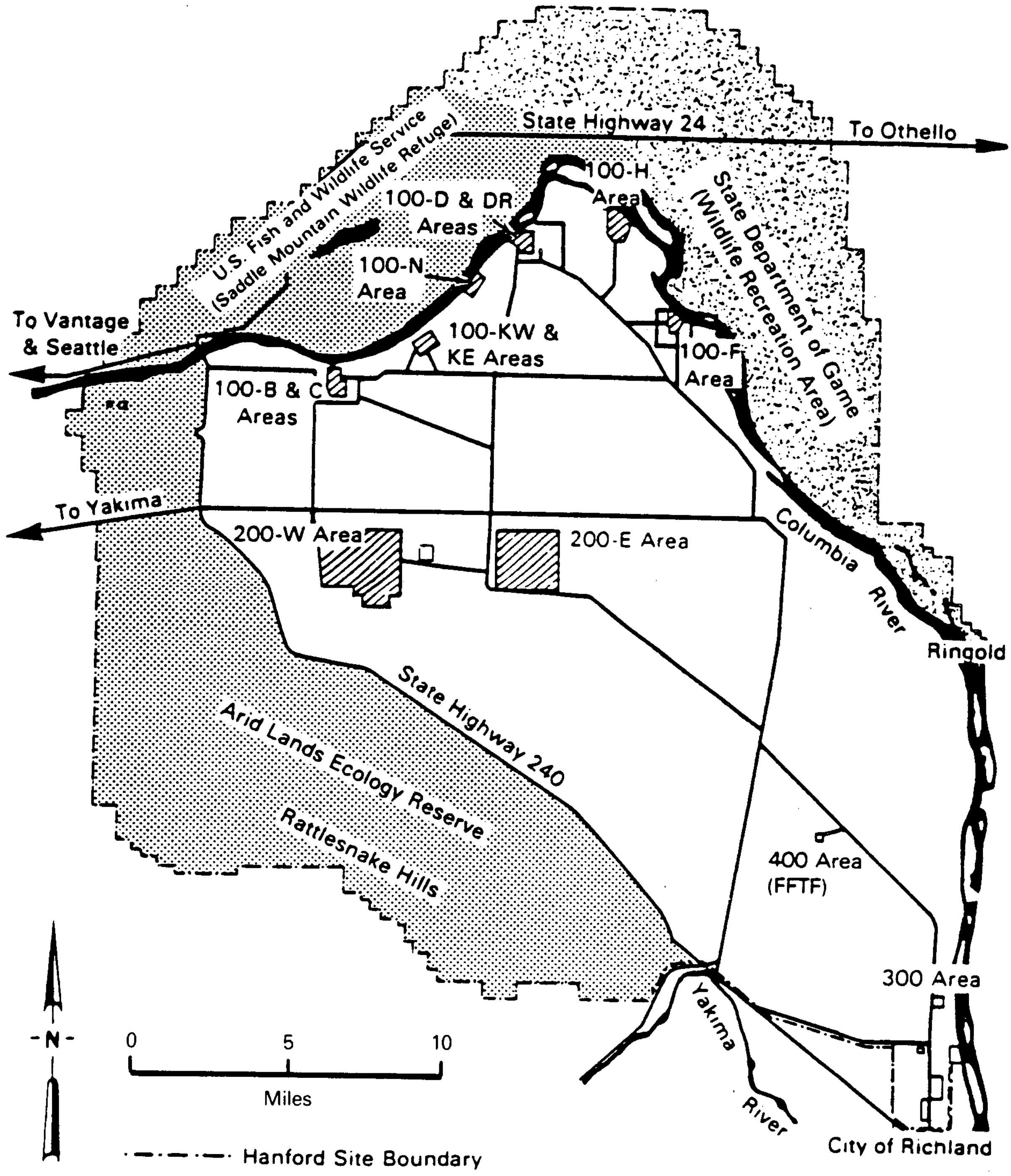

FIGURE 2.1. Features of the Hanford Site

Elevations range from a low of about 105 m (345 ft) above mean sea level (MSL) in the southeastern part of the Hanford Site to a maximum of 1,091 m (3,579 ft) at the crest of Rattlesnake Mountain to the west. (See Section 2.3 for a discussion of geologic features peculiar to each operational area.)

2.1.2 Meteorology

The Site lies east of the Cascade Mountains and, as a result, has a semiarid climate reflecting the rainshadow effect of the mountains. The average annual precipitation for the Site is about 160 mm (6.3 in.). Ten percent of this amount falls from July through September, and 42% falls from November through January. The greatest amount of rainfall recorded in a 12-hour period was 47.8 mm (1.9 in.).

Because of the limited rainfall, surface runoff from the Hanford Site is minimal. The annual precipitation mostly evaporates, resulting in small amounts of water available for runoff or infiltration.

2.1.3 Hydrology and Hydrogeology

The Columbia River (the fifth largest river by volume in North America) is the dominant aquatic ecosystem on the Hanford Site. Numerous dams have been built on the river. The only free-flowing section in the United States is between Priest Rapids Dam and McNary Reservoir, along the Hanford Site. No significant tributaries enter the stream in this section.

The Columbia has a long-term annual average flow of about 3,600 m^3/s (127,000 cfs). [The Yakima River, by comparison, flows an average of about 90 m^3/s (3,180 cfs).] The flow rates of the Columbia are influenced by water usage and upstream reservoir projects. The reservoirs provide active storage of more than 4.6×10^{10} m^3 (37,000,000 acre-ft) of water.

The uppermost aquifer in the Pasco Basin is an unconfined system within the Hanford and Ringold Formations. The elevation of this aquifer ranges from about 105 m (345 ft) above MSL at the Columbia River to about 145 m (475 ft) above MSL at the west boundary of the Hanford Site. The depth of the water table varies from place to place. It is dependent on the local topography, the transmissivity of the soil column, and the proximity of active liquid-waste disposal sites. It ranges from a few centimeters to more than 100 m (330 ft) below the land surface. The current estimate of the than 100 m (330 ft) below the land surface. The current estimate of the maximum saturated thickness of the unconfined aquifer is about 70 m (230 ft). Figure 2.2 shows the 1983 simulated water-table contours of the unconfined aquifer and general flow paths (shown as solid lines) from the 200 Area. As shown in Figure 2.2, most of the ground water from the 200 Areas flows south-east, with a small portion flowing between Gable Mountain and Gable Butte.

Confined aquifers are located within fractured basalt and the permeable sediments (interbeds) between some of the basalt units underlying the region. The confined aquifers found at various depths in the basalt are important sources of water in many parts of the Pasco Basin.

Since 1943 large volumes of process cooling water and low-level radio-active liquid wastes have been released to the ground through cribs, ditches, and ponds. Liquid wastes discharged to the ground percolate downward and laterally, and they eventually enter the unconfined ground water underlying the Hanford Site. Soluble and mobile contaminants (i.e., those not retained significantly by the soil column) in the liquid effluents, such as tritium and nitrates, have reached the ground water under the Site, but are restricted primarily to the unconfined aquifer. More than 300 monitoring wells are currently in use by the Pacific Northwest Laboratory (PNL) to monitor the movement of contaminants in the unconfined aquifer.

Percolating waste water in proximity to the 200 Area has created localized ground-water mounds that have raised the water table. Disposal at other operating areas has also occurred. Smaller amounts of waste water have been disposed of through ground facilities at the various 100 Areas and at the 300 Area. The Fast Flux Test Facility (FFTF) in the 400 Area contributes very little waste to the ground water.

2.1.4 Sources of Drinking Water

Because of the availability of Columbia River water, ground water is used for drinking in only a few locations: 1) the 400 Area, 2) the guard station at the Yakima Barricade near the western boundary of the Site, 3) the Hanford Patrol Training Academy near Route 10 (Horn Rapids Road), and 4) intermittently, at Washington Public Power Supply System's (Supply System) mothballed plants, WNP #1 and #4 (Figure 2.3). Of the four wells, only the

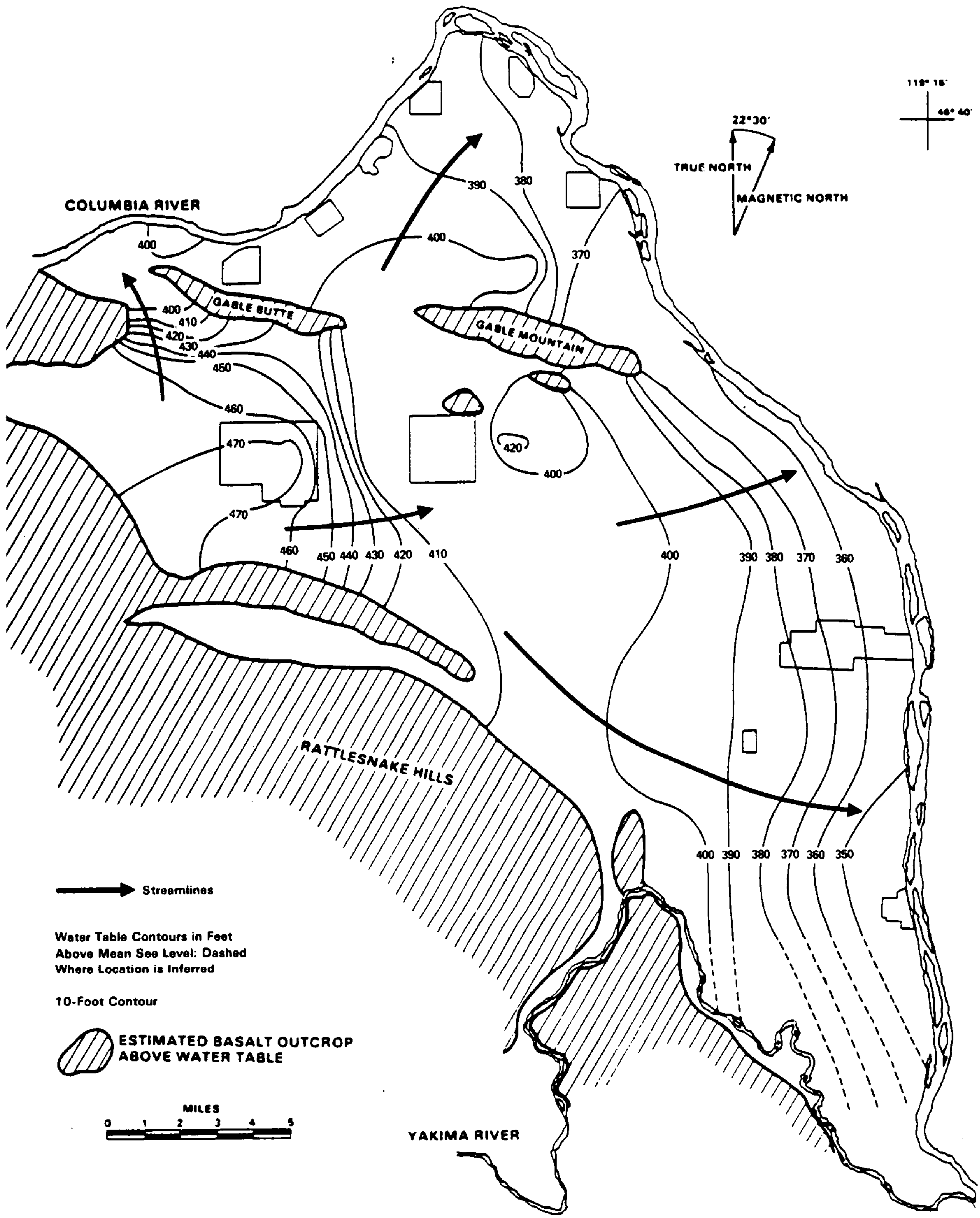

FIGURE 2.2. Water-Table Contour Map of the Hanford Unconfined Aquifer with Streamlines Indicating Direction of Flow from the 200 Areas [simulated 1983 conditions (DOE 1987b)]

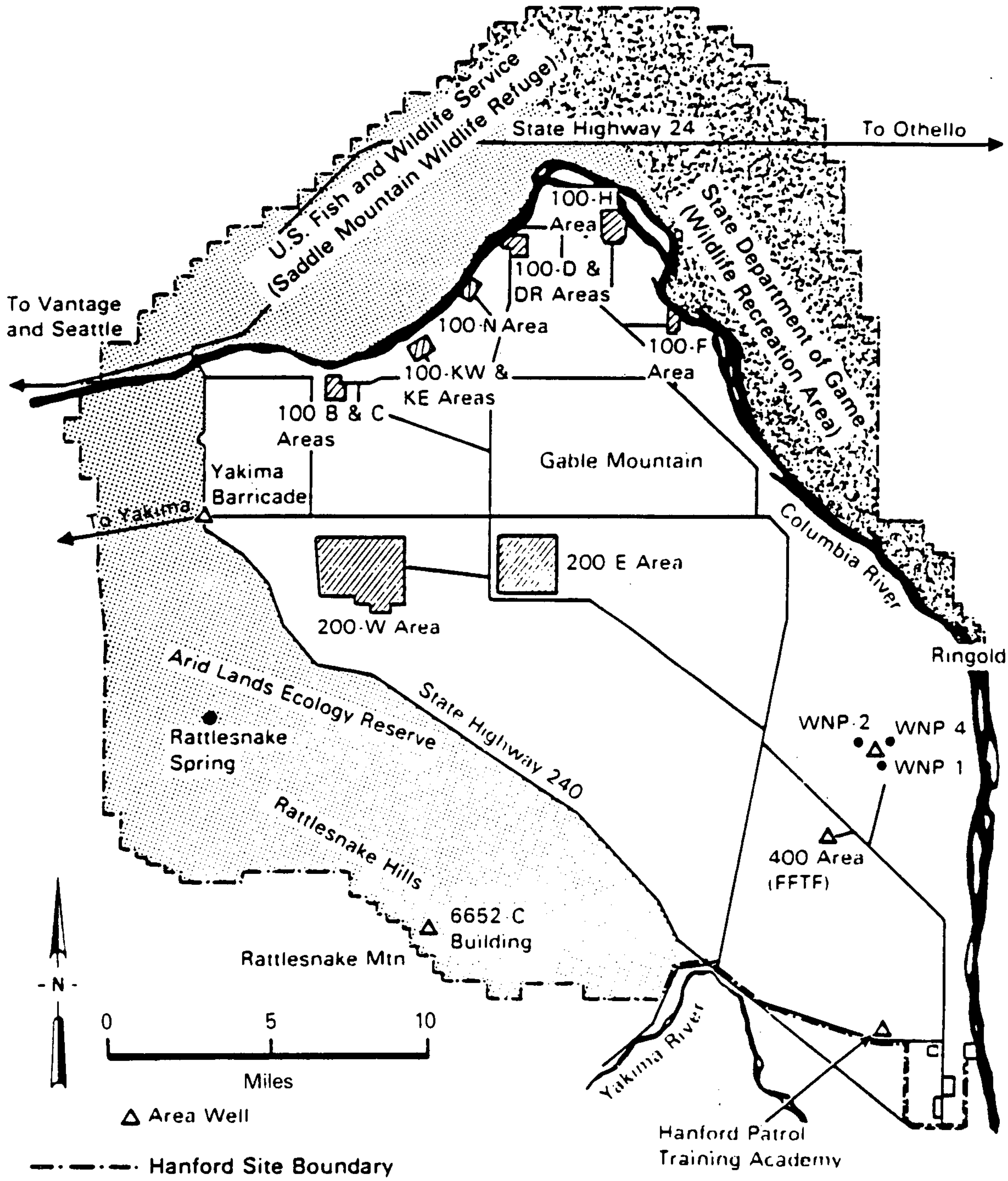

FIGURE 2.3. Drinking-Water Well Locations on the Hanford Site

400-Area well is reported to have detectable concentrations of Hanford-related contaminants (Cline, Rieger, and Raymond 1985).

2.1.5 Land Use

The Hanford Site is an isolated, controlled-access area and has been used for production and test reactor operations and related activities for over four decades. Much of the Site has been disturbed from its natural state, either by early farming activities or by post-1943 construction and operation of the plutonium-production facilities at Hanford. Those areas that have not been disturbed are dominated by sagebrush and bitterbrush with an understory dominated by cheatgrass and Sandberg's bluegrass.

Because access to the Hanford Site is restricted, the area has become a habitat for a wide variety of animals, including several on the Federal Threatened and Endangered Species List (U.S. Department of Interior 1985) and the State of Washington's Special Species List (Washington State 1984). From the federal list, threatened or endangered species that have been observed in the vicinity of the Site include the Aleutian Canada goose, the bald eagle, and the American peregrine falcon. The Special Species List of the Washington State Department of Game places species in three categories: sensitive, threatened, and endangered. The animals on this list that might be found on the Site are listed in Table 2.1.

The federal government lists no plant species that grow on the Hanford Site as either threatened or endangered. Two plants that are found on the Site are candidates for future classification as either threatened or endangered. These three species are *Astragalus columbianus* (Sauer, Mastrogiuseppe, and Smookler 1979), *Rorippa calycina* (Sauer and Leder 1985), and *Arenaria franklinii* var. *thompsonii* (Washington State 1986). The Washington Natural Heritage Program (Washington State 1984) lists several species as "sensitive" that probably grow on the Site, including three dryland species, *Erigeron piperianus*, *Chaenactis douglasii* var. *glandula*, and *Cryptanthaleucophea*. *Cyperus rivularis* and *Lindernia anagallidae*, two sensitive species listed by the state, are likely to grow along the banks of the Columbia River.

TABLE 2.1. Hanford Site Animals on the Special Species List of the Washington State Department of Game - Non-Game

Sensitive Species	Threatened Species	Endangered Species
Northern goshawk (visitant)	Bald eagle (winter resident)	White pelican (visitant)
Swainson's Hawk (nesting)	Ferruginous hawk (occasional nester)	Aleutian Canada goose (possible visitant)
Golden eagle (visitant)	Pygmy rabbit (status unknown)	Sandhill crane (visitant)
Burrowing owl (nesting)		American peregrine falcon (visitant)
Western bluebird (visitant)		Merriam's shew (resident)
Sage thrasher (visitant)		Pallid bat (visitant)
Loggerhead shrike (nesting)		Long-eared myotis (visitant)
Sage sparrow (nesting)		
Giant Columbia River limpet (status unknown)		
Columbia River spire snail (status unknown)		

A 31/km^2 (120-mi^2) area in the southwestern corner of the Hanford Site called the Arid Lands Ecology Reserve (see Figure 2.1) is set aside for long-term ecological studies. Other areas of the Site are managed for short-term ecological study. Islands in the upper portion of the Columbia River adjacent to the Hanford Site are excluded from public use by the DOE and are used as a wildlife refuge and for DOE environmental research. The land north of the Columbia River is controlled by the Washington State Department of Game and the U.S. Fish and Wildlife Service as hunting areas and a game refuge.

Land use within a 48-km (30-mi) radius of the Site includes residential, suburban, corporate city, agricultural, industrial and commercial, scenic, recreational, and general use areas. The predominant use of lands within the 48-km (30-mi) radius is agricultural, with farms located along or near all the Site boundaries.

2.1.6 Population

Population in the area surrounding the Hanford Site is sparse, consisting primarily of farms and farming communities to the north, east, and west of the Site. The Tri-Cities (Kennewick, Pasco, and Richland), located to the south and southeast of the Hanford Site, represent the major population concentration in the area (Sommer, Rau, and Robinson 1981).

In 1980, an estimated 341,000 people were living within an 80-km (50-mi) radius of the Hanford Meteorological Station (HMS) (see Figure 2.4) (DOE 1987).

2.1.7 Air Quality

Air quality in the vicinity of the Hanford Site is generally quite good. Wind-eroded dust is a problem in the area, and the dust storms that occur in the region can produce high total-suspended particulate concentrations. However, on both an annual and a short-term basis, the region is in compliance with the National Ambient Air Quality Standards for particulate matter. All other pollutant levels also satisfy the federal and state of Washington standards (DOE 1984).

2.2 PURPOSE AND HISTORY

In 1943, after the Fermi experiment showed that nuclear fission could be controlled in a small reactor, the U.S. Army Corps of Engineers selected Hanford as the location to build larger versions of the Fermi reactor to produce plutonium for possible use in military weapons. Construction started in March 1943 on three reactor facilities and three chemical processing facilities. The first of the reactors went into operation about 18 months after the start of construction, and the first plutonium was available some 4 months later.

After World War II, five reactors similar to those built during the war were constructed. A total of eight graphite-moderated reactors used the

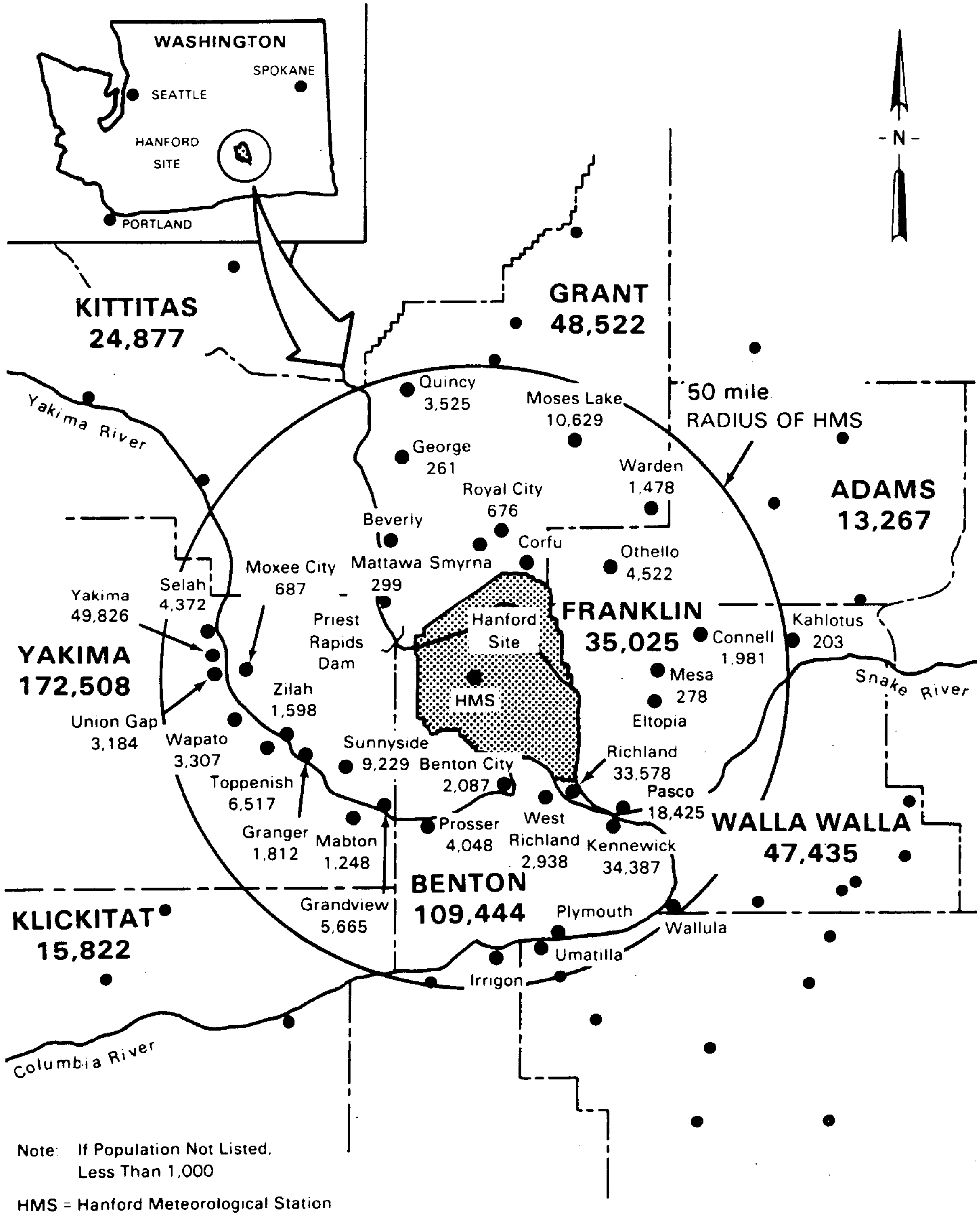

FIGURE 2.4. United States Census Populations for 1980 of Cities Within 80 km (50 mi) of the Hanford Meteorological Station (DOE 1987b)

Columbia River for once-through cooling (i.e., water circulated through the reactors only once before being released back to the river).

Early in the 1950s, construction began on the research and development facilities known as the Hanford Laboratories. This marked the first diversification of Hanford from a purely defense-materials production facility to one heavily involved in peacetime uses of the atom.

In 1963 the N Reactor was built. The N Reactor is different from the other eight reactors in that it can generate steam as a by-product of the plutonium production and does not need to use river water as a once-through coolant. Since 1966 the Supply System has used the steam to generate electricity.

A presidential decision was made in early 1964 to begin shutting down the older Hanford reactors. This decision resulted in the closing down of all eight of the older reactors by the end of 1971, leaving the N Reactor as the only operational production reactor until it was recently placed on a cold stand-by status.

2.3 DESCRIPTION OF OPERATIONAL AREAS

Environmental features specific to each operational area are described below; the waste-processing history of each area is also discussed. Each area is identified by number (i.e., 100, 200, 300, 400, and 600) and by letter (e.g., the 100-F Area is the location of the 100-Area F Reactor). Appendix B provides further information on waste-disposal site locations and types of waste-processing facilities in Hanford's operational areas.

2.3.1 100 Areas

The nine 100 Areas (B, C, D, DR, F, H, KE, KW, and N) border the Columbia River in the northernmost part of the Hanford Site. Each of the nine areas has one production reactor. Eight of these reactors have been shut down and are slated for decommissioning; only the N Reactor is operational, and it has been placed on cold stand-by status. Because some of the areas are contiguous (B/C, D/DR, KE/KW), the Hanford Site map shows only six 100 Areas (Figure 2.1).

The 100 Areas are generally flat with no major surface features. The Hanford formation lies near the surface of the 100 Areas, covered by a thin layer of wind-deposited silt and fine sand. The water table is found in these sediments at a depth of about 20 m (66 ft), except in the F and H Areas where the depth to the water table is about 35 m (115 ft) and 40 m (131 ft), respectively. The depth to the Ringold Formation is about 25 m (82 ft); the top of the basalt bedrock is approximately 240 m (790 ft) below the surface. Because the water table occurs within the highly permeable sandy gravels of the Hanford formation, it fluctuates as the river level rises and falls. The ground water generally flows from the 100 Areas and toward the river.

When active, each of the 100 Areas included support facilities such as powerhouses. Except for the ones at the 100-N Area, these powerhouses produced process steam from coal-fired boilers; 100-N Area has oil-fired boilers. Adjacent to each area's powerhouse were large storage areas that received railroad carloads of coal, as well as disposal areas for fly ash/clinker disposal. Most areas also included water-treatment plants, water-storage tanks, subsurface sewage-disposal systems, raw-water intake structures, and process sewers.

B and C Areas. The B and C Reactors are located adjacent to each other on a 2.6-km^2 (650-acre) site (the 100 B/C Area) and are the farthest of the 100 Areas upstream from Richland. The B Reactor was operated from 1944 to 1968, and the C Reactor was operated from 1952 to 1969. Virtually all the facilities in the area are inactive, with the exception of the B/C export water system, which continues to provide the raw-water supply to the 200 Areas and some 100 Areas. An electrical substation in the area taps power for the pumps providing the 200 Area water. Fewer than 100 people work in this area (Yandon 1977).

When the reactors were operational, cooling water was drawn from the river and treated with alum, sulfuric acid, and chlorine. Excess sulfuric acid was used to maintain the pH of the water within a desired range. To control oxidation of aluminum parts in the reactor, sodium dichromate was used to maintain an oxidation coating on aluminum parts. The chlorine was added for algae control in the settling basins; at times copper sulfate was added for additional algae control. Chromic acid, oxalic acid, and nitric acid were used for dummy fuel-element decontamination.

In addition to vertical safety rods for emergency reactor shutdown, the reactors were equipped with hoppers of nickel-plated boron steel balls, nickel-plated carbon steel balls, and stainless steel balls that would drop into the vertical safety rod channels for emergency shutdown. This system required no supplementary power source. Although it was never used, a third safety system, one involving the use of a potassium borate solution, was in place at the reactors.

A supplementary control system, in addition to the normal horizontal control rods, was incorporated into the reactors. This supplementary control system consisted of a Poison[a] Column Control Facility that could charge selected process tubes with a lead-cadmium poison to absorb neutrons. Boron-carbide aluminum poison splines were also used for supplementary control.

The coolant water system and backup control and shutdown systems at the other seven once-through-cooled reactors were similar to the those in the 100-B/C Area.

D and DR Areas. The 100-D/DR Areas, covering about 3.9 km^2 (970 acres), are located 11 km (7 mi) downriver of the 100-B/C Area. The D Reactor was operated from 1944 to 1967, and the DR Reactor from 1950 to 1965. These areas are extensively used, and their utilities and services are still in operation. The electrical substation serves as a backup supply for the 100-N Area. The water system is a backup system for the 100-B water system, which supplies water to the 200 Areas. An engineering laboratory is operated here in support of the N Reactor. Approximately 20 people are employed in the D and DR Areas (Yandon 1977).

F Area. The 100-F Area is located about 10.4 km (6.4 mi) downriver of the D/DR Reactors and is the 100 Area closest to Richland. This area covers about 2.2 km^2 (540 acres). The F Reactor was operated from 1945 to 1965. At one time, PNL operated a biology laboratory in this area to study the effects

(a) The term "poison" refers to a material's ability to absorb neutrons and thus control the rate of fission.

of inhaled and ingested radioactive and toxic materials on animals. Approximately 25 employees supporting decommissioning activities currently work in the F Area.[a] Except for the reactor and reactor support facilities, the site has been decommissioned.

H Area. The 100-H Area is located about 5.2 km (3.2 mi) downriver of the 100-D/DR Areas and covers about 1.3 km^2 (320 acres). Very little activity continues in this area. Several major buildings, including the powerhouse, stacks, and some of the water-treatment buildings, have been removed. The H Reactor was operated between 1945 and 1965.

K Area. The 100-KE/KW Areas, covering about 0.6 km^2 (150 acres), are almost 4 km (2.5 mi) downriver of the 100-B/C complex and contain two shutdown reactors. These reactors were operated between 1955 and 1971.

Considerable use is made of the shutdown 100-KE/KW Areas. For example, spent fuel from the N Reactor is stored there. All services and utilities except the powerhouse are in operation. The Decommissioning Services Section of Westinghouse Hanford Company (WHC) also operates from offices and laboratories in this area. A research and development laboratory is operated in this area; the Fuel Operations Section of WHC has personnel stationed at the K Area to operate the KE and KW fuel-storage basins. Altogether, fewer than 1,000 people work in the K Area (Yandon 1977).

N Area. The 100-N Area, about 0.4 km^2 (90 acres) in size and 3.7 km (2.3 mi) downriver of the 100-K Area, contains the N Reactor and the Supply System generating plant. The N Reactor is the only Hanford production reactor still operational; however, it has been placed on cold stand-by status. The N Reactor is a dual-purpose unit that can provide low-pressure steam for an 860-MWe supply system generating plant nearby. The reactor core's cooling water is designed to be recycled after it is passed through a heat exchanger that cools the water and produces the steam that can be used by the Supply System generating plant. Fewer than 1,500 people work in this

(a) Letter from J. J. Dorian, UNC Nuclear Industries, to T. J. McLaughlin, Pacific Northwest Laboratory, April 16, 1986.

area (Yandon 1977); however, the work force is expected to be reduced considerably during phase-out of the N Reactor to cold stand-by status.

The reactor's water-treatment plant is an updated version of the treatment systems used at the older reactors. The nonradioactive effluents it treats originate from the secondary side of the cooling-water system. Radioactive waste streams are discharged to cribs. The water from these waste streams eventually discharges to the Columbia River via the ground water. The N Reactor contains some additional alloys and materials that were not present in the older reactors. These materials are protected from corrosion and the heat transfer surfaces protected against fouling by suitable water treatment.

2.3.2 200 Areas

In the approximate middle of the Hanford Site, on a plateau about 11 km (7 mi) from the Columbia River, are the two 200 Areas (200-East and 200-West), dedicated to chemical separations and waste management. Irradiated fuel, waste-processing, and waste-storage activities are located in these two areas because they are the most isolated from the Site boundaries and are the farthest from both surface and ground water. The water table in this area is 46 to 91 m (150 to 300 ft) below the surface.

The 200 Area plateau is a glacial fluvial gravel bar. A thin surface layer of wind-blown silts and sands covers the well-sorted, coarse sands that comprise the sediments of the Hanford formation.

Fewer than 3,000 employees work in the 200 Areas (per shift); slightly more than half are in the 200-West Area (Yandon 1977).

The 200 Areas contain nonradioactive support facilities, including transportation maintenance buildings, service stations, and coal-fired powerhouses (with baghouses for airstream cleanup) for process steam production, steam transmission lines, raw-water treatment plants, water-storage tanks, electrical maintenance facilities, and subsurface sewage disposal systems. In short, the 200 Areas are almost cities in that they have most of the utilities necessary to be self-supporting.

2.3.2.1 200-East Area Plants

The 200-East Area is a controlled area of approximately 8.4 km^2 (3.2 mi^2). It is about 10 km (6.2 mi) from the Columbia River and 18 km (11 mi) from the nearest Hanford Site boundary. It is located on a plateau at an elevation of approximately 200 m (656 ft) above MSL. The surface slopes from southwest to northeast, with a maximum difference in elevation across the area of about 25 m (82 ft). Depth to ground water ranges from 47 to 103 m (155 to 338 ft).

There are no naturally occurring surface water bodies within the 200-East Area. However, process cooling water and aqueous wastes are discharged to an open ditch that carries the effluents to a large impoundment (B Pond) located just east of the area. West Lake is a small, natural lake located about 4 km (2.5 mi) north of the area. Gable Mountain Pond, formed as a result of waste-water disposal from the 200 Areas, is about 3 km (1.9 mi) to the north. It was removed from service in 1987.

PUREX Plant. The Plutonium URanium EXtraction (PUREX) Plant is the most recently constructed of the irradiated-fuel processing plants. Constructed between April 1953 and October 1955, the PUREX Plant took over fuel-processing operations from the REDuction OXidation (REDOX) Plant. The PUREX Plant was operated from 1956 to 1972; in 1972 it was placed in operational standby mode. Plant operations were resumed in 1983.

At this facility, uranium, plutonium, and neptunium are separated from fission products found in the production reactors' irradiated uranium fuel. The process steps involve fuel-element decladding, uranium metal dissolution, solvent extraction, ion exchange, and product loadout.

Zirconium cladding on fuel elements is removed in an ammonium fluoride-ammonium nitrate (AFAN) solution. Ammonium fluoride reacts with the zirconium, resulting in a soluble zirconium compound. The ammonia and hydrogen evolved during decladding present a potential combustion hazard. Therefore hydrogen is converted to ammonia by reaction with ammonium nitrate present in the AFAN solution. The dissolver solution is then processed to remove plutonium and uranium that dissolved with the cladding. Gas released from the dissolver is treated to remove iodine in a silver reactor, is acid-adsorbed, and is only then released to the atmosphere. The off-gases are treated with hydrogen peroxide to remove nitrogen oxides before being released to the atmosphere.

Declad fuel elements are dissolved in nitric acid for the solvent extraction processes. An organic solvent is used to separate the uranium, plutonium, and neptunium from associated fission products and from each other. The organic solvent used in a series of extraction and stripping operations is a 30% solution of tributyl phosphate in a normal paraffin hydrocarbon (kerosene) diluent. The first extraction cycle separates the bulk of the fission products from the plutonium, uranium, and neptunium; the fission products remain in the aqueous phase. The organic phase is sent to the partitioning cycle where the plutonium is partitioned from the uranium and neptunium. The plutonium stream is routed through two additional solvent-extraction cycles for further purification. After purification, the plutonium stream is concentrated. From 1956 to 1972, the concentrated plutonium nitrate solution was sent to the plutonium finishing operations located in the 200-West Area. When the PUREX Plant resumed operations in 1983, another facility was added that produced plutonium oxide from the plutonium nitrate.

The other stream from the partition cycle, which bears the neptunium and uranium, is routed to the final uranium cycle where neptunium is separated. The aqueous neptunium stream is sent to the backcycle waste system for concentration and recycling to the solvent-extraction column. The uranium stream is routed to a column that strips the uranium from the organic stream with an aqueous nitric acid solution; concentration of the aqueous solution follows. The uranium product, uranyl nitrate hexahydrate (UNH), is then stored in tanks until it is shipped to the uranium oxide (UO_3) plant in the 200-West Area.

A portion of the concentrated neptunium solution from the final uranium cycle is sent to the neptunium recovery and purification cycle. In this cycle, neptunium is separated from the uranium, plutonium, and the remaining fission products in the neptunium stream. This separation is accomplished by a series of extractions and ion-exchange columns. The plutonium and uranium fractions are recycled to the backcycle waste system and partitioning cycle, respectively.

Supporting process systems include organic solvent decontamination and recovery, nitric acid recovery, and waste concentration and recovery.

B Plant. The B Plant, one of the original fuels-separation facilities, was constructed between August 1943 and February 1945; it was operated until 1952. The plant used the bismuth phosphate process to separate plutonium from irradiated uranium fuel. This process produced a very dilute waste stream that contained the uranium and most of the fission products from the fuel elements. Unlike the PUREX process, the bismuth phosphate process separated plutonium from uranium and fission products by precipitating the plutonium onto a bismuth phosphate carrier.

The uranium fuel elements processed by the bismuth phosphate process were jacketed with aluminum. These jackets were removed in a sodium hydroxide-sodium nitrate ($NaOH-NaNO_3$) solution, with the $NaNO_3$ acting as a hydrogen scavenger. Some of the silicon used as a binder in the fuel elements was dissolved during jacket removal. This operation produced sodium silicate, sodium aluminate, and sodium nitrite.

After jacket removal, the fuel elements were dissolved in nitric acid; sulfuric acid was then added to complex the uranium. Complexing of uranium prevented it from being precipitated as uranyl phosphate during later plutonium precipitation. The metal solution was pre-treated with sodium nitrite to oxidize or reduce plutonium to the correct state for precipitation. Bismuth phosphate was then added to the metal solution and the resulting slurry was centrifuged. The solid cake was redissolved in nitric acid for further decontamination of the plutonium.

The decontamination involved several dissolutions and subsequent precipitations of plutonium. Sodium bismuthate and sodium dichromate were used as oxidizing agents, and sodium nitrite or oxalic acid was used as a reducing agent during the plutonium decontamination. The final plutonium precipitate was washed with ammonium nitrate.

The next process involved transferring the plutonium from the bismuth phosphate carrier to a lanthanum fluoride carrier. Hydrofluoric acid was used to acidify the transfer solution and cause lanthanum fluoride to precipitate, carrying the plutonium with it. Potassium hydroxide was used to change the lanthanum precipitate into a soluble compound; then the precipitate was dissolved in nitric acid. The plutonium was then reduced using ammonium sulphate and precipitated as a peroxide by the addition of hydrogen peroxide. The plutonium peroxide was dissolved into nitric acid. This solution was concentrated to produce the final plutonium nitrate product, which was originally shipped offsite for conversion to plutonium oxide or plutonium metal.

In 1968, the B Plant was converted to a waste-fractionization plant as part of a program to solidify high-level waste. The B Plant now functions to remove cesium and strontium from PUREX current acid waste and from high-level supernatant liquids, as well as sludges from self-boiling liquid waste.

The solids are removed from the current acid waste and treated for strontium removal, and the liquid is treated with phosphotungstic acid to precipitate the cesium. The supernatant liquid is sent to a series of solvent extraction columns, similar to those used at the PUREX Plant, to remove and purify any remaining strontium. The cesium precipitate is redissolved in sodium hydroxide and treated in ion exchange columns for further purification. Liquid from stored waste is treated the same as current acid waste, except that the solids have already separated in the storage tanks. Sludge from the storage tanks and solids from current acid waste are dissolved in an acid solution and sent to the solvent-extraction columns for strontium removal.

Cesium solutions are converted to cesium chloride by the addition of hydrochloric acid. The liquid is evaporated to yield solid cesium chloride. This solid is encapsulated in Hasteloy™ cylinders and stored in an underwater storage basin at B Plant.

Strontium is precipitated as strontium fluoride by the addition of sodium fluoride. The strontium fluoride is filtered, dried, and encapsulated in Hasteloy™ cylinders. These cylinders, like the cesium cylinders, are stored in an underwater storage basin at B Plant.

Semiworks and Critical Mass Laboratory. The Semiworks was built in 1949 as a pilot plant for the REDOX Process; it was later converted to pilot the PUREX process. The Semiworks originally operated from 1952 to 1957. In 1960, the Semiworks was reactivated and equipped for the processing and loadout of fission products; it then operated as both a production and a process demonstration pilot project for converting the B Plant to a waste-partitioning facility. In 1967, the Semiworks was shut down, and it is now being decontaminated and decommissioned. Chemical processes at this facility were similar to those at the REDOX and PUREX plants.

At the Critical Mass Laboratory, research focuses on the criticality safety of plutonium in various forms and combinations with other elements. The resulting data are used to verify analytical methods that predict criticality safety for plutonium in various fuel cycles.

2.3.2.2 200-West Area Plants

The 200-West Area is a controlled area of approximately 8.2 km^2 (3.2 mi^2); it is about 8 km (5 mi) from the Columbia River and 11 km (6.8 mi) from the nearest Site boundary. In the early 1980s, it was expanded to the west to add land for future burial grounds. There are no naturally occurring surface water bodies within the 200-West Area; however, process cooling water and aqueous waste are discharged to surface impoundments, creating several artificial ponds within or adjacent to the area.

The water table beneath the 200-West Area lies within the Ringold Formation, which has a high HRS permeability rating. The water table lies at a depth of 55 to 82 m (180 to 270 ft).

U Plant. Although the U Plant (constructed between 1943 and 1944) was one of the three original fuels-separation facilities designed to use the bismuth phosphate process, it was never used for that purpose.

Uranium was not recovered by the bismuth phosphate extraction of plutonium from irradiated fuel. However, the later-developed REDOX and PUREX processes recovered the uranium, which still had economic value. Following

Following startup of the REDOX Plant, the U Plant was converted to recover the uranium from stored radioactive waste. From 1952 to 1958, stored waste was transferred to the U Plant for uranium recovery. The resultant sludge was dissolved in nitric acid, and then the uranium was extracted using tributylphosphate in a normal paraffin diluent. This process left the fission products, sulfate, and phosphate ions in the aqueous acid solution. The uranium was then stripped from the organic solvent with nitric acid. This nitric acid solution was concentrated and sent to the uranium oxide process.

Although the uranium recovery processing is no longer occurring, the adjacent uranium oxide plant is still operating. This plant received uranyl nitrate solution from the recovery process and from the REDOX Plant and calcined it to uranium trioxide. The uranium oxide plant now processes the product uranium from the PUREX Plant. Nitric acid is recycled to the PUREX process as a by-product of the calcination process. The uranium trioxide is shipped offsite for use as nuclear fuel.

REDOX Plant. The REDOX process for fuels separation succeeded the bismuth phosphate process and preceded the PUREX process. The REDOX Plant was constructed from May 1950 to August 1951; it operated until it was shut down in July 1967. An analytical laboratory near the facility is still operating. This laboratory supports B Plant operations and performs research and development in support of waste management and environmental control operations. The laboratory also functions as a backup laboratory to the PUREX and Z Plant analytical laboratories.

The REDOX Plant used a solvent extraction process to separate uranium and plutonium from fission products and each other. Methyl isobutyl ketone (MIBK) was the organic solvent that was used.

The fuel elements were prepared for nitric acid dissolution using the methods from the bismuth phosphate process. Sodium dichromate was added to the nitric acid solvent to oxidize plutonium to a state suitable for organic extraction.

Aluminum nitrate was added to the acid solution as a salting agent for the first extraction column. This salting agent caused the uranium and plutonium to be preferentially extracted by MIBK, leaving the fission products in the aqueous phase. In a second extraction column, a reducing agent was added to the aqueous phase to reduce the plutonium so that it would be removed from the uranium and extracted into the aqueous phase. The organic uranium solution and the aqueous-plutonium solution were then processed separately, purified further, and concentrated into their respective products: UNH and plutonium nitrate. The plutonium nitrate was sent to Z Plant for processing into plutonium oxide or plutonium metal. The UNH was sent to the uranium oxide plant.

The organic solvent was treated for recycling by removing decomposition products and by further decontamination. Aqueous streams were concentrated, then the aluminum nitrate was converted to sodium aluminate by sodium hydroxide before disposal.

T Plant. The T Plant was one of the original bismuth phosphate fuels-separation facilities; it was constructed from June 1943 to October 1944 and operated for the bismuth phosphate process from 1944 to 1956. Since 1956, facilities in the T Plant have been used for decontamination and equipment repair.

Z Plant - Plutonium Finishing Plant (PFP). Constructed in 1949, the Z Plant was the site of the plutonium laboratory and finishing operations, including the processing of plutonium scrap materials and preparation of plutonium products. The plutonium parts preparation ceased in December 1965. A process known as "recouplex" was operated at the plant from 1955 to 1962 to recover plutonium from scrap and produce a plutonium nitrate solution. The Plutonium Reclamation Facility began operations in 1964 to perform the functions of the recouplex process.

The recouplex process used nitric acid and hydrofluoric acid to dissolve solids and a tributyl phosphate-carbon tetrachloride solvent extraction process for recovery of purified plutonium nitrate solutions. Aluminum nitrate was used to salt the aqueous streams for selective extraction of plutonium and to create complexed fluoride ions as aluminum fluoroxide nitrate to prevent their interference during plutonium extraction. Americium was also recovered in the Plutonium Reprocessing Facility using dibutyl butyl quently been replaced with tributyl phosphate.

The Plutonium Processing Facility converts plutonium nitrate to plutonium oxide and then to plutonium metal, if metal is the desired product. The plutonium oxide is made by precipitating the plutonium as plutonium oxalate and then calcining the precipitate. To produce metal, the plutonium oxide is first converted to plutonium fluoride. The fluoride is placed in an iron can, which is placed in a magnesium oxide crucible with calcium metal. A reducing charge is applied to the crucible to reduce the plutonium fluoride to plutonium metal, which is then molded into a button. The remaining iron, calcium, and magnesium are dissolved in nitric acid for disposal.

2.3.3 300 Area

The 300 Area is located about 1.6 km (1 mi) north of the Richland city limits, on the west bank of the Columbia River. Roughly rectangular in shape, the area covers about 1.5 km^2 (370 acres); waste-management facilities have been added just to the north of the 300 Area.

This relatively flat area is about 15 m (50 ft) above the average elevation of the adjacent river. The Hanford Site land surface surrounding the 300 Area is devoid of prominent surface features and slopes gently upward to the northwest.

The surface sediments in the 300 Area are largely wind-transported sands and silts. These sediments, which were deposited in dunes up to about 3 m (9.8 ft) in depth, have been largely stabilized by vegetation. Below this layer lie 20 to 25 m (66 to 82 ft) of coarse-grained glaciofluvial deposits known as the Pasco gravels; the permeability of these deposits is very high.

The high porosity and permeability of the sands and gravels that underlie the area allow any precipitation to infiltrate rapidly. Flooding of any portion of the 300 Area by rainwater is therefore highly improbable. There are no natural streams or watercourses other than the Columbia River within or adjacent to the 300 Area.

Ground water enters the 300 Area from the northwest, west, and southwest and flows into the Columbia River. Throughout most of the 300 Area, the ground water flows toward the east and southeast. Only in the southern porground water flows toward the east and southeast. Only in the southern portion of the area does the ground water flow in a northeasterly direction. The water table generally slopes downward from west to east; depth to ground water is from 10 to 15 m (34 to 48 ft). Variations in the river level, ground-water withdrawal from area wells, and discharge of waste water to the process ponds and leaching trenches cause variations in the level of the water table.

The residence nearest the 300 Area is approximately 1.5 km (0.9 mi) east across the Columbia River. A number of irrigated farms are located just across the river from the 300 Area. The northern part of Richland, lying within about 4 km (2.5 mi) of the 300 Area, is an industrial park. The nearest residences in Richland are about 4.6 km (2.9 mi) from the 300 Area boundary. The nearest city water intake is the Richland pumping station, 6 km (3.7 mi) downstream from the 300 Area.

Most of the facilities in the 300 Area, completed in 1943 and the years immediately following, were used to support the fabrication of reactor fuel. Fuel elements are fabricated by a coextrusion process. This process forms the zirconium cladding and the uranium-silicon fuel core from primary material components and bonds the two together in one operation. The fuel elements are protected with a copper jacket for the extrusion process. The jacket also prevents atmospheric contamination of the reactive fuel element, and the copper is easily lubricated for extrusion. Lubricants are removed using organic solvents such as trichloroethylene. After extrusion into billets, the copper is removed by dissolution into nitric acid. The uranium core is recessed by chemical milling so that the billets can receive an end cap. The chemical milling is performed using copper sulfate, nitric acid, and sulfuric acid. A zirconium end cap is then brazed on with beryllium. The fuel elements are tested for cap attachment, cap to core bonding, cladding to core bonding, and cladding to cap bonding before fuel-element supports and locking clips are attached. Next, the tubes are autoclaved for 72 hours in 360°C (680°F) steam to detect any perforations in the cladding or end caps. Finally, the elements are packaged for storage and shipment.

The activities in the 300 Area included many technical and service support functions, as well as fuel manufacturing. As the Hanford production reactors were shut down, fuel-manufacturing activities decreased and other activities increased. Thus, for over 15 years, research and development programs have constituted a major part of the activities in the 300 Area. The newer facilities mostly house laboratories and large test facilities in support of peaceful uses of plutonium, reactor-fuels development, liquid-metal technology, fast-flux test facility support, gas-cooled reactor programs, and life-sciences programs.

The 300 Area contains a number of support facilities, including a convertible oil/coal powerhouse for process steam production; raw-water intake, treatment, and storage; and other facilities necessary to support fuels production, research, and development. Slightly more than 3,000 workers are employed in the 300 Area (Yandon 1977).

2.3.4 400 Area

The 400 Area is a controlled area of about 0.5 km2 (130 acres) located in the southeast part of the Hanford Site; it is approximately 7.2 km (4.5 mi) from the Columbia River and 6.2 km (3.9 mi) from the nearest Site boundary.

The area is located at an elevation of about 170 m (558 ft) above MSL. The land around the area slopes gently away to the south and east toward the Columbia and Yakima rivers. The site is devoid of prominent topographic features.

The glaciofluvial deposits on which the 400 Area is located extend from the surface to a depth of about 45 m (148 ft). The surface sediments are coarse sands merging into the coarse Pasco gravels. The water table beneath the 400 Area is in the upper part of the Ringold Formation, at a depth of about 50 m (164 ft).

The ground water moves from west to east toward the Columbia River. A small amount of ground water is withdrawn from the unconfined aquifer for sanitary use and air conditioning, but the effect on ground-water level is not significant.

8 km (5 mi) to the southwest. The Richland city limits are about 11 km (6.9 mi) to the southeast.

The area houses the Fast Flux Test Facility (FFTF), consisting of an experimental reactor and associated support facilities. The liquid-sodium-cooled reactor is equipped with vertical control and safety rods that contain boron carbide to absorb neutrons. The control rods are used to control the power level, and the safety rods provide a means for rapid reactor shutdown. Although the reactor is not a breeder reactor, its irradiation environment is similar to that of a liquid-metal fast breeder reactor (LMFBR). This similarity provides a facility where the fast neutron-flux irradiation environment of an LMFBR can be studied (AEC 1972).

Because the reactor is cooled with liquid sodium metal and the waste heat is disposed of using a sodium-to-air heat exchanger, no cooling water is required to support the reactor. This lack of a need for cooling water means that there is no discharge of radioactive liquids from the FFTF area.

Several chemicals are used at the FFTF for treatment of air-conditioning cooling water and sanitary water and for demineralized water production. These chemicals include chlorine and sodium hypochlorite, which are used for bacterial and algae control. Sulfuric acid is used to maintain the pH of air-conditioning water between 7.0 and 7.5. A small demineralizer produces water used for the cleaning of the sodium coolant. Regeneration of the demineralizer results in the production of about a kilogram of waste sodium sulfate per month (AEC 1972).

2.3.5 600 Area

The 600 Area basically includes all of the Hanford Site not occupied by the 100, 200, 300, or 400 Areas. Land within the 600 Area is used for:

- the ALE Reserve, a 310-km^2 (120-mi^2) tract set aside for ecological studies
- a 4-km^2 (990-acre) tract leased to the state of Washington, part of which is used for low-level waste disposal
- a 4.4-km^2 (1,100-acre) tract for Supply System nuclear power plants

- a 2.6-km^2 (640-acre) tract transferred to the state of Washington as a potential site for the disposal of nonradioactive hazardous wastes
- about 130 km^2 (50 mi^2) under permit to the U.S. Fish and Wildlife Service
- a 225-km^2 (87-mi^2) tract under permit to Washington State Department of Game for recreational game management
- support facilities for the controlled-access areas
- the Near-Surface Test Facility in Gable Mountain, which was part of the Basalt Waste Isolation Project (BWIP) to assess the feasibility of storing high-level radioactive waste in basalt formations
- a 46.7-km^2 (18-mi^2) tract that was designated as the reference repository location for BWIP - This site includes all of the 200-West Area (DOE 1982, 1984). The site of the principal borehole and exploratory shaft for BWIP covered about 1 km^2 (250 acres) and was located just west of the 200-West Area within the reference repository location.

The 600 Area contains several inactive waste sites that received liquid and/or solid wastes. The generation of the wastes entering these 600 Area sites involved both pre-Hanford activities (e.g., community landfills) and Hanford construction and operation activities.

2.3.6 Other Areas

Other Hanford areas are the downtown Richland area, where federal and contractor employees work in the Federal Building and several other buildings in the vicinity of the Federal Building (700 Area), the area south of the 300 Area primarily used for research and development (3000 Area), and the area between the 700 and 3000 Areas that is the main shipping, receiving, warehousing, transportation, maintenance, utilities, and service station area (1100 Area). The 1100 Area contains two presently known sites that are governed by the Comprehensive Environmental Response, Compensation and Liability Act as amended by the Superfund Amendment Reauthorization Act (Superfund) program of the EPA. These sites are: 1) the 100 Area Battery Acid Disposal Pit, and 2) the ethylene glycol storage tank leakage area.

3.0 EVALUATION OF ENGINEERED-FACILITY SITES

The assessment activities associated with the engineered-facility evaluations resulted in identifying, investigating, and scoring 335 engineered-facility sites, plus 20 newly discovered engineered-facility sites. The HRS was used to evaluate these sites.

3.1 HRS EVALUATION ON THE ENGINEERED-FACILITY SITES

The HRS evaluations of the Hanford engineered-facility sites (CERCLA Program sites) were conducted considering the ground-water, surface-water, and direct-contact routes. The air route was not evaluated because the HRS system requires that "the only acceptable evidence of release for the air route is data that show levels of a contaminant at or in the vicinity of the facility that significantly exceed background levels" (40 CFR 300), and no such data were found for any of the sites. Lacking such data, the HRS system automatically assigns the air pathway a score of zero. The fire and explosion route was not evaluated because of the nature of the radionuclides and chemical constituents and the manner in which they were found in the wastes.

To make the evaluation of this large group of engineered-facility sites more manageable, the sites were grouped in the following way (in accordance with the classification subdivisions discussed in Chapter 1):

- 100-Area Liquid Sites with Release[a] to Ground and/or Surface Water
- 100-Area Liquid Sites with No Release[a] to Ground and/or Surface Water
- 100-Area Solid-Waste Sites
- 200-Area Liquid Sites with Release[a] to Ground and/or Surface Water

(a) As determined by the soil column release criteria [i.e., volume necessary to consider sites as having a release equal to 0.1 (area x depth)].

- 200-Area Liquid Sites with No Release[a] to Ground and/or Surface Water
- 200-Area Solid-Waste Sites
- 300-Area Inactive Waste Sites
- 600-Area Inactive Waste Sites.

The results from the HRS evaluation are presented in Tables 3.1 through 3.8.

3.2 SUPPLEMENTAL TECHNICAL ASSESSMENT ON THE ENGINEERED-FACILITY SITES

The HRS migration scores are not intended for use in setting priorities for further characterization of sites for the CERCLA Program. Such priorities (i.e., establishing priorities for performing RI/FS activities) will be established through the formal scoping process, which will involve the participation of the regulatory authorities. To provide a more in-depth look at the sites evaluated using the HRS, supplemental technical assessments were performed. The major deficiency in the HRS scoring process is the false highs and false lows that may occur in the assessment of liquid-waste disposal sites with and without observed releases. These supplemental assessments were done not to invalidate the "observed release" parameter, but to identify which sites may be over- or under-ranked by HRS.

Other performance assessments of potential hazards have been conducted for defense high-level, transuranic, and tank wastes currently stored at the Hanford Site (DOE 1987). These assessments evaluated the impacts of disposal of various defense wastes over 10,000 years. These long-term assessments sometimes differed from the HRS assessments on one major point: the evaluation of future impacts. The HRS considers a site potentially hazardous

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(a) As determined by the soil column release criteria [i.e., volume necessary to consider sites as having a release equal to 0.1 (area x depth)].

TABLE 3.1. 100-Area Liquid Sites with Release to Ground and/or Surface Water

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
116-DR-7	100 D/DR	Crib	28.95
116-DR-3	100 DR	Trench	40.09
116-KE-1	100 KE/KW	French Drain	40.09
116-KW-1	100 KE/KW	Crib	40.09
116-B-2	100 B/C	Trench	40.09
116-B-5	100 B/C	Crib	40.09
116-F-7	100 F	Crib	40.93
100 KW*1	100 KE/KW	Dry Well	40.09
100 KW*2	100 KE/KW	French Drain	40.09
116-DR-1	100 D/DR	Trench	42.32
116-DR-2	100 D/DR	Trench	42.32
116-H-1	100 H	Trench	42.32
116-H-2	100 H	Trench	42.32
116-H-3	100 H	French Drain	42.32
116-K-1	100 H	Crib	42.32
116-B-1	100 KE/KW	Trench	42.32
116-C-1	100 B/C	Trench	42.32
116-C-2	100 B/C	Crib	42.32
116-F-3	100 F	Trench	42.32
116-F-2	100 F	Trench	42.32
116-F-6	100 F	Trench	42.32
116-F-9	100 F	Trench	42.32
116-F-10	100 F	French Drain	42.32
100 KE*2	100 KE/KW	French Drain	42.32
116-DR-6	100 D/DR	Trench	42.32
100 KE*1	100 KE/KW	Dry Well	42.32
116-D-1B	100 D/DR	Trench	42.32
116-B-4	100 B/C	French Drain	44.54
116-F-1	100 F	Trench	44.55
116-KE-2	100 KE/KW	Crib	49.00
116-K-2	100 KE/KW	Trench	51.23
116-F-11[a]	100 F	French Drain	0.00
116-F-12[a]	100 F	French Drain	0.00
116-F-13[a]	100 F	French Drain	0.00
116-KE-3[a]	100 KE/KW	French Drain	0.00
116-KW-2[a]	100 KE/KW	French Drain	0.00
116-B-9[a]	100 B/C	French Drain	0.00
116-B-10[a]	100 B/C	Dry Well	0.00
116-C-2-2[a]	100 B/C	Crib	0.00
116-D-6[a]	100 D/DR	French Drain	0.00
116-DR-8[a]	100 D/DR	Crib	0.00

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. However, volume data for the site were sufficient to exceed release-to-the-environment criteria (i.e., 10% soil column volume); therefore, the site is recommended as having a significant priority for further characterization (as discussed in Section 3.2).

TABLE 3.2. 100-Area Liquid Sites with No Release to Ground and/or Surface Water

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
117-H[(a)]	100 H	Crib	0.00
117-B[(a)]	100 B/C	Crib	0.00
117-D[(a)]	100 D/DR	Crib	0.00
116-F-5	100 F	Crib	3.66
116-F-4	100 F	Crib	4.63
116-H-4	100 H	Exhumed Trench	4.63
116-D-3	100 D/DR	French Drain	8.64
116-D-4	100 D	French Drain	8.64
116-D-1A	100 D/DR	Trench	9.12
116-D-2	100 D/DR	Crib	9.12
116-DR-4	100 D/DR	Crib	9.12
116-B-3	100 B/C	Crib	16.22
116-B-6-1	100 B/C	Crib	16.22
116-B-6-2	100 B/C	Crib	16.22
100 KE*3	100 KE/KW	Trench	18.51

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. Its priority for further characterization efforts is addressed later in Section 3.2 (Supplemental Assessment) .

if it has already contaminated the environment and the release of contaminants has been observed. The potential for an observed release is evaluated, but that potential is not weighted as heavily in the overall scoring. Of particular interest to the CERCLA Program is the recharge rate (i.e., the net infiltration rate from rain and snow melt that may represent a driving force to mobilize contaminants contained in the unsaturated zone). Because the distribution of liquid waste beneath the sites classified as having no observed release is unknown, an accurate assessment of the site's potential hazard could not be made using the HRS system. Site recharge and drainage are mechanisms by which contaminants may reach the underlying aquifers; it may be only a matter of time before many waste-disposal sites will have an observed release. Such future releases represent a potential hazard not identified by the HRS scorings. Because some liquid-waste disposal sites

TABLE 3.3. 100-Area Solid Waste Sites

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
118-C-2[a]	100 B/C	Burial Ground	0.00
100-K Burning Pit[a]	100 KE/KW	Burning Pit	0.00
100-F Burning Pits-2	100 F	Burning Pit	0.08
100-H Burning Pit	100 H	Burning Pit	0.08
100-D/DR Burning Pit	100 D/DR	Burning Pit	0.13
100-B/C Burning Pit	100 B/C	Burning Pit	0.21
118-H-2	100 H	Burial Ground	1.17
118-H-3	100 H	Burial Ground	1.17
118-H-4	100 H	Burial Ground	1.17
118-H-5	100 H	Burial Ground	1.17
118-F-7	100 F	Burial Ground	1.17
118-F-2	100 F	Burial Ground	1.34
118-F-3	100 F	Burial Ground	1.34
118-F-6	100 F	Burial Ground	1.67
118-F-4	100 F	Burial Ground	1.75
118-H-1	100 H	Burial Ground	1.75
118-D-1	100 D/DR	Burial Ground	1.84
118-D-4	100 D/DR	Burial Ground	1.84
118-D-5	100 D/DR	Burial Ground	1.84
118-DR-1	100 D/DR	Burial Ground	1.84
118-F-1	100 D/DR	Burial Ground	2.01
118-F-5	100 F	Burial Ground	2.01
118-D-2	100 D/DR	Burial Ground	2.75
118-D-3	100 D/DR	Burial Ground	2.75
118-B-2	100 B/C	Burial Ground	3.04
118-B-3	100 B/C	Burial Ground	3.04
118-B-4	100 B/C	Burial Ground	3.04
118-B-5	100 B/C	Burial Ground	3.04
118-B-7	100 B/C	Burial Ground	3.04
118-B-1	100 B/C	Burial Ground	4.56
118-C-1	100 B/C	Burial Ground	4.56
118-B-6	100 B/C	Burial Ground	6.05
118-K	100 KE/KW	Burial Ground	6.08

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. Its priority for further characterization efforts is addressed later in Section 3.2, Supplemental Assessment.

TABLE 3.4. 200-Area Liquid Sites with Release to Ground and/or Surface Water

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
216-S-16P	200 West	Pond	32.71
216-U-4	200 West	Reverse Well	32.71
216-A-40	200 East	Trench	32.71
216-U-11	200 West	Ditch	37.75
216-Z-1(D)	200 West	Ditch	45.30
216-Z-11	200 West	Ditch	45.30
216-N-2	200 North	Crib	45.30
216-N-3	200 North	Crib	45.30
216-N-4	200 North	Pond	45.30
216-N-5	200 North	Crib	45.30
216-N-6	200 North	Pond	45.30
216-N-7	200 North	Crib	45.30
216-B-2-2	200 East	Crib	45.30
216-S-11	200 East	Pond	45.30
216-Z-17	200 West	Trench	45.30
216-U-4B	200 West	Dry Well	45.30
216-U-3	200 West	French Drain	47.27
216-A-4	200 East	Crib	47.81
216-A-6	200 East	Crib	47.81
216-B-4	200 East	Reverse Well	47.81
216-B-10A	200 East	Crib	47.81
216-B-11A&B	200 East	Reverse Well	47.81
216-C-10	200 East	Crib	47.81
216-S-3	200 East	French Drain	47.81
216-S-4	200 East	French Drain	47.81
216-S-5	200 East	Crib	47.81
216-S-6	200 West	Crib	47.81
216-S-17	200 West	Pond	47.81
216-S-16D	200 West	Ditch	47.81
216-S-21	200 West	Crib	47.81
216-T-8	200 West	Crib and Tile Field	47.81
216-T-28	200 West	Crib	47.81
216-Z-10	200 West	Reverse Well	47.81
216-A-28	200 East	French Drain	47.81
216-U-4A	200 West	Reverse Well	47.81
216-A-36A	200 East	Crib	50.33
216-B-6	200 East	Reverse Well	50.33

TABLE 3.4. (contd)

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
216-T-4-1(D)[(a)]	200 West	Ditch	0.00
216-N-1[(a)]	200 North	Pond	0.00
216-B-3-1[(a)]	200 East	Ditch	0.00
216-B-3-2[(a)]	200 East	Ditch	0.00
216-B-50	200 East	Crib	50.33
216-B-57	200 East	Crib	50.33
216-C-1	200 East	Crib	50.33
216-S-9	200 West	Crib	50.33
216-S-20	200 West	Crib	50.33
216-Z-7	200 West	Crib	50.33
216-T-2	200 West	Reverse Well	50.33
216-Z-1&2	200 West	Crib	52.85
216-S-1&2	200 East	Crib	55.36
216-A-7	200 East	Crib	57.88
216-A-9	200 East	Crib	57.88
216-A-21	200 East	Crib	57.88
216-A-24	200 East	Crib	57.88
216-A-27	200 East	Crib	57.88
216-B-43	200 East	Crib	57.88
216-S-7	200 West	Crib	57.88
216-T-19	200 West	Crib	57.88
216-A-5	200 East	Crib	60.40
216-B-5	200 East	Reverse Well	60.40
216-B-44	200 East	Crib	60.40
216-T-3	200 West	Reverse Well	60.40
216-B-12	200 East	Crib	62.92
216-B-16	200 East	Crib	62.92
216-B-45	200 East	Crib	62.92
216-B-46	200 East	Crib	62.92
216-B-48	200 East	Crib	62.92
216-B-49	200 East	Crib	62.92
216-U-1&2	200 West	Crib	62.92
216-B-7 A&B	200 East	Cribs	65.43
216-T-7	200 West	Crib and Tile Field	65.43

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. However, volume data for the site were sufficient to exceed release to the environment criteria (i.e., 10% soil column volume), and it is therefore recommended as having a significant priority for further characterization efforts (as discussed in the Supplemental Assessment Section).

TABLE 3.5. 200-Area Liquid Sites with No Release to Ground and/or Surface Water

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
216-A-32[a]	200 East	Crib	0.00
216-A-33[a]	200 East	French Drain	0.00
216-U-9[a]	200 West	Ditch	0.00
216-B-2-1[a]	200 East	Ditch	0.00
216-S-18[a]	200 East	Trench	0.00
216-T-30	200 West	Trench	0.65
216-A-13	200 East	French Drain	0.71
216-B-13	200 East	French Drain	0.71
216-B-51	200 East	French Drain	0.71
216-C-8	200 East	French Drain	0.71
216-B-60	200 East	Crib	0.98
216-T-12	200 West	Trench	0.98
216-Z-16	200 West	Crib	0.98
216-B-53A	200 East	Trench	0.98
216-U-13	200 West	Trench	0.98
216-A-39	200 East	Crib	0.98
216-A-1	Outside, East of 200 East	Crib	1.03
216-A-23B	200 East	French Drain	1.03
216-A-11	200 East	French Drain	1.03
216-A-12	200 East	French Drain	1.03
216-A-14	200 East	French Drain	1.03
216-A-15	200 East	French Drain	1.03
216-A-16	200 East	French Drain	1.03
216-A-17	200 East	French Drain	1.03
216-A-18	200 East	Trench	1.03
216-A-31	200 East	Liquid Waste Disposal Sites	1.03
216-A-35	200 East	French Drain	1.03
216-A-41	200 East	Crib	1.03
216-B-9	200 East	Crib and Tile Field	1.03
216-B-10B	200 East	Crib	1.03
216-B-54	200 East	Trench	1.03
216-B-58	200 East	Crib	1.03
216-C-3	200 East	Crib	1.03
216-C-6	200 East	Crib	1.03
216-S-12	200 West	Trench	1.03
216-S-14	200 West	Trench	1.03
216-T-29	200 West	French Drain	1.03

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. Its priority for further characterization efforts is addressed later in the Supplemental Assessment Section.

TABLE 3.5. (contd)

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
216-T-33	200 West	Crib	1.03
216-T-34	200 West	Crib	1.03
216-S-15	200 West	Pond	1.03
216-S-22	200 West	Crib	1.03
216-S-23	200 West	Crib	1.03
216-U-5	200 West	Trench	1.03
216-U-6	200 West	Trench	1.03
216-U-7	200 West	French Drain	1.03
216-Z-4	200 West	Crib	1.03
216-Z-6	200 West	Crib	1.03
216-Z-8	200 West	French Drain	1.03
216-B-53B	200 East	Trench	1.03
216-A-34	200 East	Ditch	1.09
216-C-4	200 East	Crib	1.09
216-C-5	200 East	Crib	1.09
216-T-20	200 West	Crib	1.09
216-U-15	200 West	Trench	1.09
216-Z-1A	200 West	Tile Field	1.09
216-T-14	200 West	Trench	1.20
216-T-15	200 West	Trench	1.20
216-T-16	200 West	Trench	1.20
216-T-17	200 West	Trench	1.20
216-U-8	200 West	Crib	1.20
216-B-36	200 East	Trench	1.25
216-B-38	200 East	Trench	1.25
216-B-39	200 East	Trench	1.25
216-B-40	200 East	Trench	1.25
216-B-41	200 East	Trench	1.25
216-B-42	200 East	Trench	1.25
216-T-23	200 West	Trench	1.25
216-T-5	200 West	Crib	1.25
216-B-21	200 East	Trench	1.31
216-B-24	200 East	Trench	1.31
216-B-25	200 East	Trench	1.31
216-B-27	200 East	Trench	1.31
216-B-29	200 East	Trench	1.31
216-B-35	200 East	Trench	1.31
216-B-47	200 East	Crib	1.31
216-Z-3	200 West	Crib	1.31
216-B-15	200 East	Crib	1.36
216-B-17	200 East	Crib	1.36
216-B-18	200 East	Crib	1.36
216-B-20	200 East	Trench	1.36
216-B-22	200 East	Trench	1.36
216-B-23	200 East	Trench	1.36
216-B-26	200 East	Trench	1.36
216-B-30	200 East	Trench	1.36

TABLE 3.5. (contd)

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
216-B-31	200 East	Trench	1.36
216-B-32	200 East	Trench	1.36
216-Z-12	200 West	Crib	1.36
216-Z-18	200 West	Crib	1.36
216-B-28	200 East	Trench	1.36
216-T-35	200 West	Crib	1.38
216-T-36	200 West	Crib	1.38
216-B-8	200 East	Crib and Tile Field	1.42
216-B-33	200 East	Trench	1.42
216-B-34	200 East	Trench	1.42
216-B-37	200 East	Trench	1.42
216-B-52	200 East	Trench	1.42
216-T-32	200 West	Crib	1.42
216-S-13	200 West	Crib	1.45
216-T-21	200 West	Trench	1.52
216-T-18	200 West	Crib	1.60
216-T-22	200 West	Trench	1.67
216-T-24	200 West	Trench	1.67
216-T-27	200 West	Crib	1.72
216-B-19	200 East	Crib	1.81
216-T-26	200 West	Crib	1.81
216-T-25	200 West	Trench	1.89
216-A-22	200 East	French Drain	1.96
216-Z-5	200 West	Crib	2.00
216-A-20	200 East	Trench	2.07
216-A-26A	200 East	French Drain	2.07
216-S-8	200 West	Trench	2.07
216-A-19	200 East	Trench	2.18
216-B-14	200 East	Crib	2.27
216-Z-9	200 West	Crib	2.27
216-T-6	200 West	Crib	2.50
216-A-23A	200 East	French Drain	2.61
216-A-2	200 East	Crib	4.39
216-T-10[a]	200 West	Liquid Waste	0.00
216-T-11[a]	200 West	Liquid Waste	0.00
216-T-13[a]	200 West	Liquid Waste	0.00
216-T-31[a]	200 West	Liquid Waste	0.00
216-T-4A[a]	200 West	Liquid Waste	0.00
216-T-9[a]	200 West	Liquid Waste	0.00

(a) Although site was used for waste disposal, no inventory was available; therefore, the site did not score. Its priority for further characterization efforts is addressed later in the Supplemental Assessment Section.

TABLE 3.6. 200-Area Solid-Waste Sites

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
200 East Burning Pit[a]	200 East	Solid Waste	0.00
218-E-1	200 East	Solid Waste	0.70
218-E-14	200 East	Solid Waste	0.70
218-E-2	200 East	Solid Waste	0.70
218-E-2A	200 East	Solid Waste	0.00
218-E-3	200 East	Solid Waste	0.00
218-E-6	200 East	Solid Waste	0.00
218-E-9	200 East	Solid Waste	0.00
218-W-3	200 West	Solid Waste	0.70
200 West Burning Pit[a]	200 West	Solid Waste	0.00
Construction Surface Laydown Area[a]	200 West	Solid Waste	0.00
Z Plant burning pit[a]	200 West	Solid Waste	0.00
218-W-1	200 West	Solid Waste	0.70
218-W-1A	200 West	Solid Waste	0.70
218-W-2	200 West	Solid Waste	0.70
218-W-4A	200 West	Solid Waste	0.70
218-W-7	200 West	Solid Waste	0.70
218-W-8	200 West	Solid Waste	0.70
218-E-12A	200 East	Solid Waste	0.70
218-E-13	200 East	Solid Waste	0.00
218-E-4	200 East	Solid Waste	0.70
218-E-5	200 East	Solid Waste	0.70
218-E-5A	200 East	Solid Waste	0.70
218-E-7	200 East	Solid Waste	0.70
218-E-8	200 East	Solid Waste	0.70
218-W-11[a]	200 West	Solid Waste	0.00
218-W-9[a]	200 West	Solid Waste	0.00
200 Area Construction Pit[a]	600	Solid Waste	0.00

(a) Although the site was used for waste disposal, no inventory was available; therefore, the site did not score. Its priority for further characterization efforts is addressed later in the Supplemental Assessment Section.

TABLE 3.7. 300-Area Inactive Waste Sites

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
316-1	300	Pond	79.30
316-2	300	Pond	79.30
316-3	300	Trench	79.30
316-4	300	Crib	16.60

TABLE 3.8. 600-Area Inactive Waste Sites[(a)]

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
213-J and K	600	Cribs	0.00
Original Central Landfill	600	Landfill	0.00
618-10	600	Landfill	0.00
618-11	600	Landfill	0.00
618-12	600	Landfill	0.00
618-13	600	Landfill	0.00
618-3	600	Landfill	0.00
618-4	600	Landfill	0.00
618-5	600	Landfill	0.00
618-6	600	Landfill	0.00
618-7	600	Landfill	0.00
618-8	600	Landfill	0.00
618-9	600	Landfill	0.00
Horn Rapid Disposal Site	600	Landfill	0.00
J.A. Jones #1	600	Landfill	0.00
J.A. Jones #2	600	Landfill	0.00
P-11	600	Crib	0.00
USBR-2.4-D	600	Landfill	0.00
618-1	600	Landfill	0.00
618-2	600	Landfill	0.00

(a) Although the sites in the 600 Area were used for waste disposal, no inventory was available; therefore, these sites did not score. Their priority for further characterization efforts are addressed later in the Supplemental Assessment Section.

without observed releases may have a potential for release in the future, it is recommended that these sites be examined closely in future characterization efforts.

The sections that follow describe the technical basis for evaluating the liquid-waste disposal sites that should receive close examination in future characterization efforts. For the purpose of these technical assessments, liquid-waste disposal sites were grouped into those containing liquid effluents from 100-Area reactor operations and liquid effluents from 200-Area nuclear fuel processing. Information used in the supplemental analysis came primarily from ERDA (1975), Maxfield (1979), Dorian and Richards (1978), and Volume 2 of this document (HISS Data Base).

3.2.1 Technical Basis for the 100-Area Supplemental Assessment

As stated in Chapter 2.0, disposal facilities (now inactive) within the 100 Areas formerly supported production reactor operations. The reactor areas had a variety of disposal facilities to store or discharge wastes generated within them. The disposal facilities in each area usually included a burning pit, one or more solid-waste burial grounds, and several liquid-waste disposal sites. The remaining disposal facilities within the 100 Areas received liquid wastes. The liquid-waste disposal sites generally represent a more significant release hazard than solid-waste disposal sites, because the liquid waste can more readily migrate into the unconfined aquifer. (This is not to suggest that contaminants from solid-waste disposal sites could not be released to the ground water or surface water as leachates; rather, because no liquid is associated with the waste, net infiltration is the only mechanism to contaminate ground and surface waters.) It was determined that further investigation of solid-waste disposal sites would be unnecessary.

Liquid effluents produced by inactive 100-Area operations can be separated into four categories based on effluent content:

- reactor coolant
- liquid effluents from ruptured-fuel storage
- decontamination waste streams
- miscellaneous liquid wastes.

Although most reactor coolant streams were discharged to the Columbia River via outfall structures, some reactor coolants from primary reactor cooling systems moved into cribs and trenches and subsequently to the river via springs. These effluents, though high in volume, contained relatively low concentrations of radionuclides. Reactor coolant is considered to pose little environmental concern because most of the radionuclide inventory has already reached the ground and surface waters.

Liquid effluents from ruptured-fuel storage were generated when a reactor or fuel storage basin received broken fuel assemblies. Two types of liquid effluents were produced. The first, ruptured-fuel storage basin effluents, contained large volumes and considerable radionuclide concentrations. The second type of effluent, process-tube drainage, consisted of small-volume, secondary streams of ruptured-fuel storage effluent. Although the second type is more radioactive than the first, its comparatively small volume makes it potentially less hazardous. The primary reason for closely examining these sites is that such sites usually have only radionuclide inventories, and, hence, the HRS score corresponds to a potentially hazardous concentration of radionuclides in the waste stream.

Decontamination waste streams, unlike reactor coolant and ruptured-fuel storage liquid effluents, contained significant quantities of chemicals as well as radionuclides. Decontamination processes often use acids, bases, or organic complexants to remove radionuclides from the surfaces of various equipment and facilities. In addition, significant volumes of decontamination agents were used to flush all of the once-through cooled reactors (105-B, -C, -D, -DR, -F, -KE, -KW, -H) as part of shutdown and standby operations. The volume of waste disposed of in the decontamination-waste disposal sites varied widely. All of these sites received some hazardous chemical constituents, but in some instances the volume was so small that it is unlikely that environmental impacts resulted. Because decontamination wastes contain both radionuclides and hazardous chemicals, these sites should be closely examined during future characterization efforts. Those sites with migration scores more than 28.5 should be given priority during characterization efforts.

Miscellaneous liquid waste refers to specialized waste streams that may have been chemically hazardous as well as radioactive. Liquid-waste streams in this category are handled in the same manner as decontamination wastes that should be examined closely during characterization efforts.

These four categories represent the range of liquid effluents discharged as a direct result of reactor operations. The 100-Area liquid-waste disposal sites categorized with the supplemental assessment method are discussed in Section 3.3 of this chapter.

3.2.2 Technical Basis for the 200-Area Supplemental Assessment

Liquid-waste streams disposed of to the ground in the 200 Areas have been categorized for the purpose of evaluating the potential hazard from 200-Area liquid-effluent disposal sites. Based on the type of hazardous substances contained in each waste steam, five categories have been established. The five categories, from potentially least hazardous to potentially most hazardous, are:

1. steam condensate and cooling water
2. process condensate
3. stack flushes, stack drainage, cell drainage, and cold start-up waste (referred to as miscellaneous liquid waste)
4. process, organic, chemical, laboratory, and decontamination waste (referred to as process waste)
5. tank and scavenged waste.

These general categories were used in conjunction with the HRS scores to identify the potentially hazardous liquid-effluent disposal sites in the 200 Areas and to complement the HRS score by providing site-specific information not otherwise addressed. For example, a waste may have contained complexants that increased contaminant mobility. Although these complexants were not hazardous chemicals (and thus contributed little to the score), they increased the potential hazard of a disposal facility by mobilizing radioactive contaminants. The HRS scores, in combination with waste characteristics, allow a more comprehensive evaluation of the potential hazard from past waste-disposal practices. The relative potential hazard from each liquid-effluent disposal site will be described on a plant-by-plant basis for the 200-East and 200-West Areas in Section 3.3.

Steam condensate and cooling water are primarily river water with little potential for chemical or radioactive contamination. These liquid effluents made up a large portion of the water used in the 200 Areas. Steam condensate and cooling water were most commonly discharged through unlined ditches to ponds for evaporation or drainage to the ground water. Accidental releases of radioactive and hazardous substances to these facilities have occurred, but represent only a small fraction of the waste volume discharged to these sites. Sites that received steam condensate and cooling water are not considered to need a high priority in further characterization efforts.

Process condensate is that water condensed from closed systems that has been in direct contact with radioactive material. Process condensate can be acidic or alkaline and often contains relatively low concentrations of nitrate, ammonia, and possibly volatile organic compounds. Certain of these process condensates also likely contain potentially volatile radionuclides. Carbon-14, tritium, iodine-129, ruthenium-106, and other radionuclides could be contained in process condensates. Because of their radionuclide content, most process condensates were discharged to cribs. Process condensates with migration scores of 28.5 or greater should be given a significant priority in further characterization efforts. Process condensate sites with migration scores less than 28.5 need to be closely examined, but can be given a lower priority.

Miscellaneous liquid wastes include a wide variety of potentially hazardous wastes. These liquid effluents are not well characterized but could contain more highly concentrated, potentially hazardous substances. Liquid wastes in this designation were all in relatively low volumes. Disposal facilities receiving these liquids were primarily cribs, but several french drains and reverse wells also received these liquid wastes. These waste streams were considered to pose potential risk to the environment, except when they were ranked low by the HRS and included no hazardous chemicals. Sites in this category should be investigated with the same priority as the sites containing process condensate.

Process, organic, chemical, laboratory, and decontamination waste contain radionuclides and hazardous chemicals. These waste streams are generated as a result of direct contact with radioactive material. In many cases, these liquids were used to leach, extract, or immobilize certain radionuclides. These liquid wastes are environmentally important because they may contain complexants that enhance the mobility of other hazardous chemicals and radionuclides. Disposal facilities receiving these effluents were primarily cribs. The volume of waste disposed of at individual sites varied dramatically from plant to plant. Sites in this category with migration scores greater than 28.5 should be given a significant priority in future characterization efforts. Sites with scores less than 28.5 should be closely examined, but can be given a lower priority in future characterization efforts.

Tank and scavenged waste are the most concentrated liquid wastes discharged to the ground. Tank wastes included condensate from boiling tank waste or tank supernate. Tank supernate contained a high concentration of salt and usually was basic. This waste was produced from the neutralization of high-level radioactive waste sent to a waste tank. During neutralization, a sludge precipitated and settled out in the tank. This sludge immobilized certain radionuclides from the high-level waste. The radionuclide inventory remaining in the tank supernate was likely to be highly mobile because of the presence of organic and inorganic complexants. Scavenged waste was produced when tank waste from the bismuth-phosphate extraction process was scavenged to recover uranium. These wastes represent the most highly concentrated chemical and radioactive liquid wastes disposed of to the ground within the 200 Areas. Nearly all of the scavenged waste was pumped through pipes from the U Plant to the B cribs and trenches. Sites with migration scores greater than 28.5 that received tank or scavenged wastes should be given a high priority in future characterization efforts. Tank- and scavenged-waste disposal sites with migration scores less than 28.5 should be given the highest priority of sites for which no release was observed.

The waste categories described in this section provide the basis for the supplemental technical assessments that were performed for all 100- and

200-Area liquid-waste disposal sites. The results of these assessments are discussed in the following section.

3.3 EVALUATION OF POTENTIAL HAZARDS ASSOCIATED WITH THE ENGINEERED-FACILITY SITES

This section discusses the site-specific hazards associated with the original 335 liquid- and solid-waste disposal sites. These discussions focus on site characteristics that influence the designation of a waste site's priority in future characterization efforts. For liquid-waste disposal sites within the 100 and 200 Areas, the final designation of a site was dependent on both the HRS migration score and a supplemental technical assessment. For solid-waste disposal sites, the designation of a site was solely dependent on its HRS migration score.

3.3.1 100-Area Inactive Waste-Disposal Sites

Tables 3.9 and 3.10 list the results of the technical assessments for liquid-waste disposal sites with migration scores greater than 28.5 and less

TABLE 3.9. 100-Area Liquid-Waste Disposal Sites with Migration Scores Greater Than 28.5

Reactor Coolant	Ruptured Fuel Effluents	Decontamination Waste	Miscellaneous
116-DR-3			
116-K-2	116-C-2	116-B-4	100-KE*1
116-B-1[(a)]	116-F-2	116-D-1B	100-KE*2
116-C-1[(a)]	116-F-3	116-F-1	100-KW*1
116-DR-1	116-H-1	116-H-3	100-KW*2
116-DR-6			116-KE-2
116-K-1			116-F-9
116-DR-2			116-DR-7
116-F-10			116-B-5
116-H-2			116-F-7
116-F-6			
116-B-2			
116-KE-1			
116-KW-1			

(a) Also used to receive reactor coolant diverted during fuel failures.

TABLE 3.10. 100-Area Liquid-Waste Disposal Sites with Migration Scores Less Than 28.5

Reactor Coolant	Ruptured-Fuel Effluents	Decontamination Waste	Miscellaneous
116-D-1A	116-B-3	116-B-6-1	100-KE*3
116-DR-8	116-D-2	116-B-6-2	116-B-10
116-F-11	116-DR-4	116-D-3	116-B-9
116-F-12	116-F-4	116-D-4	116-D-6
116-F-13	116-H-4	116-C-2-2[(a)]	116-KE-3
116-KW-2		116-F-5	
117-B			
117-C			
117-D			
117-H			

(a) Also received ruptured fuel effluents.

than 28.5, respectively. Liquid-waste disposal sites listed in Table 3.9 are in either the "significant priority" or the "low priority" designation. Ruptured fuel effluents, decontamination waste, and miscellaneous-waste disposal sites with migration scores greater than 28.5 are recommended for significant priority in future characterization efforts. Reactor coolant sites are not recommended for high priority in future characterization efforts based on the technical assessment, but they need to be carefully evaluated because of the large volumes of waste discharged and the mobility of radionuclides contained in the waste streams. Radionuclides in reactor coolant may have been flushed through the soil column and may have reached the unconfined aquifer and the Columbia River. Decontamination and miscellaneous-waste disposal sites listed in Table 3.10 should be considered as low priority sites. Reactor coolant and ruptured-fuel effluent waste-disposal sites were considered predominantly radionuclide-only sites. Reactor coolant and ruptured-fuel effluent waste-disposal sites with migration scores less than 28.5 should be considered as low priority sites because the potential hazard from liquids with these concentrations of radionuclides is considered relatively low.

The burning pits and solid-waste disposal sites listed in Table 3.11 present the smallest potential migration hazard in the 100 Areas according to

TABLE 3.11. 100-Area Solid-Waste Disposal Sites

Burial Grounds	Burial Grounds	Burning Pits
118-B-6	118-B-4	100-B/C Burning Pit
118-B-1	118-B-5	100-D/DR Burning Pit
118-C-1	118-B-7	100-F Burning Pit
118-D-2	118-C-2	100-H Burning Pit
118-D-3	118-D-1	100-K Burning Pit
118-F-1	118-D-4	
118-F-2	118-D-5	
118-F-3	118-DR-1	
118-F-5	118-F-4	
118-F-6	118-F-7	
118-H-1	118-H-2	
118-K	118-H-3	
118-B-2	118-H-4	
118-B-3	118-H-5	

the HRS, primarily because of the characteristics of the waste. Burning pits were used to incinerate nonradioactive combustible material, mostly trash, office waste, and small amounts of solvents and paint wastes. Solid-waste disposal sites were used to store or dispose of radioactively contaminated equipment and material generated by reactor operations. Contaminated solid waste, irradiated reactor components, and contaminated construction waste are characteristic of the wastes buried at these sites. No burning pit or solid- waste disposal site is known to have directly contaminated the unconfined aquifer or the Columbia River. With the limited inventories of hazardous chemicals in burning pit residues and the chemically inert nature of the radioactive solid wastes, it is apparent that these sites represent the lowest potential migration hazard within the 100 Areas. Thus, these sites should be considered as low priority sites.

3.3.2 200-Area Inactive Waste-Disposal Sites

The following site-specific discussions deal with liquid-effluent disposal facilities in order by their letter (i.e., plant) designation. This section discusses liquid-effluent disposal facilities designated as 216-A, -B, -C, -N, -S, -T, -U, or -Z, according to their plant of origin (see

Appendix B for discussion of designations). Solid-waste disposal sites are not discussed further, because their evaluation under the HRS is considered fairly straight forward.

A-Plant Liquid-Waste Disposal Sites

Inactive sites with the designation 216-A-xx are associated with the Plutonium/URanium EXtraction (PUREX) Plant. Figure 3.1 illustrates the distribution of liquid-waste disposal sites within waste categories.

Most liquid waste (by volume) discharged to the ground consists of steam condensates and cooling water. Most of the A-designated sites received miscellaneous waste, such as stack, cell, and cold-start-up wastes. One site received process condensate; only five sites received process wastes, and one received tank wastes. In general, liquids discharged to A-Plant sites represent less potential risk than liquids discharged to most other plant sites. The primary process wastes generated at the PUREX Plant were highly radioactive and were stored in double-shell tanks. Because much of the plant's liquid effluent was stored in these tanks, a much smaller fraction of the radionuclide and chemical inventories was discharged to the ground. In addition, the PUREX process was more efficient than older processes at extracting transuranic (TRU) waste from waste streams discharged to the ground, as shown by the fact that no A-designated sites are considered to be TRU-Contaminated Soil Sites (DOE 1987).

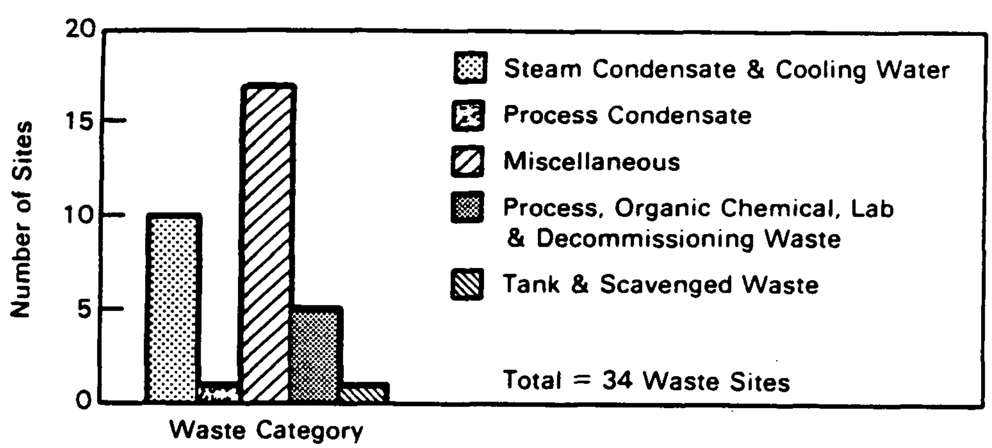

FIGURE 3.1. Distribution of Liquid-Waste Categories at A Plant

Tables 3.12 and 3.13 list the A-designated waste-disposal sites with migration scores greater than 28.5 and less than 28.5, respectively. All of the sites listed in Table 3.12, except 216-A-40, should be considered as having a significant priority for further characterization efforts. Site 216-A-40 is a low priority site because it received only steam condensate and cooling water. Of the waste-disposal sites listed in Table 3.13, the miscellaneous liquid-waste disposal sites and process-waste disposal sites are recommended as sites that should be given a significant priority for further characterization efforts, while all steam-condensate and cooling-water waste-disposal sites should be considered as low priority sites.

The 216-A-5 Crib received process condensate from the PUREX Plant. The liquids contained organic solvents that may be discharged as condensates. In addition, these condensates probably contain potentially volatile radionuclides. Although the actual distribution of volatile organics and radionuclides is unknown for the 216-A-5 waste stream, this source likely represents a higher potential risk than do process condensates generated later in the process cycle. Another factor that increased the potential hazard from the 216-A-5 Crib was that the volatile organics and radionuclides that may be

TABLE 3.12. Inactive A-Plant Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-A-40
Process condensate	216-A-5
Miscellaneous liquid waste	216-A-27 216-A-4 216-A-7 216-A-6 216-A-28 216-A-36A
Process waste	216-A-21 216-A-9
Tank and scavenged waste	216-A-24

TABLE 3.13. Inactive A-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-A-11 216-A-12 216-A-34 216-A-13 216-A-14 216-A-35 216-A-32 216-A-33
Process condensate	None
Miscellaneous liquid waste	216-A-1 216-A-19 216-A-23A 216-A-20 216-A-26A 216-A-15 216-A-16 216-A-17 216-A-18 216-A-41 216-A-23B 216-A-39
Process waste	216-A-2 216-A-22 216-A-31
Tank and scavenged waste	None

contained in this liquid effluent were not well sorbed by the Hanford sediments (Routson 1973; Delegard and Barney 1983).

Similar statements can be made about the 216-A-24 Crib. This crib has been categorized as a tank-waste disposal site because it held condensate collected from tank-farm condensers. In addition, tank and scavenged waste were mixed in tanks, yielding a potentially more hazardous condensate. Reports suggest that a release of contaminants to the ground water from both 216-A-5 and 216-A-24 may have occurred. Several other A-Plant waste-disposal sites have discharged liquids to the unconfined aquifer, but these accidents were considered less hazardous because of the relatively high proportion of

PUREX liquid wastes retained in tanks. Wastes from A-designated sites represent a small portion of Hanford's radionuclide and hazardous chemical inventories when compared with other plants, because of the large fraction of PUREX liquids retained in double-shell tanks.

B-Plant Liquid-Waste Disposal Sites

Liquid-effluent disposal sites having the 216-B-xx designation received waste from the B Plant as well as several other processing facilities. The distribution of liquid-waste disposal sites with the B designation is illustrated in Figure 3.2.

In general, waste was discharged to these facilities in three distinct operating phases. Sites 216-B-4 through B-13 serviced B Plant during its initial operating phase. The second phase that discharged liquids to the B-designated sites was the effort undertaken to recover uranium from bismuth-phosphate waste stored in single-shell tanks. These uranium-scavenged liquids and other first-cycle supernatants were discharged to disposal sites numbered 216-B-14 through B-49. The final major operation phase that discharged liquids to the remaining B-designated sites was predominantly from 300-Area operations. Tables 3.14 and 3.15 list the B-designated sites with migration scores above and below 28.5, respectively. All sites listed

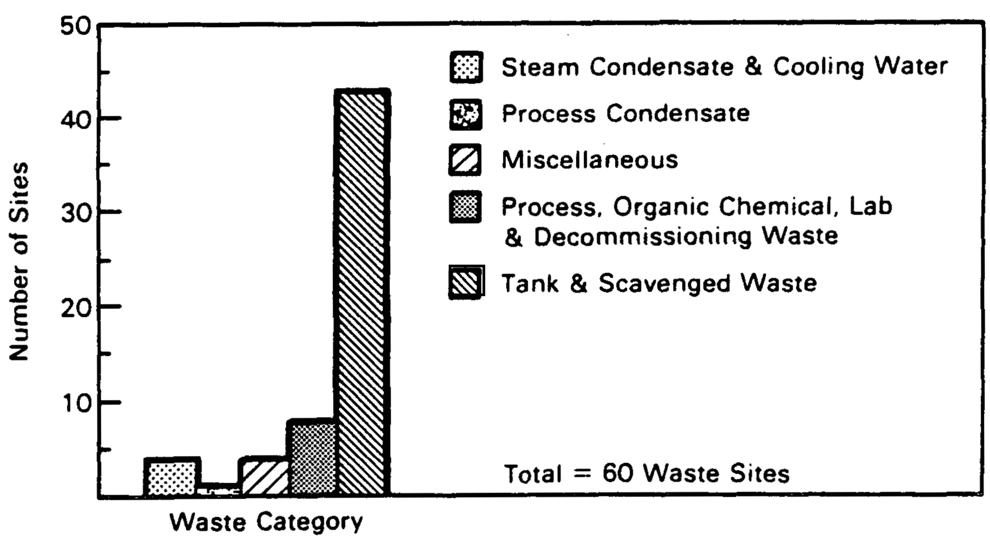

FIGURE 3.2. Distribution of Liquid-Waste Categories at B Plant

TABLE 3.14. Inactive B-Plant Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-B-2-2
Process condensate	216-B-11-A&B
Miscellaneous liquid waste	216-B-4
Process waste	216-B-6 216-B-10A 216-B-12
Tank and scavenged waste	216-B-7A&B[(a)] 216-B-57 216-B-5[(a)] 216-B-16 216-B-45 216-B-46 216-B-48 216-B-49 216-B-44 216-B-43 216-B-50

(a) TRU-Contaminated Soil Site (DOE 1987).

in Table 3.14 except site 216-B-2-2 are recommended as needing a significant priority for future characterization efforts. The three steam-condensate and cooling-water disposal sites listed in Table 3.15 should be considered as low priority sites. All remaining sites should be considered as having a significant priority for further characterization efforts. Specific sites are discussed below.

Liquids discharged from the B Plant during the initial operating phase contained higher concentrations of both radionuclides and fission products than did the corresponding PUREX process effluents. The less efficient nature of the bismuth-phosphate process left significant amounts of transuranic radionuclides in liquid effluents discharged to the ground. The site 216-B-5 Reverse well and 216-B-7A&B Cribs have been designated as TRU-Contaminated Soil Sites (DOE 1987). Sites 216-B-6, 216-B-8, and 216-B-9

TABLE 3.15. Inactive B-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site	
Steam condensate and cooling water	216-B-2-1	
	216-B-3-1	
	216-B-3-2	
Process condensate	None	
Miscellaneous liquid waste	216-B-51	
	216-B-13	
	216-B-60	
Process waste	216-B-53A	
	216-B-53B[(a)]	
	216-B-54	
	216-B-58	
	216-B-10B	
Tank and scavenged waste	216-B-14	216-B-42
	216-B-19	216-B-47
	216-B-37	216-B-15
	216-B-40	216-B-17
	216-B-36	216-B-18
	216-B-39	216-B-23
	216-B-38	216-B-24
	216-B-41	216-B-25
	216-B-35	216-B-27
	216-B-20	216-B-29
	216-B-21	216-B-33
	216-B-22	216-B-34
	216-B-26	216-B-52
	216-B-30	216-B-28
	216-B-31	216-B-9
	216-B-32	216-B-8

(a) TRU-Contaminated Soil Site (DOE 1987).

all received wastes from the same source as these TRU-contaminated sites, and so may have a significant TRU inventory. The migration of TRU from crib sites represents a smaller potential hazard than migration from reverse wells, because these radionuclides are sorbed by Hanford sediments. Disposal facilities 216-B-5, 216-B-11A&B, 216-B-4, and 216-B-6 are reverse wells that discharge directly into the unconfined aquifer, and thus have a higher hazard potential.

All of the liquid effluents discharged during the uranium recovery effort were either scavenged wastes or tank wastes. These liquid wastes were similar and are considered to be potentially hazardous. Each of the sites, 216-B-14 through B-49, remained active for a maximum duration of only a few months. Sites 216-B-14 through 216-B-19 and sites 216-B-43 through 216-B-49 were cribs that received a calculated volume of waste (i.e., they were "specific-retention" cribs). Discharges of these wastes to the ground were halted if calculations and monitoring suggested that releases of long-lived radionuclides to the ground water could occur.

In addition to the cribs, trenches were designed to immobilize the long-lived radionuclides near their discharge points. Sites 216-B-20 through B-42 were trenches designed for specific retention. None of these specific-retention trenches were identified as discharging to the unconfined aquifer, but nearly all of the specific-retention B-designated cribs have released contamination to the ground water. Minor amounts of chemical contamination from the specific-retention trenches could have gone undetected because these facilities were designed to immobilize radionuclides but not necessarily chemicals near the trench bottom, and because the primary method of detecting releases to the ground water was scintillation logging, which is accurate for radionuclides only.

Of the B-designated sites receiving waste from the 300 Area, only 216-B-53A was contaminated by TRU. None of the sites have been identified as releasing contaminants to the unconfined aquifer.

Taken all together, liquid wastes discharged to sites with the B designation represent potentially the most hazardous wastes released to the ground within the 200 Areas. No other group of sites received nearly as great a volume of contaminated liquid effluent. Thus, these sites should be assigned a relatively high priority for future characterization efforts.

C-Plant Liquid-Waste Disposal Sites

Liquid-effluent disposal sites with the 216-C-xx designation received waste from the Semiworks and the Critical Mass Laboratory. These liquid-effluent disposal sites received a very small volume of liquid waste compared to other groups of sites. Because these facilities produced such small volumes of liquid, several kinds of liquid effluent were often released to the same C-designated site. As indicated in Figure 3.3, no tank or scavenged wastes were discharged to C-designated sites. Two C-designated sites did receive some steam condensate and cooling water, but because these sites also received significant volumes of process condensates, they were classified accordingly. These same two sites, 216-C-1 and 216-C-10, had migration scores greater than 28.5 and are recommended as needing a significant priority for future characterization efforts. Table 3.16 lists the inactive C-designated sites with migration scores less than 28.5.

S-Plant Liquid-Waste Disposal Sites

Inactive sites with the designation 216-S-xx were associated with the REDOX Plant. Many of the liquid effluents generated at the REDOX Plant were highly radioactive and so required tank storage. This storage of these more concentrated wastes reduced the volume of concentrated liquid effluent discharged to the ground. However, as illustrated by Figure 3.4, the REDOX

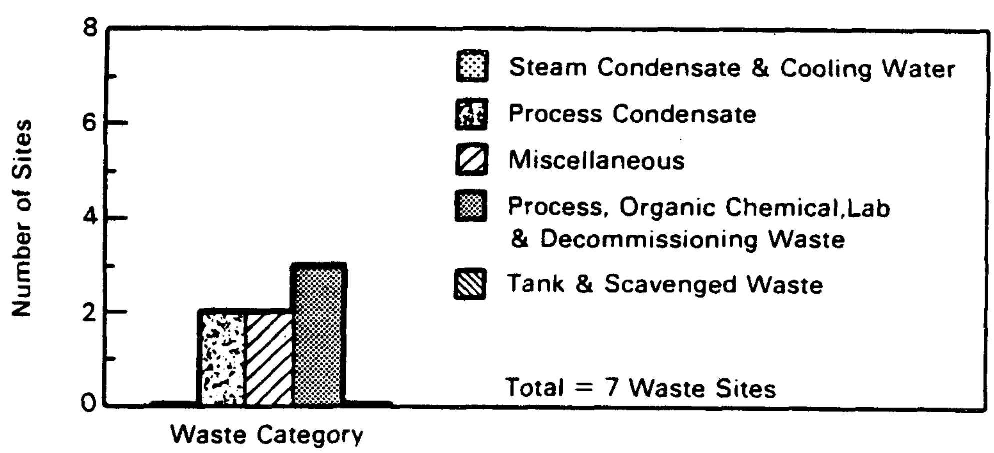

FIGURE 3.3. Distribution of Liquid-Waste Categories at C Plant

TABLE 3.16. Inactive C-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site
Steam condensate and cooling water	None
Process condensate	None
Miscellaneous liquid waste	216-C-6 216-C-5
Process waste	216-C-3 216-C-8 216-C-4
Tank and scavenged waste	None

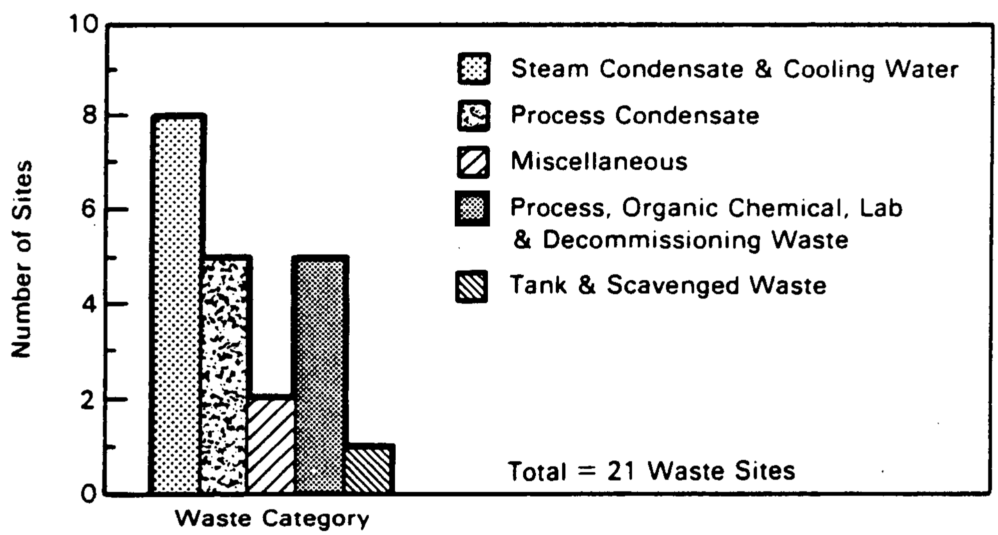

FIGURE 3.4. Distribution of Liquid-Waste Categories at S Plant

processes required large volumes of cooling water to dissipate heat generated by the highly concentrated wastes, and so total volumes of liquid waste remained large.

Tables 3.17 and 3.18 list the liquid-waste disposal sites with migration scores greater than 28.5 and less than 28.5, respectively. The sites listed

TABLE 3.17. Inactive S-Plant Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-S-3 216-S-16D 216-S-6 216-S-17 216-S-16P 216-S-4 216-S-5
Process condensate	216-S-7 216-S-1&2[a] 216-S-9 216-S-21
Miscellaneous liquid waste	None
Process waste	216-S-20 216-S-11
Tank and scavenged waste	None

(a) TRU-Contaminated Soil Site (DOE 1987).

TABLE 3.18. Inactive S-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-S-18
Process condensate	216-S-23
Miscellaneous liquid waste	216-S-8 216-S-12
Process waste	216-S-13 216-S-22 216-S-14
Tank and scavenged waste	216-S-15

in Table 3.17 should be given a significant priority for future characterization efforts. All sites listed in Table 3.18 should be given a significant priority for future characterization, except for 216-S-18. Discussions of noteworthy sites follow.

The S-designated liquid-waste disposal sites primarily contained steam condensates and cooling water from the REDOX Plant, like the A-designated liquid-waste disposal sites supporting the PUREX Plant. Several process-condensate liquid-waste disposal sites were also associated with the REDOX Plant. As at the PUREX Plant, process condensates discharged to S-designated liquid-waste disposal sites contained volatile organic solvents and potentially volatile radionuclides. In addition, process condensate discharged to 216-S-1&2 contained TRU radionuclides in concentrations sufficient for this site to be designated a TRU-Contaminated Soil Site (DOE 1987). Condensates from the same process were discharged to 216-S-7, 216-S-9, and 216-S-23, which suggests that these S-designated sites may have a significant TRU content. Observed releases of contaminants to the unconfined aquifer have occurred at 216-S-1&2, 216-S-7, 216-S-9, and 216-S-21 process-condensate cribs. The other S-designated liquid-waste disposal sites at which an observed release has occurred contained steam condensate and cooling water, except site 216-S-20. Site 216-S-20 received liquid waste from the 222-S laboratory. Of the remaining S-designated liquid-waste disposal sites where a release was not suspected, 216-S-8, 216-S-13, and 216-S-14 are potentially hazardous sites because of their high organic content (see Volume 2, HISS Data Base).

T-Plant Liquid-Waste Disposal Sites

Inactive liquid-waste disposal sites with the designation 216-T-xx serviced the T-Plant area. Two major operations generated wastes discharged to T-designated liquid-waste disposal sites. Liquid wastes generated during the bismuth-phosphate process operations were discharged to liquid-waste disposal sites 216-T-2 through T-8, 216-T-14 through T-26, 216-T-30, and 216-T-32. Liquid effluents discharged to these T-designated sites were similar to those wastes discharged from the B Plant's initial operating phase. The other T-designated liquid-waste disposal sites received low-volume discharges from intermittent decontamination projects and 300-Area laboratory wastes. The distribution of waste sites between the established liquid-waste disposal categories is shown in Figure 3.5.

The T-designated sites exhibit a distribution of waste streams discharged to the ground that is similar to the B-designated sites. Tables 3.19 and 3.20 list T-designated sites by waste category in descending order of migration scores. Sites scoring greater than 28.5 are listed in Table 3.19,

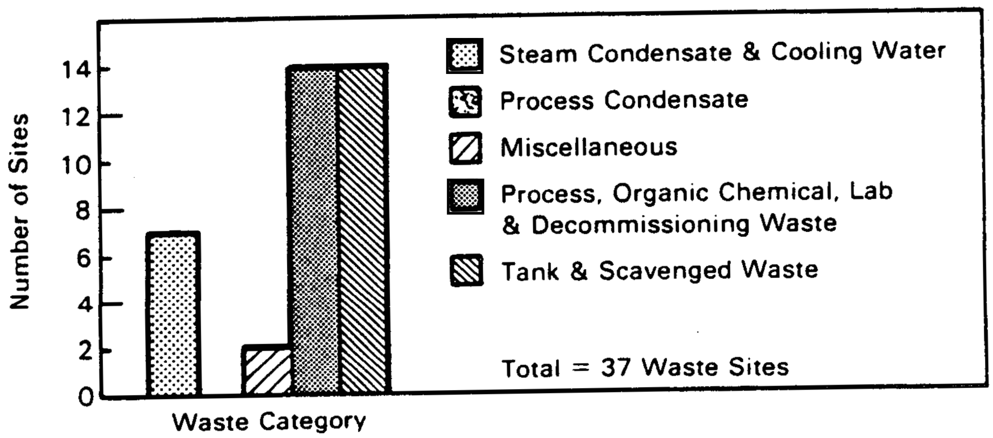

FIGURE 3.5. Distribution of Liquid-Waste Categories at T Plant

TABLE 3.19. Inactive T-Plant Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Steam condensate and cooling water	None
Process condensate	216-T-19
Miscellaneous liquid waste	216-T-3[(a)]
Process waste	216-T-2 216-T-8 216-T-28
Tank and scavenged waste	216-T-7

(a) TRU-Contaminated Soil Site (DOE 1987).

TABLE 3.20. Inactive T-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site
Steam condensate and cooling water	216-T-36
	216-T-4-2D
	216-T-31
	216-T-4-1D
	216-T-4-1P
Process condensate	None
Miscellaneous liquid waste	216-T-6[a]
	216-T-29
Process waste	216-T-35
	216-T-27
	216-T-34
	216-T-30
	216-T-33
	216-T-20
	216-T-12
	216-T-10
	216-T-11
	216-T-13
	216-T-9
Tank and scavenged waste	216-T-25
	216-T-26
	216-T-22
	216-T-24
	216-T-18[a]
	216-T-21
	216-T-32[a]
	216-T-23
	216-T-5
	216-T-14
	216-T-15
	216-T-16
	216-T-17

(a) TRU-Contaminated Soil Site (DOE 1987).

sites scoring less than 28.5 in Table 3.20. All sites listed in Table 3.19 should be given a significant priority for future characterization efforts. All of the sites listed in Table 3.20 should be given a significant priority for further characterization, except for the steam-condensate and cooling-water disposal sites. Information about specific T-designated sites follows.

Most of the liquid effluent discharged to T-designated sites was created by bismuth-phosphate processing. As discussed above, this process was much less efficient at recovering TRU content than were the later processing operations. As a result, four of the T sites have been designated TRU-Contaminated Soil Sites: 216-T-3, 216-T-6, 216-T-18, and 216-T-32. Site 216-T-3 is a reverse well that may have released its TRU inventory into the unconfined aquifer and so poses the greatest hazard among these sites. Site 216-T-2 is also a reverse well but it received only a small volume of laboratory waste and so is less hazardous.

Many of the T-designated liquid-waste disposal sites were specific-retention trenches. These sites received predetermined volumes of liquid effluent to prevent long-lived radionuclides breaking through to the ground water. Sites 216-T-14 through T-18 and 216-T-21 through T-25 were specific-retention trenches that received tank wastes.

The T-designated liquid-waste disposal sites probably received the next highest inventory of hazardous substances discharged to the ground within the 200 Areas after the B-designated sites.

U-Plant Liquid-Waste Disposal Sites

Inactive sites with the designation 216-U-xx received liquid effluents generated at the U Plant. Most of the U-designated liquid-waste disposal sites operated for a long time and serviced the low-volume waste streams produced during both uranium-recovery processing of tank wastes and the uranium-oxide conversion processes. The distribution of liquid-waste streams discharged to U-designated sites is illustrated in Figure 3.6. Because most of the product streams processed at U Plant had been extracted for plutonium and segregated with respect to the remaining fission product, liquid effluents discharged to sites at this plant received a lessened radionuclide inventory. The predominant radionuclide in liquid effluents discharged to

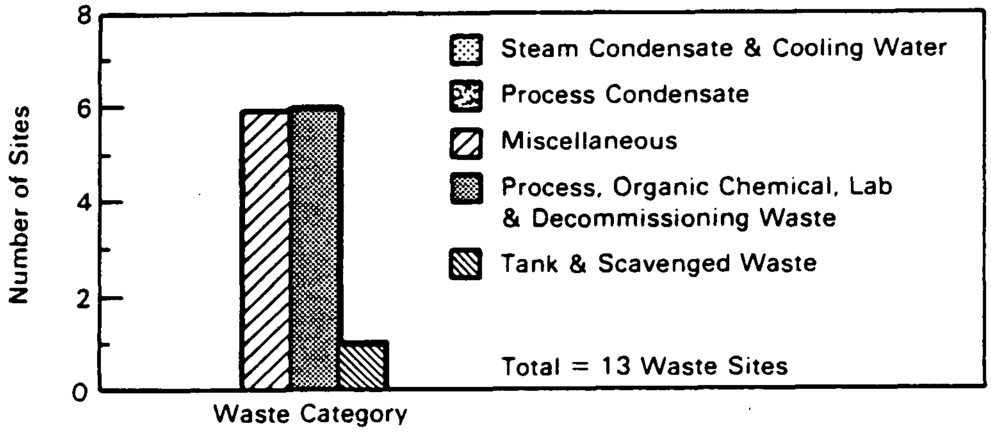

FIGURE 3.6. Distribution of Liquid-Waste Categories at U Plant

sites with the U designation was uranium. Because of their limited radionuclide inventory, nearly all of the liquid wastes generated at the U Plant were discharged to the ground.

The waste-disposal sites with migration scores greater than 28.5 are listed by category in Table 3.21 and those less than 28.5 in Table 3.22. All sites listed in Tables 3.21 and 3.22 should be given a significant priority for future characterization efforts.

TABLE 3.21. Inactive U-Plant Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Steam condensate and cooling water	None
Process condensate	None
Miscellaneous liquid waste	216-U-1&2
Process waste	216-U-11 216-U-4 216-U-4A 216-U-4B
Tank and scavenged waste	216-U-3

TABLE 3.22. Inactive U-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site
Steam condensate and cooling water	None
Process condensate	None
Miscellaneous liquid waste	216-U-8 216-U-13 216-U-5 216-U-6 216-U-7
Process waste	216-U-9 216-U-15
Tank and scavenged waste	None

Release to the ground water at sites with the U designation was limited to 216-U-1&2 Cribs, 216-U-4 series Reverse wells, and 216-U-9 and 216-U-11 Ditches. The remaining U-Plant liquid-waste disposal sites received small volumes of liquids that did not break through to the ground water. Although 216-U-3, 216-U-5, 216-U-6, and 216-U-8 received hazardous substances including uranium, these sites are potentially less hazardous than comparable sites in other areas because of the removal of fission products and TRU elements before processing at the U Plant.

Z-Plant Liquid-Waste Disposal Sites

Inactive liquid-waste disposal sites with the 216-Z-xx designation received liquid effluents from the Z Plant. Because operations at the Z Plant received product streams containing predominantly TRU radionuclides and few fission products, liquid effluents discharged at Z-designated sites were considered low-level wastes. Consequently, nearly all of the Z-designated liquid-waste disposal sites contain or are likely to contain TRU elements, especially plutonium. The distribution of liquid-waste streams discharged to Z-designated sites is illustrated in Figure 3.7. All liquid wastes discharged to the ground from the Z Plant were process wastes. Of the sites, only 216-Z-1&2, 216-Z-1(0), 216-Z-10, 216-Z-11, and 216-Z-17 had migration scores greater than 28.5; site 216-Z-10 was TRU-contaminated.

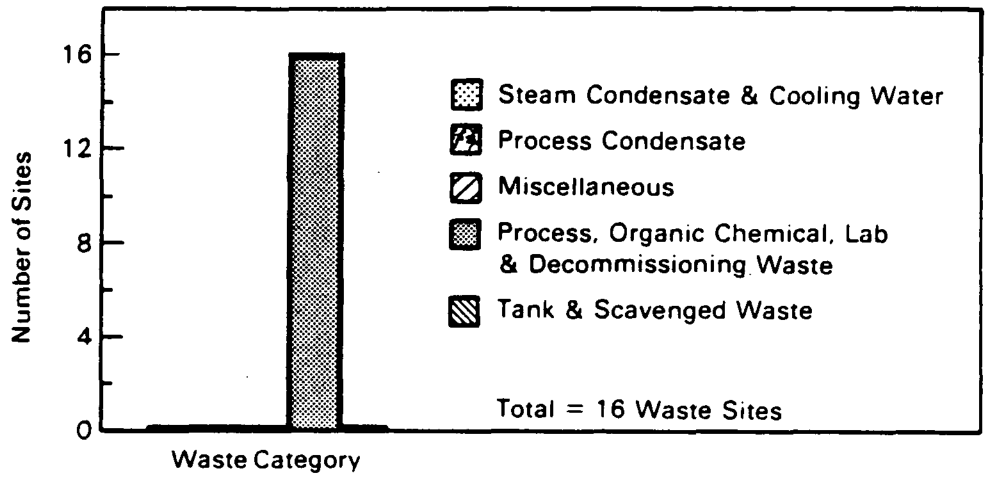

FIGURE 3.7. Distribution of Liquid-Waste Categories at Z Plant

These sites should all be given a significant priority for future characterization efforts. Sites 216-Z-1A, 216-Z-1(0), 216-Z-3, 216-Z-5, 216-Z-8, 216-Z-9, 216-Z-11, 216-Z-12, and 216-Z-18 are all TRU-Contaminated Soil Sites (DOE 1987). The site 216-Z-10 Reverse well presents the greatest potential hazard among sites with the Z designation because it has discharged TRU into the ground water. Previous studies have shown that plutonium is concentrated near the discharge point for several of the Z-designated cribs that have already been characterized (Price et al. 1979; Kasper 1982). Table 3.23 lists the inactive Z-Plant Sites with migration scores less than 28.5.

TABLE 3.23. Inactive Z-Plant Waste-Disposal Sites with Migration Scores Less Than 28.5

Waste Type	Site	
Process waste	216-Z-9[a]	216-Z-3[a]
	216-Z-5[a]	216-Z-4
	216-Z-12[a]	216-Z-6
	216-Z-18[a]	216-Z-8[a]
	216-Z-1A[a]	216-Z-16

(a) TRU-Contaminated Soil Sites (DOE 1987).

Further investigation is necessary to identify the distribution of other potentially hazardous substances discharged to these liquid-waste disposal sites.

200-North Liquid-Waste Disposal Sites

Inactive liquid-waste disposal sites with the designation 216-N-xx received waste from the 200-North Area irradiated-fuel storage basins. For the purpose of the technical assessment, all liquids discharged to sites with the N designation are considered as having included miscellaneous liquid waste. The distribution of liquid-waste streams discharged to N-designated sites is illustrated in Figure 3.8. The N-designated sites received discharged radioactive sludge and other solids deposited in the storage basins. Cooling water from the basins also overflowed into these facilities. The only inactive N-designated site that had a migration score of less than 28.5 was 216-N-1. Table 3.24 lists the inactive N-designated sites with migration waste. All of these wastes were somewhat radioactive, but contained a very limited hazardous chemical inventory.

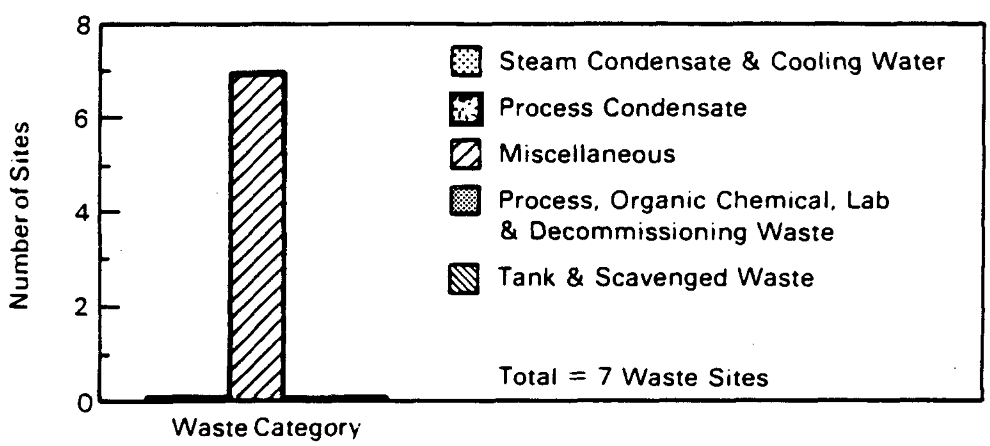

FIGURE 3.8. Distribution of Liquid-Waste Categories in the 200-North Area

TABLE 3.24. Inactive 200-North Waste-Disposal Sites with Migration Scores Greater Than 28.5

Waste Type	Site
Miscellaneous liquid waste	216-N-2
	216-N-3
	216-N-5
	216-N-6
	216-N-7
	216-N-4

Table 3.25 lists all the 200-Area inactive solid-waste disposal sites. The nonradioactive solid-waste disposal sites within the 200 Areas include:

- 200-East Burning Pit
- 200-West Burning Pit
- Z-Plant Burning Pit
- Nonradioactive Burial Ground
- Construction Pit.

All solid-waste disposal sites within the 200 Areas received low HRS scores. These sites represent a relatively low potential hazard because of the limited inventories and the lack of a liquid driving force that would promote migration. The TRU-contaminated burial-ground assessments described by DOE (1987b) can be used in evaluating the long-term potential hazard for the six solid-waste disposal sites considered to be TRU (see Table 3.25). The sites listed in Table 3.25 should be given a lower priority for further characterization efforts.

3.3.3 300-Area Inactive Waste-Disposal Sites

All of the inactive disposal sites within the 300 Area received potentially hazardous wastes. Liquid effluents discharged to the ground in the 300 Area had low levels of radionuclides. These were predominantly uranium, but the wastes also contained a diverse hazardous chemical inventory. The four liquid-effluent disposal sites within the 300 Area received a combination of liquid-waste streams. Because three of these sites received process and laboratory wastes containing hazardous chemicals and large volumes of liquids, they are considered to have observed releases and so are

TABLE 3.25. Inactive 200-Area Solid-Waste Disposal Sites

Site	Description
218-E-1[a]	Burial Ground
218-E-2	Burial Ground
218-E-2A	Burial Ground
218-E-3	Burial Ground
218-E-4	Burial Ground
218-E-5	Burial Ground
218-E-5A[a]	Burial Ground
218-E-6	Burial Ground
218-E-7	Burial Vaults (3)
218-E-8	Burial Ground
218-E-9	Burial Vault
218-E-12A	Burial Ground
218-E-13	Burial Ground
218-E-14	Burial Tunnel (above ground)
218-W-1[a]	Burial Ground
218-W-1A	Burial Ground
218-W-2[a]	Burial Ground
218-W-3[a]	Burial Ground
218-W-4A[a]	Burial Ground
218-W-7	Vault
218-W-8	Vault
218-W-9	Burial Ground
218-W-11	Burial Ground
200 East Burning Pit	Burning Pit
Construction Pit	Pit
Non-Rad. Burial Ground	Burial Ground
200 West Burning Pit	Burning Pit
Z Plant Burning Pit	Burning Pit

(a) TRU-contaminated soil site (DOE 1987b).

ranked high by HRS. Site 316-4 (300 North Crib) received a smaller volume of liquid waste than the other three sites. Hexone contaminated with uranium was discharged to this facility. Hexone is not soluble in water and would be expected to form a surface layer on the unconfined aquifer. Sites 316-1, 316-2, 316-3, and 316-4 should be given a significant priority for further characterization efforts.

3.3.4 600-Area Inactive Waste-Disposal Sites

Inactive waste-disposal sites within the 600 Area of the Hanford Site were used to support a number of nuclear and non-nuclear operations. All of these sites are considered dry-waste burial grounds, and all received low scores using HRS. However, some of the sites contained pipe facilities and caissons, and others reportedly received liquid wastes. Among the types of waste disposed in these facilities were nuclear-fuel fabrication wastes, 300-Area laboratory waste, renovation and construction debris, Burial Ground ordinary trash, and contaminated soil.

Table 3.26 lists the 600-Area solid-waste disposal sites. All of these sites should be given a reasonably low priority for further characterization efforts, but certain of these sites received small volumes of liquid waste. Discussion of their potential hazards follows. The dry-waste burial trenches and landfills receiving construction wastes or ordinary trash are 618-6 (which has been exhumed), P-11 (also exhumed), the Original Central Landfill, and Horn Rapids Disposal.

The other inactive 600-Area disposal sites may represent a potential hazard. Some sites are burial grounds that hold caissons and "pipe facilities" or that received liquid organic wastes. These sites (and the waste types they hold) are 618-9 [uranium-contaminated organic solvent in 208-L (55-gal) drums], 618-10 (300-Area wastes in pipe facilities), and 618-11 (including wastes in caissons and pipes). The 618-9 site received 18,925-L

TABLE 3.26. 600-Area Solid-Waste Disposal Sites

Cribs	Burial Grounds	Landfills
213-J and K	618-1[a]	Horn Rapids Disposal
P-11	618-10	J. A. Jones #1
	618-11[a]	J. A. Jones #2
	618-12	Original Central Landfill
	618-13	USBR-2,4-D
	618-2[a]	
	618-3	
	618-4	
	618-5	
	618-6	
	618-7	
	618-8	
	618-9	

(a) TRU-contaminated soil sites (DOE 1987).

(5,000 gal, 0.37% of its column volume) of uranium-contaminated organic solvent. The 618-10 site may also have received uranium-contaminated organic liquid waste. A few dry-waste burial trenches received uranium-contaminated building materials, trash, or soil. These sites, located near the 300 Area, are 618-3, 618-4, 618-5, 618-12, 618-13, and USBR-2,4-D.

Several dry-waste burial trenches received nuclear-fuel fabrication wastes and 300-Area laboratory wastes. These sites are 618-1, 618-2, 618-7, 618-8, 213-J, and 213-K. The 213-J and 213-K sites also received some decontamination solution and associated dry wastes.

3.4 HRS EVALUATION OF THE 20 NEWLY DESIGNATED ENGINEERED-FACILITY SITES

HRS evaluations were conducted on 20 newly designated engineered-facility sites. These new engineered-facility sites included: 1) 10 retention basins (8 in the 100 Areas and 2 in the 200 Areas), 2) Midway No. 1 landfill, 3) Midway No. 2 landfill, 4) White Bluffs landfill, 5) East White Bluffs landfill, 6) sodium-dichromate barrel disposal facility, 7) Hanford trailer camp landfill, 8) White Bluffs pickling-acid crib located between the 100-D and 100-H Areas, 9) Hanford Townsite landfill, 10) Riverland Railroad car wash pit, and 11) 1100-Area battery acid pit. The location of each of these 20 additional engineered-facility sites is shown in Figure 3.9.

3.4.1 Retention Basins

Eight retention basins located in the Hanford 100 Areas and two retention basins located in the Hanford 200 Areas were evaluated using the HRS methodology. The eight retention basins in the 100 Areas included the 107-B, 107-C, 107-D, 107-DR, 107-F, 107-H, 107-KE, and 107-KW basins. The two retention basins located in the Hanford 200 Areas were the 207-S and 207-Z.

Process Description

The retention basins were concrete-lined basins with an internal baffle. The floor of the basins consisted of concrete slabs with joints. Originally, these joints were sealed with neoprene water seals. However, over time these seals deteriorated. Contaminated waste process-water (200-Area retention basins) and reactor cooling water (100-Area retention basins) were diverted

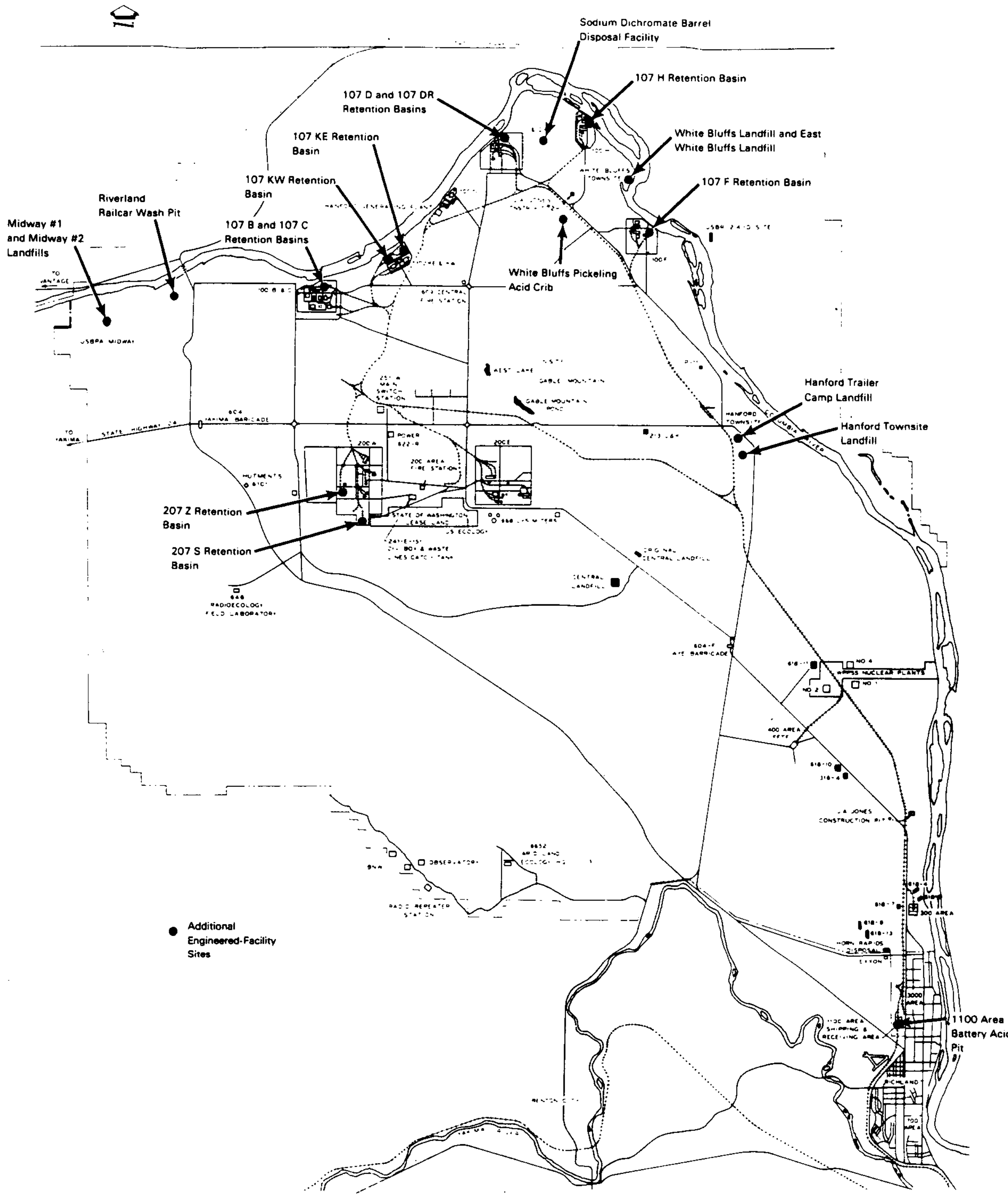

FIGURE 3.9. Location of the 20 Newly Designated Engineered-Facility Sites

to these retention basins. The 200-Area retention basins were used primarily as sewage basins to manage the contaminated waste water before it was released to the soil column. The 100-Area retention basins were used to contain the contaminated cooling water long enough to allow for the decay of short-lived radionuclides and to allow the waste water to thermally cool before being released to the Columbia River.

HRS Evaluation Results

The results of the HRS evaluations conducted on these retention basins are presented in Table 3.27.

Supplemental Analysis

The retention basins in the 100 Areas were used to retain cooling-water effluent from their respective reactor for purposes of allowing radioactive decay and thermal cooling before the effluent was released to the Columbia River. All of the basins in the 100 Areas were known to have leaked substantial quantities of reactor cooling water during operation [e.g., an estimated 18,925 to 37,850 L/min (5,000 to 10,000 gal/min)]. The total radionuclide inventories in the vicinity of the basins range from a few curies to a few hundred curies. In addition, all of the 100-Area retention basins are located in proximity to the Columbia River. Thus, a significant potential exists for the migration of contaminants from the contaminated soil column, in the vicinity of the retention basins, to the river.

TABLE 3.27. Retention Basin Sites

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
107-B	100	Retention basin	76.91
107-C	100	Retention basin	76.91
107-D	100	Retention basin	76.91
107-DR	100	Retention basin	76.91
107-F	100	Retention basin	76.91
107-H	100	Retention basin	76.91
107-KE	100	Retention basin	76.91
107-KW	100	Retention basin	76.91
207-S	200	Retention basin	1.42
207-Z	200	Retention basin	1.03

The 207-Z retention basin (200 Areas) received steam condensate, cooling water, and potentially contaminated waste from the Z Plant. Considering the supplemental technical analysis criteria described earlier, even though the site received a low HRS score, it should be given significant priority for further characterization efforts because of the hazard potential of the waste (i.e., process waste). The 207-Z retention basin received a low HRS score because of the remoteness of the site and because the volume was not sufficient for it to be considered a site having a release to the ground water.

The 207-S retention basin (200 Areas) received process cooling water and steam condensate from the 202-S Building, which is associated with REDOX operation. Considering the supplemental technical analysis criteria, the low HRS score appears reasonable, because the hazard potential of the waste is low and the volume was not sufficient for it to be considered as a site having a release to the ground water.

3.4.2 White Bluffs Pickling-Acid Crib

The White Bluffs pickling acid crib is in the 600 Area of the Hanford Site, located directly south of where the old White Bluffs ice plant was located, and directly east of what was Federal Avenue in the area that was previously the town of White Bluffs.

Process Description

The White Bluffs pickling acid crib was used in the process for the pickling of carbon steel and stainless steel new piping, which was used in the reactor buildings during construction. The waste pickling acid was neutralized and sent to the crib for disposal. However, indications are that the acid may not have always been neutralized before disposal.

HRS Evaluation Results

The results of the HRS evaluation conducted on the White Bluffs pickling acid crib are presented in Table 3.28.

Supplemental Analysis

The White Bluffs pickling acid crib received several thousand gallons of sulfuric and nitric acid from the pickling process. Also, indications are

TABLE 3.28. White Bluffs Pickling Acid Crib

Site	Waste-Site Location (Area)	Waste Site Type	HRS Migration Score
White Bluffs Pickling Acid Crib	600	Crib	35.49

that the waste acid may not have always been neutralized before disposal. Considering the status of the inventory of the site, the HRS score appears to be reasonable, and the site should be given a significant priority for further characterization efforts.

3.4.3 Landfills

Six landfills scattered throughout the Hanford 600 Area were evaluated using the HRS evaluation methodology. These six landfills include: 1) Midway No. 1 landfill, 2) Midway No. 2 landfill, 3) White Bluffs landfill, 4) East White Bluffs landfill, 5) Hanford trailer camp landfill, and 6) Hanford Townsite landfill.

Process Description

The six landfill sites were used for the disposal of commercial domestic waste from the respective communities that each served. No known radioactive contaminants were disposed of in these landfill sites. Because no regulations controlled the disposal of hazardous substances during the time that these landfills were operating, it is assumed that the waste in the landfills potentially contains household solvents, lead from old paints, arsenic (early pesticide), and other hazardous constituents.

HRS Evaluations

The results of the HRS evaluation conducted on these landfills are presented in Table 3.29.

Supplemental Analysis

No records are available to describe the content of the waste disposed of in these landfills. Thus, it was assumed that these landfills would be no different than any other historically operated commercial landfill and would

TABLE 3.29. Landfills

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
Hanford Townsite Landfill	600	Landfill	7.72
Hanford Trailer Camp Landfill	600	Landfill	3.67
Midway Landfill No. 1	600	Landfill	8.36
Midway Landfill No. 2	600	Landfill	11.49
East White Bluffs Landfill	600	Landfill	7.59
White Bluffs Landfill	600	Landfill	8.69

contain certain amounts of hazardous constituents. These landfills received fairly low HRS scores because they are located in remote areas. Based on the review of the limited information available about these landfills, the HRS scores appear to be reasonable indicators of the ability for contaminants from the landfills to reach offsite receptors. However, these landfills must be characterized to determine the content and quantity of any hazardous wastes as they are readily accessible to onsite personnel.

3.4.4 1100-Area Battery Acid Pit

The 1100-Area battery acid pit is located on the west side of the 1171 building. The 1171 building is part of the current maintenance operation facility located adjacent to the Richland City limits.

Process Description

The 1100-Area battery acid pit is an approximately 3.7-m-diameter (12-ft-diameter), 3-m-deep (10-ft-deep) pit that is filled with river rock and sand. The pit was used to dispose of waste electrolyte from old lead-acid storage batteries. The waste acid was simply poured from the batteries into the pit and allowed to percolate into the sand.

HRS Evaluation

The results of the HRS evaluation conducted on the 1100-Area battery acid pit are presented in Table 3.30.

Supplemental Analysis

The quantity of waste battery acid disposed of in the pit is estimated to be approximately 56,775 L (15,000 gal). The contaminants of concern are

TABLE 3.30. 1100-Area Battery Acid Pit

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
1100-Area Battery Acid Pit	1100	Disposal Pit	38.54

sulfuric acid and lead. The 1100-Area battery acid pit is located approximately 0.8 km (0.5 mi) from Richland Recharge Well 3000-D, which is one of the several wells in the area used to supply drinking water to the Richland system. Considering this information, the HRS score appears to fairly accurately represent the potential significance of this site and the site should be given a significant priority for further characterization efforts.

3.4.5 Sodium Dichromate Barrel Disposal Site

The sodium dichromate barrel disposal site is located between the Hanford 100-D and 100-H Areas. It is approximately 183 m (200 yd) north of the old access road that extends between the 100-D east badgehouse and the 100-H badgehouse.

Process Description

The sodium dichromate barrel-disposal site is a landfill area approximately 30 m by 15 m (100 ft by 50 ft), which was used to dispose of empty (i.e., containing some residuals) crushed sodium dichromate barrels. The crushed barrels contained residual amounts of sodium dichromate that was used for water treatment in the Hanford 100 Areas. The site has been backfilled, but some debris is still exposed.

HRS Evaluation

The results of the HRS evaluation conducted on the sodium dichromate barrel disposal site are presented in Table 3.31.

Supplemental Analysis

The wastes disposed of at the site were empty crushed drums containing sodium-dichromate residue. It was estimated, assuming that 1% of the original quantity of sodium dichromate remained in the drum on disposal, that 28 Mg (30.9 tons) of sodium dichromate was disposed of at the site. A depth

TABLE 3.31. Sodium Dichromate Barrel Disposal Site

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
Sodium Dichromate Barrel Disposal Site	600	Drum Landfill	4.43

of 9.8 m (32 ft) from the lowest point of waste disposal to the ground water was estimated for the site. Considering the proximity to the ground water and the fact that the constituent of concern is sodium dichromate, the HRS score appears to be somewhat low in representing the significance of the site and the site should be given a reasonably significant priority for further characterization efforts.

3.4.6 Riverland Railroad Car Wash Pit

The Riverland Railroad car wash pit is located 0.8 km (0.5 mi) west of State Highway 240 and 2.1 km (1.3 mi) southwest of the Vernita Bridge near the Midway Substation.

Process Description

The Riverland Railroad car wash pit was used to collect the waste water from the steam cleaning and low-level decontamination station set up for cleaning and decontaminating locomotive engines and railroad cars used on the Hanford Site. The site is suspected of being contaminated with various petroleum products, heavy metals, and radionuclides (low level). The general Riverland site was decontaminated and released in 1963, with five of the buildings at the Riverland site auctioned off to the general public.

HRS Evaluation

The results of the HRS evaluation conducted on the Riverland Railroad car wash pit are presented in Table 3.32.

Supplemental Analysis

The Riverland Railroad car wash pit was assumed to have received enough waste water to exceed the 10% soil-column assumption (DOE 1986), which categorizes it as a site having a release to the environment (i.e., ground water). Also, considering the contaminants associated with the site and the

TABLE 3.32. Riverland Railroad Car Wash Pit Site

Site	Waste-Site Location (Area)	Waste-Site Type	HRS Migration Score
Riverland Railroad Car Wash Pit	600	Surface Impoundment	23.70

availability of the site to the public, even though no significant population lives within 4.8 km (3 mi), the HRS score appears to be slightly low, and the site should be given a significant priority for the further characterization efforts.

4.0 EVALUATION OF UNPLANNED-RELEASE SITES

The evaluation involved 291 individual unplanned-release (spill) sites located on the Hanford Site. These 291 sites encompassed a broad spectrum of unplanned-release conditions, ranging from spills of small amounts of material from a container to large volumes released during a process pipe break. They also involved conditions such as the release of small amounts of contaminants in the form of particulate matter from minor transportation accidents involving the transport of contaminated equipment and the release of contaminants associated with the intentional and accidental burning of materials.

The information available for assessing the impact of these Hanford unplanned releases varied considerably in quantity and content. Much of the information was general in nature and amounted to brief descriptions of the occurrence and a radiological survey-instrument reading or set of readings that were taken at the time of the occurrence. There were many cases where a brief description of the occurrence was the only information available. The general nature of this information made it difficult to derive the specific input information necessary for conducting the Hazard Ranking System (HRS) evaluations. Several assumptions and, in many cases, sets of generalized criteria had to be established to perform the evaluations. In all cases, these assumptions and criteria were established considering the conservative aspects of the situation (i.e., directed toward input that would yield the higher score). However, every attempt was made to make each conservative assumption as realistic as current knowledge of the situation allowed.

4.1 EVALUATION PROCEDURE

The evaluations of the Hanford unplanned-release sites were conducted considering the ground-water, surface-water and direct-contact routes. The air route was not evaluated because the HRS system requires that "the only acceptable evidence of release for the air route is data that show levels of a contaminant at or in the vicinity of the facility that significantly exceed background levels" (40 CFR 300), and no such data were found for any of the sites. Lacking such data, the HRS system automatically assigns the air pathway a score of zero. The fire and explosion route was not evaluated because of the nature of the radionuclides and chemical constituents and the manner in which they were found in the wastes.

4.2 ASSUMPTIONS AND GENERALIZED CRITERIA

As mentioned earlier, the information available for most of the unplanned-release sites was not complete enough, by itself, to perform the evaluations. Thus, a number of conservative assumptions and sets of criteria were developed and applied to the sites. These assumptions and criteria were developed considering existing knowledge of the facility(ies) that would normally be associated with the system or area involving the unusual occurrence (unplanned release). Generalized sets of chemicals and radionuclides that are normally associated with these facilities were used in cases where such information was not provided in the unusual-occurrence report. Because HRS does not require (as input for performing the evaluation) the quantity/concentration of each chemical, in cases where the unusual-occurrence reports did not provide chemical quantities, the chemicals were entered as having unknown quantities (i.e., they were entered on the data base as 99999999999.9999 to indicate unknown quantity). The following is a listing of the general assumptions used to interpret unusual-occurrence descriptions and survey readings and to produce quantity and/or concentration data:

- An efficiency of 7% was assumed for the conversion of counts per minute (cpm) to disintegrations per minute (dpm).
- 4×10^2 mR/hr/Ci/m^3 was used as a conversion factor for gamma emitters.
- 3×10^2 cpm/mR/hr was used as a conversion factor for gamma emitters.
- 1.8×10^{-2} mR/hr/Ci/m^3 was used as a conversion factor for alpha emitters.
- 1 R/hr/Ci/m^2 was used as a surface-contamination conversion factor.
- 10 rad/hr/Ci/m^2 was used as a surface-contamination conversion factor.

- 3×10^{-3} μCi/m^2/cpm was used as a surface-contamination conversion factor.
- That 1 shovel of dry Hanford sand equals approximately 1 L (approximately 0.4 ft^2) was assumed for spot contamination.
- Surface contamination over an area was assumed to be at a 2.5-cm (1-in.) depth for undisturbed areas, and at a 0.3-m (1-ft) depth for disturbed areas.
- 2×10^{-4} Ci ^{239}Pu/Ci ^{137}Cs ratio was used to estimate plutonium from cesium information.
- 7×10^{-4} Ci enriched U/Ci ^{137}Cs ratio was used to estimate uranium from cesium information.
- 110 rad/hr at 0.3 m (1 ft) from a pipe leak was estimated to be approximately 9,841 L (2,600 gal) of waste for buried pipe leaks (considering gamma emitters - assuming generalized cesium-dominant mixture; information was adapted from an actual situation where such a reading was measured).
- Fire hose 7.6-cm (3-in.) diameter wash-down flow rate of 244 cm/sec (8 ft/sec) for 5 min, which results in 3.4 m^3 (120 ft^3 or 900 gal) of water, was assumed.
- 1 ton = 1 yd^3 = 4 drums, and 1 drum = 50 gal was assumed [from HRS user manual (40 CFR 300)].
- Density of 1.65 g/cm^3 (103 lb/ft^3) was assumed for soil, and a density of 1.0 g/cm^3 (62.4 lb/ft^3) was assumed for liquid tank wastes.

4.3 HRS EVALUATION RESULTS

The evaluation of the unplanned-release sites at Hanford resulted in 142 sites receiving HRS scores. Of the 142 sites receiving scores, 14 sites received migration scores greater than 28.5. Table 4.1 provides a summary listing of the unplanned-release sites that received high HRS migration scores, along with their respective scores.

TABLE 4.1. Unplanned-Release Sites with Migration Scores Greater Than 28.5 - Summary Table

Site	Waste-Site Location (Area)	HRS Migration Score
UPR-1100-4	1100	34.58
UPR-100-K-1	100	53.24
UPR-100-N-1	100	44.37
UPR-100-N-12	100	70.99
UPR-100-N-17	100	50.28
UPR-100-N-2	100	44.37
UPR-100-N-3	100	73.95
UPR-100-N-5	100	68.03
UPR-100-N-9	100	47.33
UPR-300-12	300	62.88
UPR-300-13	300	59.74
UPR-300-38	300	62.88
UPR-300-39	300	40.02
UPR-300-40	300	59.74

Of the 142 unplanned-release sites receiving scores, 13 sites received direct-contact scores greater than 25. Table 4.2 provides a summary listing of the unplanned-release sites with high, direct-contact scores (i.e., scores greater than 25, which is only an arbitrary level chosen for evaluation purposes) and their respective HRS scores.

The 142 unplanned-release sites receiving scores were grouped into two site categories: those sites with an observed release to the ground water or surface water and those sites without an observed release to the ground water or surface water. The same soil-column breakthrough test criteria used for evaluating the engineered facilities was used to determine whether a site fit into the "observed release site" or the "no observed release site" category. The soil-column test criteria used was that 0.1 (area x depth) = volume was necessary to be considered an "observed release site" (DOE 1986). Table 4.3 shows the "observed release sites" and their respective HRS scores.
Table 4.4 shows the unplanned-release sites that fall into the "no observed release site" category and their respective HRS scores.

TABLE 4.2. Unplanned-Release Sites with a Summary Table of Direct-Contact Scores Greater Than 25

Site	Waste-Site Location (area)	HRS Direct Contact Score
UPR-100-F-1	100	50.00
UPR-300-1	300	87.50
UPR-300-11	300	87.50
UPR-300-14	300	87.50
UPR-300-2	300	87.50
UPR-300-4	300	87.50
UPR-300-5	300	87.50
UPR-600-1	600	75.00
UPR-600-10	600	50.00
UPR-600-11	600	50.00
UPR-600-12	600	75.00
UPR-600-15	600	87.50
UPR-600-2	600	50.00

4.4 UNPLANNED-RELEASE SITES EVALUATED BUT NOT SCORED

Several of the unplanned-release sites (pre-November 1980) listed on the Hanford Inactive Site Surveillance (HISS) Data Base were not scored using the HRS. These sites and the reasons for their not being scored are presented in this section by site category.

A systematic approach for the evaluation of these sites to ensure that each site does not pose a health or environmental threat is currently being developed/negotiated with the U.S. Environmental Protection Agency (EPA). The evaluation agreed on will be applied to each of these sites, with each site showing that it does not pose a health or environmental threat before it is eliminated from the CERCLA/SARA process.

There are 50 unplanned-release sites listed on the HISS Data Base that were not scored because they involved releases into an engineered facility. The inventory of these unplanned releases was part of the inventory of the engineered facility when it was scored, or the unplanned-release site inventory was completely dwarfed by the engineered facility's inventory. These sites are listed in Table 4.5.

TABLE 4.3. Unplanned-Release Sites Falling into the "Observed Release Site" Category

Site	HRS Ground-Water Score	HRS Surface-Water Score	HRS Migration Score	HRS Direct-Contact Scores
100 AREAS				
UPR-100-K-1	61	69	53.24	0.00
UPR-100-N-1	51	58	44.37	0.00
UPR-100-N-12	81	92	70.99	0.00
UPR-100-N-17	57	65	50.28	0.00
UPR-100-N-2	51	58	44.37	0.00
UPR-100-N-3	84	96	73.95	0.00
UPR-100-N-5	78	88	68.03	0.00
UPR-100-N-9	54	62	47.33	0.00
300 AREA				
UPR-300-12	77	77	62.88	0.00
UPR-300-13	73	73	59.74	0.00
UPR-300-38	77	77	62.88	0.00
UPR-300-39	54	54	44.02	0.00
UPR-300-40	73	73	59.74	0.00
600 AREA				
UPR-3000-1	0	8	4.40	0.00
1100 AREA				
UPR-1100-4	42	42	34.58	0.00

Two unplanned-release sites are listed on the HISS Data Base that are pre-1980 sites with releases into post-1980 active engineered facilities. These sites were not scored because they were releases into engineered facilities and their inventories would be part of the inventory for the post-1980 engineered facility (i.e., these sites will be incorporated in with the Resource Conservation and Recover Act active sites). These sites are listed in Table 4.6.

TABLE 4.4. Unplanned-Release Sites Falling into the "No Observed Release Site" Category

Site	HRS Ground-Water Score	HRS Surface-Water Score	HRS Migration Score	HRS Direct-Contact Scores
100 Areas				
UPR-100-F-1	4	12	7.10	50.00
UPR-100-N-10	3	9	5.60	0.00
UPR-100-N-11	1	8	4.40	25.00
UPR-100-N-13	3	9	5.60	25.00
UPR-100-N-14	3	9	5.60	0.00
UPR-100-N-18	2	6	3.90	0.00
UPR-100-N-25	3	9	5.60	25.00
UPR-100-N-26	3	9	5.60	25.00
UPR-100-N-29	3	4	2.90	25.00
UPR-100-N-30	3	9	5.60	25.00
UPR-100-N-31	3	9	5.60	25.00
UPR-100-N-32	3	9	5.60	25.00
UPR-100-N-34	2	7	4.20	0.00
UPR-100-N-4	3	8	4.80	0.00
UPR-100-N-8	3	8	4.80	0.00
200-East Area				
UPR-200-E-105	2	0	1.10	0.00
UPR-200-E-107	2	0	1.00	0.00
UPR-200-E-108	2	0	1.10	0.00
UPR-200-E-109	2	0	1.00	0.00
UPR-200-E-110	2	0	1.10	0.00
UPR-200-E-112	1	0	0.80	0.00
UPR-200-E-114	2	0	1.00	0.00
UPR-200-E-119	2	0	1.00	0.00
UPR-200-E-12	2	0	1.00	0.00
UPR-200-E-15	2	0	1.10	0.00
UPR-200-E-23	1	0	0.80	0.00
UPR-200-E-24	1	0	0.80	0.00
UPR-200-E-25	2	0	1.10	0.00
UPR-200-E-3	2	0	1.10	0.00
UPR-200-E-30	2	0	0.90	0.00
UPR-200-E-31	2	0	1.03	0.00
UPR-200-E-32	2	0	1.10	0.00
UPR-200-E-36	2	0	1.30	0.00
UPR-200-E-39	2	0	1.00	0.00
UPR-200-E-4	2	0	1.10	0.00
UPR-200-E-40	2	0	1.00	0.00
UPR-200-E-43	2	0	1.00	0.00
UPR-200-E-45	2	0	1.10	0.00

TABLE 4.4. (contd)

Site	HRS Ground-Water Score	HRS Surface-Water Score	HRS Migration Score	HRS Direct-Contact Scores
200-East Area				
UPR-200-E-47	2	0	1.10	0.00
UPR-200-E-48	1	0	0.80	0.00
UPR-200-E-5	2	0	1.20	0.00
UPR-200-E-50	2	0	1.10	0.00
UPR-200-E-52	2	0	1.00	0.00
UPR-200-E-53	1	0	0.80	0.00
UPR-200-E-54	2	0	1.00	0.00
UPR-200-E-55	1	0	0.80	0.00
UPR-200-E-58	1	0	0.80	0.00
UPR-200-E-6	2	0	1.10	0.00
UPR-200-E-7	3	0	1.50	0.00
UPR-200-E-73	2	0	1.00	0.00
UPR-200-E-74	2	0	1.00	0.00
UPR-200-E-75	2	0	1.10	0.00
UPR-200-E-76	2	0	1.10	0.00
UPR-200-E-77	2	0	1.10	0.00
UPR-200-E-78	2	0	1.00	0.00
UPR-200-E-79	2	0	1.20	0.00
UPR-200-E-80	2	0	1.20	0.00
UPR-200-E-81	2	0	1.20	0.00
UPR-200-E-82	2	0	1.00	0.00
UPR-200-E-83	1	0	0.70	0.00
UPR-200-E-84	2	0	1.00	0.00
UPR-200-E-85	2	0	1.10	0.00
UPR-200-E-86	2	0	1.00	0.00
UPR-200-E-87	2	0	1.00	0.00
UPR-200-E-89	2	0	1.36	0.00
UPR-200-E-94	2	0	1.00	0.00
UPR-200-E-95	1	0	0.70	0.00
200-West Area				
UPR-200-W-100	2	0	1.30	0.00
UPR-200-W-101	2	0	1.00	0.00
UPR-200-W-102	2	0	1.00	0.00
UPR-200-W-103	2	0	1.00	0.00
UPR-200-W-132	2	0	1.00	0.00
UPR-200-W-135	2	0	1.20	0.00
UPR-200-W-17	2	0	1.20	0.00
UPR-200-W-19	2	0	1.00	0.00
UPR-200-W-22	2	0	1.00	0.00
UPR-200-W-23	1	0	0.90	0.00

TABLE 4.4. (contd)

Site	HRS Ground-Water Score	HRS Surface-Water Score	HRS Migration Score	HRS Direct-Contact Scores
200-West Area				
UPR-200-W-24	2	0	1.00	0.00
UPR-200-W-29	2	0	1.00	0.00
UPR-200-W-33	2	0	1.00	0.00
UPR-200-W-38	2	0	1.10	0.00
UPR-200-W-39	2	0	1.00	0.00
UPR-200-W-42	1	0	0.80	0.00
UPR-200-W-43	1	0	0.80	0.00
UPR-200-W-44	1	0	0.90	0.00
UPR-200-W-48	1	0	0.90	0.00
UPR-200-W-49	2	0	0.90	0.00
UPR-200-W-50	2	0	1.00	0.00
UPR-200-W-55	2	0	1.10	0.00
UPR-200-W-56	2	0	1.00	0.00
UPR-200-W-61	2	0	1.00	0.00
UPR-200-W-62	2	0	1.30	0.00
UPR-200-W-63	2	0	1.00	0.00
UPR-200-W-64	1	0	0.90	0.00
UPR-200-W-65	1	0	0.60	0.00
UPR-200-W-67	1	0	0.90	0.00
UPR-200-W-68	2	0	1.00	0.00
UPR-200-W-71	2	0	1.30	0.00
UPR-200-W-73	1	0	0.70	0.00
UPR-200-W-74	2	0	1.00	0.00
UPR-200-W-75	1	0	0.80	0.00
UPR-200-W-76	1	0	0.60	0.00
UPR-200-W-78	1	0	0.90	0.00
UPR-200-W-79	2	0	1.20	0.00
UPR-200-W-8	2	0	1.00	0.00
UPR-200-W-80	2	0	1.20	0.00
UPR-200-W-81	2	0	1.10	0.00
UPR-200-W-95	1	0	0.70	0.00
UPR-200-W-96	2	0	1.00	0.00
UPR-200-W-97	2	0	1.00	0.00
UPR-200-W-98	2	0	1.10	0.00
UPR-200-W-99	1	0	0.70	0.00
300 Area				
UPR-300-1	33	32	26.60	87.50
UPR-300-11	29	9	17.40	87.50
UPR-300-14	15	5	9.20	87.50
UPR-300-17	26	29	22.59	0.00

TABLE 4.4. (contd)

Site	HRS Ground-Water Score	HRS Surface-Water Score	HRS Migration Score	HRS Direct-Contact Scores
300 Area				
UPR-300-2	30	9	18.30	87.50
UPR-300-4	36	12	22.10	87.50
UPR-300-5	24	7	14.70	87.50
600 Area				
UPR-600-1	23	0	13.20	75.00
UPR-600-10	21	0	11.90	50.00
UPR-600-11	3	35	20.40	50.00
UPR-600-12	9	0	5.40	75.00
UPR-600-15	18	42	26.10	87.50
UPR-600-16	3	28	16.30	0.00
UPR-600-2	30	0	17.10	50.00
UPR-600-3	28	0	16.20	25.00

TABLE 4.5. Unplanned Releases into Engineered Facilities

UPR-200-E-17	UPR-200-E-34
UPR-200-E-35	UPR-200-E-51
UPR-200-E-56	UPR-200-E-59
UPR-200-E-115	UPR-200-W-16
UPR-200-W-34	UPR-200-W-47
UPR-200-W-59	UPR-200-W-66
UPR-200-W-70	UPR-200-W-72
UPR-200-W-84	UPR-200-W-104
UPR-200-W-105	UPR-200-W-106
UPR-200-W-107	UPR-200-W-108
UPR-200-W-109	UPR-200-W-110
UPR-200-W-124	UPR-200-W-134
UPR-200-W-138	UPR-300-7
UPR-300-8	UPR-300-19
UPR-300-20	UPR-300-21
UPR-300-22	UPR-300-23
UPR-300-24	UPR-300-25
UPR-300-26	UPR-300-27
UPR-300-28	UPR-300-29
UPR-300-30	UPR-300-31
UPR-300-32	UPR-300-33
UPR-300-34	UPR-300-35
UPR-300-36	UPR-300-37
UPR-600-4	UPR-600-5
UPR-600-7	UPR-600-8

TABLE 4.6. Pre-1980 Releases into Post-1980 Active Engineered Facilities

UPR-300-9
UPR-300-15

Five unplanned release sites listed on the HISS Data Base were not scored because there were no hazardous chemicals at the site and the radionuclides involved have decayed away. These sites are listed in Table 4.7.

Three unplanned release sites listed on the HISS Data Base were not scored because they did not result in a contaminated site (i.e., the situation was reported on an unusual-occurrence report, but no hazardous waste site was created as a result of the unusual occurrence). These sites are listed in Table 4.8.

There are 89 unplanned-release sites listed on the HISS Data Base that were not scored because the information available describing the release was insufficient to formulate even generalized criteria that could be used to score the site. However, the brief descriptions of these releases indicate that these sites would not result in a significant score (i.e., greater than 28.5). In all cases except one, the sites are located in the 200 Areas, which are strictly controlled by security, have a considerable soil-column depth, are located a considerable distance from the Columbia River, and are remotely located with respect to population. All of the unplanned-release sites that were scored and that meet these criteria received very low HRS

TABLE 4.7. Unplanned-Release Sites Not Scored Because of Radionuclide Decay

UPR-200-W-30
UPR-200-W-45
UPR-200-W-53
UPR-600-6
UPR-600-9

TABLE 4.8. Sites Listed that Did Not Result in a Contaminated Site

UPR-200-E-41
UPR-600-14
UPR-1100-5

scores. In the one exception, the incident occurred in the 300 Area. This incident appeared to involve a small amount of material squirting out a drain hole and primarily contaminating an employee. These sites are listed in Table 4.9.

An additional site, UPR-300-10, listed in the HISS Data Base was not scored because of insufficient information. Its impact may be significant, but the release involved a pipe located under the 325 Building, which is a currently used building, making access to the spill area essentially impossible until the building is decommissioned. Any hazardous constituents remaining in the soil column under the 325 Building as a result of the pipe leak will remain fixed (until the building is decommissioned), because the building will serve as a cap and prevent any run-off water from flowing through the contaminated portion of the soil column under the building. Characterization and any related remedial activity performed as a result of this leakage should be incorporated into the closure plan for the 325 Building. The location of the 325 Building is shown in Figure 4.1.

4.5 BRIEF DESCRIPTIONS OF THE UNPLANNED-RELEASE SITES RECEIVING HIGH HRS MIGRATION-ROUTE SCORES

The unplanned-release sites receiving high HRS migration scores are briefly discussed in this section.

4.5.1 UPR-1100-4 Unplanned-Release Site

The UPR-1100-4 unplanned-release site has an HRS migration-route score of 34.58. Antifreeze was disposed of in a 18,925-L (5,000-gal) underground tank in the 1171 Building bus garage. Loss of antifreeze in the distribution system suggested that the tank was leaking. As a result of the suspected leakage, the tank was retired from use and removed from its location under the floor of the building. The volume of waste leaking out was considered to be the capacity of the tank, because no records were available to show how much waste antifreeze was lost from the tank. The waste quantity was estimated to be approximately 25 tons.

TABLE 4.9. Potentially Low-Scoring Sites with Insufficient Information Available for Scoring

UPR-200-E-1	UPR-200-E-2
UPR-200-E-9	UPR-200-E-10
UPR-200-E-11	UPR-200-E-13
UPR-200-E-14	UPR-200-E-16
UPR-200-E-18	UPR-200-E-19
UPR-200-E-20	UPR-200-E-21
UPR-200-E-22	UPR-200-E-26
UPR-200-E-27	UPR-200-E-28
UPR-200-E-29	UPR-200-E-33
UPR-200-E-37	UPR-200-E-38
UPR-200-E-42	UPR-200-E-44
UPR-200-E-49	UPR-200-E-91
UPR-200-E-92	UPR-200-E-96
UPR-200-E-97	UPR-200-E-98
UPR-200-E-99	UPR-200-E-103
UPR-200-E-106	UPR-200-E-111
UPR-200-E-116	UPR-200-E-117
UPR-200-E-118	UPR-200-E-120
UPR-200-W-2	UPR-200-W-3
UPR-200-W-4	UPR-200-W-5
UPR-200-W-6	UPR-200-W-7
UPR-200-W-10	UPR-200-W-11
UPR-200-W-12	UPR-200-W-13
UPR-200-W-14	UPR-200-W-15
UPR-200-W-18	UPR-200-W-20
UPR-200-W-21	UPR-200-W-26
UPR-200-W-27	UPR-200-W-28
UPR-200-W-32	UPR-200-W-35
UPR-200-W-36	UPR-200-W-37
UPR-200-W-40	UPR-200-W-41
UPR-200-W-46	UPR-200-W-51
UPR-200-W-52	UPR-200-W-57
UPR-200-W-58	UPR-200-W-60
UPR-200-W-69	UPR-200-W-77
UPR-200-W-82	UPR-200-W-111
UPR-200-W-112	UPR-200-W-113
UPR-200-W-114	UPR-200-W-116
UPR-200-W-117	UPR-200-W-118
UPR-200-W-123	UPR-200-W-125
UPR-200-W-126	UPR-200-W-127
UPR-200-W-128	UPR-200-W-129
UPR-200-W-130	UPR-200-W-131
UPR-200-W-133	UPR-200-W-137
UPR-200-W-139	UPR-300-18

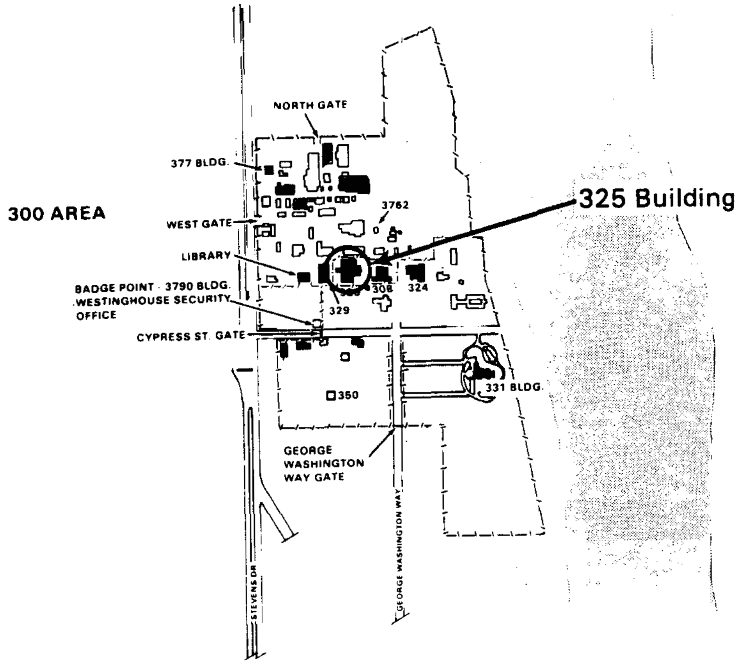

FIGURE 4.1 Location of the 325 Building in the 300 Area

4.5.2 UPR-100-K-1 Unplanned-Release Site

The UPR-100-K-1 unplanned-release site has an HRS migration-route score of 53.24. The site involved an estimated 500 million L (132 million gal) of water from the 105-KE fuel-storage basin that leaked to the ground in the vicinity of the 105-KE pickup chute. It had an estimated seepage-to-ground rate of more than 28.4 L/sec (450 gal/min) for an unknown period of time (the period of time was estimated to be about 200 days, according to the total activity reported to have leaked and according to an assumed concentration of total activity in the basin water of 5 million pCi/L). The report of the occurrence was in April 1979.

4.5.3 UPR-100-N-1 Unplanned-Release Site

The UPR-100-N-1 unplanned-release site has an HRS migration-route score of 44.37. The site involved an estimated 113,550 L (30,000 gal) of radioactive water (0.2 Ci), which leaked onto the ground as a result of a line leak from the inlet valve box near the 130 4-N emergency dump tank, contaminating an area of approximately 14 m^2 (150 ft^2). The water ran down the bank from the emergency dump tank, covered the roadway below the tank, and extended to the front of the 181-N Building.

4.5.4 UPR-100-N-12 Unplanned-Release Site

The UPR-100-N-12 unplanned-release site has an HRS migration-route score of 70.99. The site involved a leak in the spacer transport line from the 100-N fuel-storage basin that was discovered when a deep sink hole 0.6 m (2 ft) by 0.9 m (3 ft) by 0.45 m (18 in.)] was noticed in a previously back-filled zone. The occurrence was recorded on February 27, 1979. It was estimated that 946,250 L (250,000 gal) of liquid waste was released to the ground.

4.5.5 UPR-100-N-17 Unplanned-Release Site

The UPR-100-N-17 unplanned-release site has an HRS migration-route score of 50.28. The site was the result of external corrosion causing the leakage of approximately 302,800 L (80,000 gal) of diesel oil from the 166-N diesel oil supply line to the ground. The occurrence was reported in August 1966.

4.5.6 UPR-100-N-2 Unplanned-Release Site

The UPR-100-N-2 unplanned-release site has an HRS migration-route score of 44.37. The site was the result of a crack in a 2.5-cm (1-in.) body relief drain line from the FLV858 valve, which leaked thermally hot water to the ground. The leak rate was estimated at 0.6 L/sec (10 gal/min) and was determined to result from corrosion of the valve. The occurrence was reported February 19, 1980.

4.5.7 UPR-100-N-3 Unplanned-Release Site

The UPR-100-N-3 unplanned-release site has an HRS migration-route score of 73.95. The site was the result of an estimated 1,362,600 L (360,000 gal) of radioactive water (1.0 Ci of tritium) leaking onto the ground because of a line leak from the 100-H fuel-storage basin to the dummy disposal pit. The water leaked at an estimated 1.6 L/sec (25 gal/min) and formed a sink hole in the ground measuring 1.2 m (4 ft) in diameter by 0.8 m (30 in.) deep. The occurrence was reported on March 8, 1978.

4.5.8 UPR-100-N-5 Unplanned-Release Site

The UPR-100-N-5 unplanned-release site has an HRS migration-route score of 68.03. The site was the result of a leak that occurred in the piping at the radioactive chemical waste-handling facility. An estimated 90,000 gal of radioactive waste was discharged to the ground. The occurrence was reported on June 27, 1972.

4.5.9 UPR-100-N-9 Unplanned-Release Site

The UPR-100-N-9 unplanned-release site has an HRS migration-route score of 47.33. The site was the result of a back-hoe mistakenly hooking onto a buried 5-cm (2-in.) valve in a drain line during exploratory digging. An estimated 8,327 L (2,200 gal) of contaminated water leaked to the ground from a break in the drain line. The occurrence was reported on October 14, 1974.

4.5.10 UPR-300-12 Unplanned-Release Site

The UPR-300-12 unplanned-release site has an HRS migration-route score of 62.88. The site is the result of an estimated 15,140 L (4,000 gal) of radioactive rinse water overflowing in the 325-A Building. The rinse water contained promethium-147, fission products, transuranics, and nitrate ion. The waste leaked from the building basement to the soil column. The extent of contamination was never fully characterized because it occurred beneath the 325 Building. The occurrence was reported on January 8, 1979.

4.5.11 UPR-300-13 Unplanned-Release Site

The UPR-300-13 unplanned-release site has an HRS migration-route score of 59.74. The site was the result of 4,920 L (1,300 gal) of spent acid being leaked to the ground through a hole in a tank wall. The spent process acid included 2,010 kg (4,432 lb) of nitrate, 216 kg (477 lb) of copper, and 1.4 kg (3 lb) of uranium (0.005 Ci). The occurrence was reported on July 31, 1973.

4.5.12 UPR-300-38 Unplanned-Release Site

The UPR-300-38 unplanned-release site has an HRS migration-route score of 62.88. The site was the result of leakage discovered during the repair of a floor in the 313 Building. During the repair operation, solution was discovered running into a hallway from beneath a floor of acid brick. The solution was an acid waste containing nitric and sulfuric acid, contaminated with uranium in solution, with a neutralizing solution containing 50% sodium hydroxide added.

4.5.13 UPR-300-39 Unplanned-Release Site

The UPR-300-39 unplanned-release site has an HRS migration-route score of 44.02. The site was the result of leaking caustic storage tanks in the 311 tank farm, which contaminated the soil around the tanks. The incoming caustic solution stored in the tanks contains 50% sodium hydroxide. The soil around the tanks exhibits a high pH. The site was discovered when a pipe fitter was chemically burned while excavating in the area.

4.5.14 UPR-300-40 Unplanned-Release Site

The UPR-300-40 unplanned-release site has an HRS migration-route score of 59.74. The site was the result of a discovery that the drain connections between the pipe trench, the 303-F Building, and the process sewer were broken. The bottom of the trench was severely eroded, which indicated that a leak had occurred. The waste leaking out was a uranium-bearing acid waste that contained nitric and sulfuric acid with the uranium in solution. The extent of contamination involved the pipe trench area between the 311 tank farm and the 303-F Building. The leak was discovered in October 1974.

5.0 U.S. DOE HANFORD AGGREGATE SITE HRS SCORING PACKAGES FOR THE NATIONAL PRIORITY LIST

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) inactive waste sites at Hanford were combined into four administrative aggregate areas. These four aggregate areas were then evaluated using the Hazard Ranking System (HRS) methodology and scoring packages prepared for use in proposing the Hanford Site for listing on the National Priority List (NPL).

5.1 AGGREGATION OF HANFORD INACTIVE WASTE SITES

In July 1987, the U.S. Environmental Protection Agency (EPA) requested that the Department of Energy (DOE) and their subcontractors prepare HRS scoring packages for the DOE Hanford Site. The individual Hanford inactive waste sites were to be assembled into a few administrative aggregate-area sites with separate HRS scoring packages prepared for each of the aggregate-area sites. The aggregation of the inactive waste sites at Hanford was to be a joint effort on the part of EPA Region X, DOE Richland Operations Office (DOE/RL), and DOE/RL supporting contractors. Technical working meetings involving EPA Region X representatives (including an NUS Corporation contractor representative) and DOE/RL representatives [including Pacific Northwest Laboratory (PNL) and Westinghouse Hanford Company representatives] were held the week of August 4, 1987, to work out the aggregation policy for the Hanford Site. These working meetings resulted in the Hanford (CERCLA) inactive waste sites being combined into four administrative aggregate area sites. The four designated aggregate sites are as follows: 1) U.S. DOE Hanford 100 Area, 2) U.S. DOE Hanford 200 Area, 3) U.S. DOE Hanford 300 Area, and 4) U.S. DOE Hanford 1100 Area. The individual Hanford operational 600-Area sites were incorporated into either the U.S. DOE Hanford 200-Area or the U.S. DOE Hanford 300-Area aggregate sites (600-Area sites were incorporated on the basis of proximity to the defined 200 or 300 aggregate areas and their associated plumes).

The U.S. DOE Hanford 100-Area site and its 1-, 2-, and 3-mile[a] HRS zones are shown in Figure 5.1. Also shown are the approximate ground-water contamination plumes associated with the individual 100-Area site groupings that make up the U.S. DOE Hanford 100-Area site.

The U.S. DOE Hanford 200-Area site and its 1-, 2-, and 3-mile HRS zones are shown in Figure 5.2. Also shown are the approximate ground-water contamination plumes associated with the individual 200-Area sites that make up the U.S. DOE Hanford 200-Area site. The 1-, 2-, and 3-mile HRS zones are drawn around the designated site plus its associated contamination plume. This was necessary because the evaluation of the ground-water and surface-water pathways for the site requires incorporation of the plume (i.e., farthest extent of known contamination at the site). Extending the U.S. DOE Hanford 200-Area aggregate site to incorporate the ground-water contamination plume also made it necessary to incorporate many of the Hanford operational 600-Area waste sites into the 200-Area aggregate site because many of these 600-Area waste sites are located within the area bounded by the plumes.

The U.S. DOE Hanford 300-Area site and its 1-, 2-, and 3-mile HRS zones are shown in Figure 5.3. Also shown is the approximate ground-water contamination plume associated with the individual 300-Area waste sites that make up the U.S. DOE Hanford 300-Area site. This aggregate-area site is also considered to include several of the 600-Area waste-disposal sites, because of their proximity to the Hanford operational 300 Area.

The U.S. DOE Hanford 1100-Area site and its 1-, 2-, and 3-mile HRS zones are shown in Figure 5.4. This aggregate area was scored on its potential for offsite impact because there is no ground-water monitoring system established for the area and, thus, no data to establish any impact. The U.S. DOE Hanford 1100-Area site is also different from the other three aggregate areas in that its waste-disposal activity is not associated with normal Hanford processes. Instead, the waste-disposal activities are from routine maintenance practices associated with the Hanford Site. Preparatory work for

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(a) Neither metric units nor abbreviation of units are not used here because the EPA specifically designates these zones as the 1-, 2- and 3-mile zones.

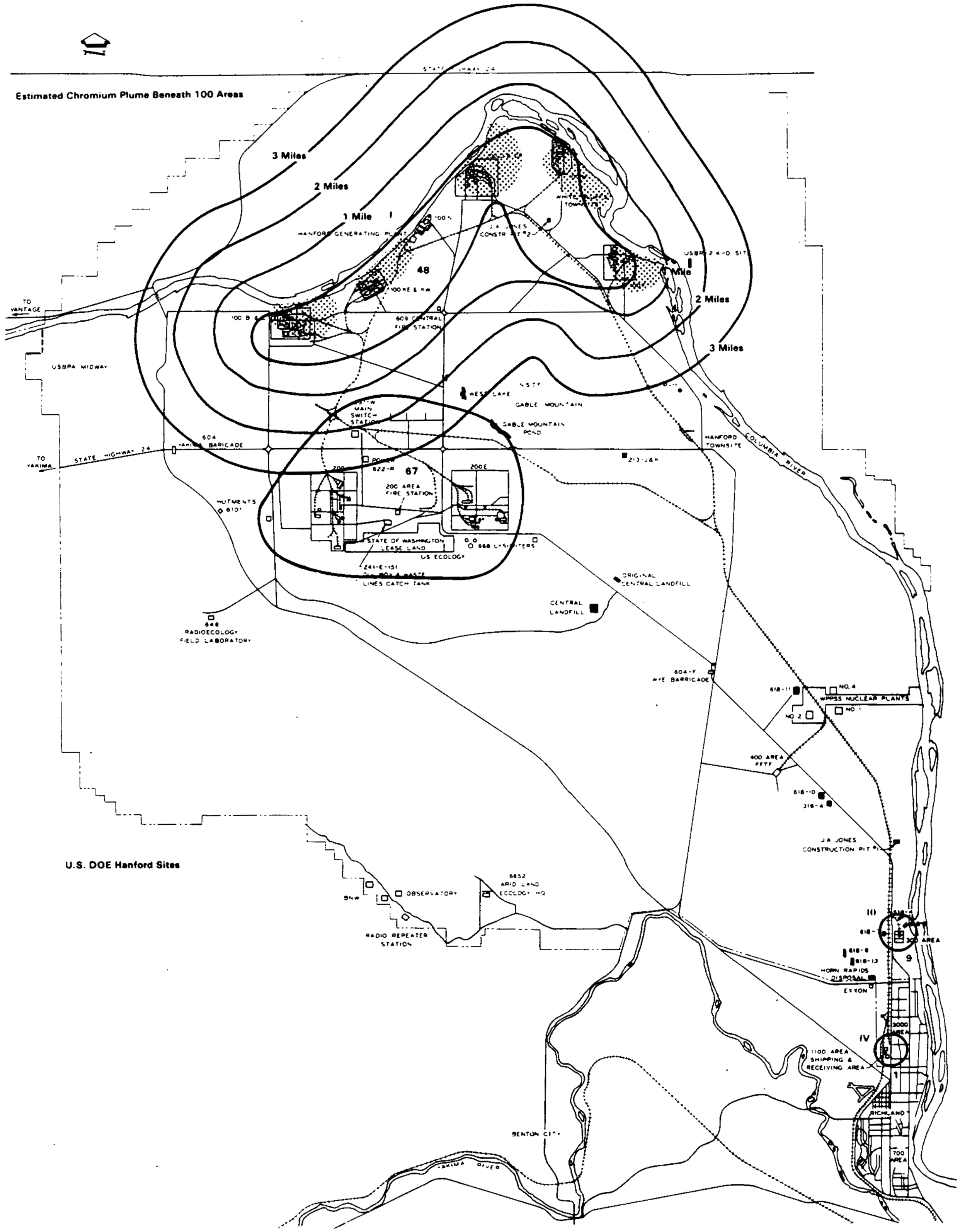

FIGURE 5.1. The U.S. DOE Hanford 100-Area Site

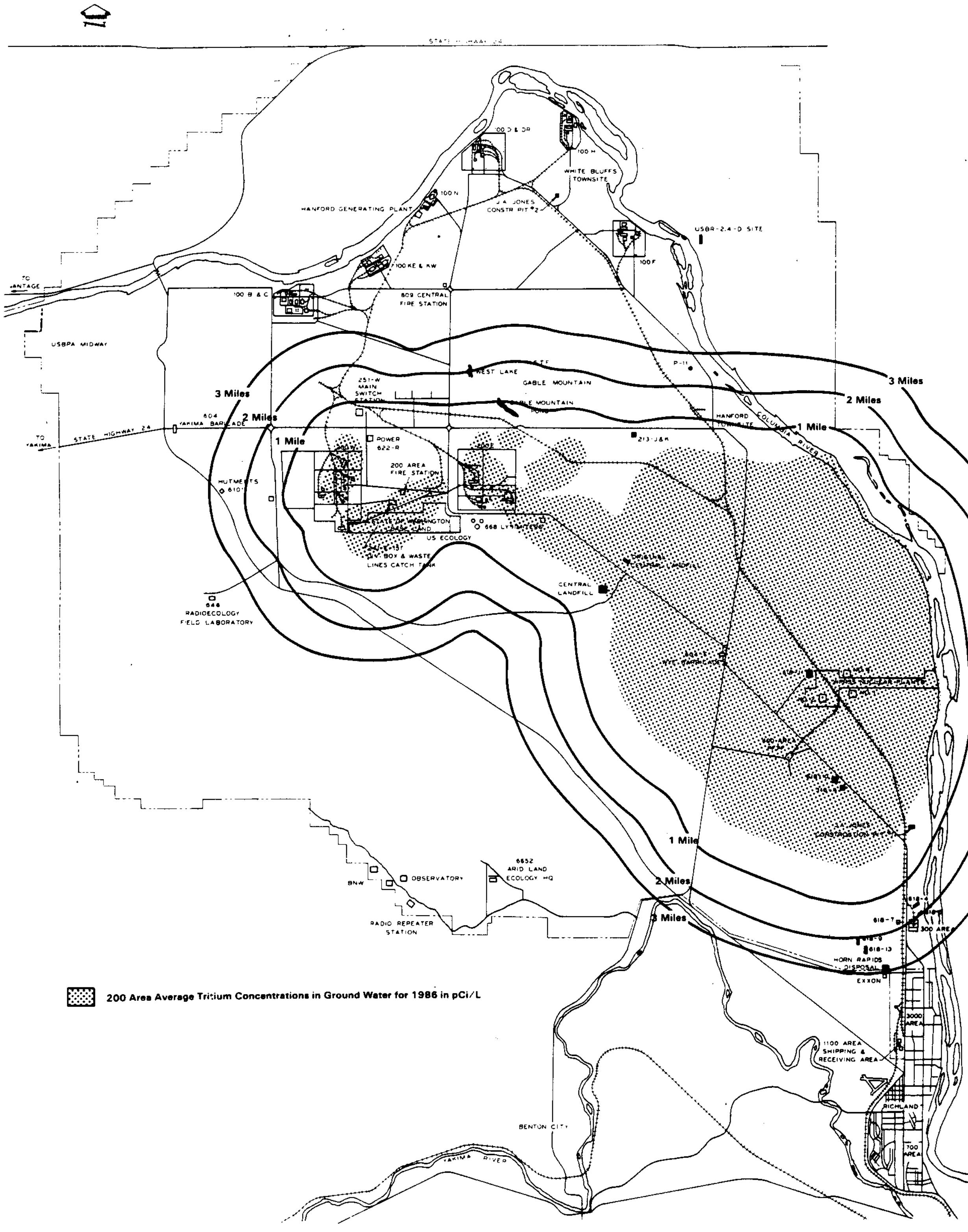

FIGURE 5.2 The U.S. DOE Hanford 200-Area Site

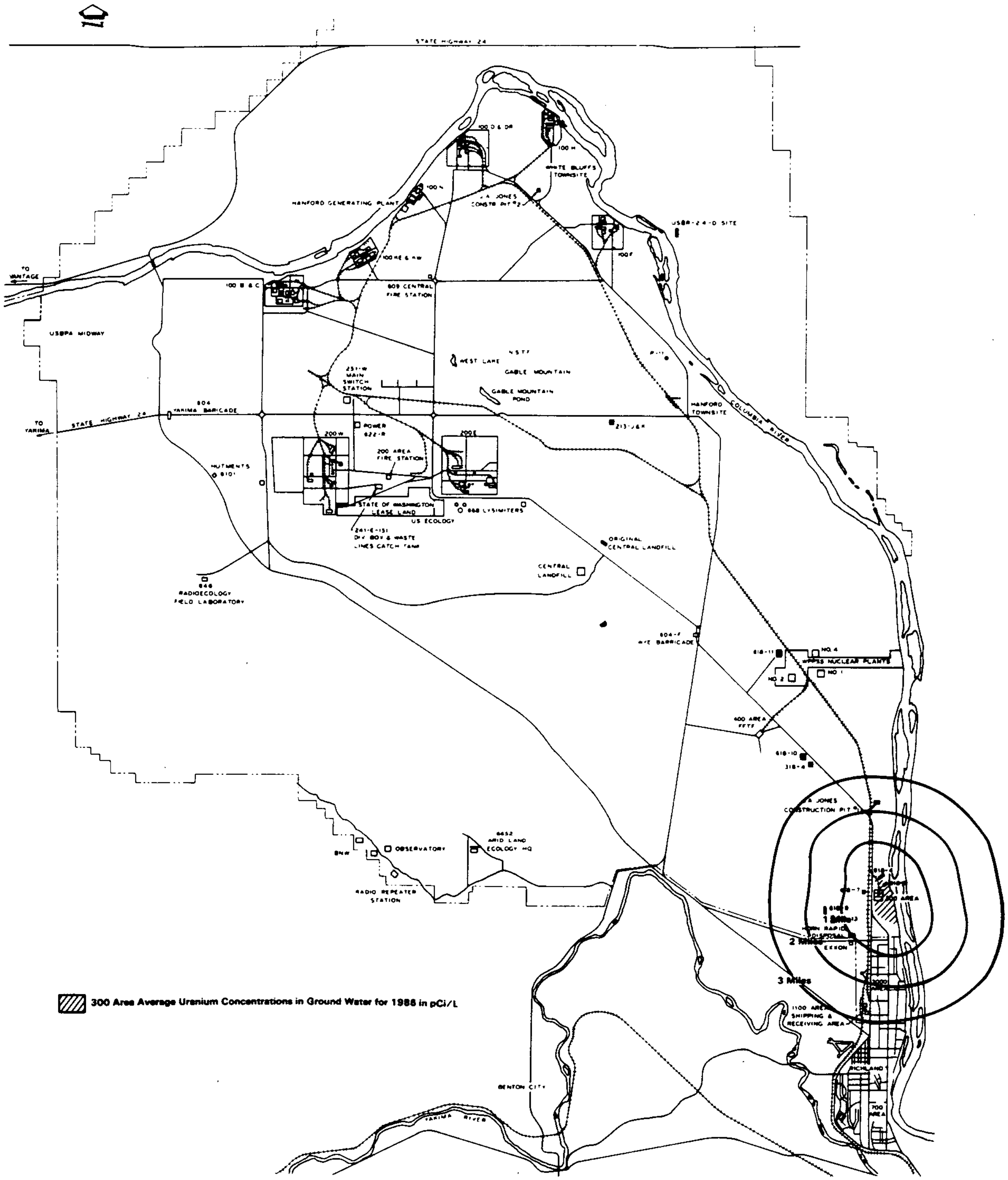

FIGURE 5.3. The U.S. DOE Hanford 300-Area Site

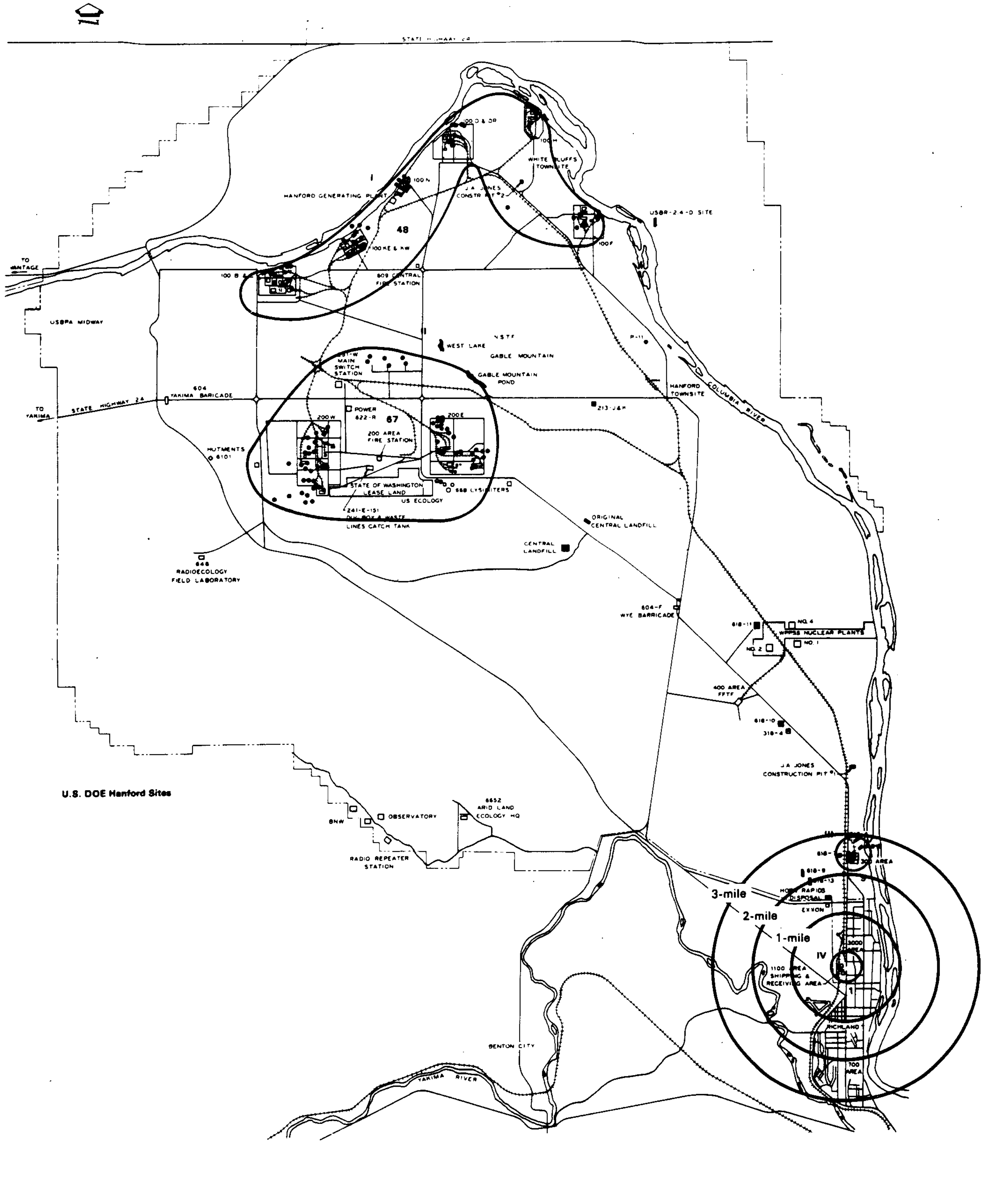

FIGURE 5.4. The U.S. DOE Hanford 1100-Area Site

conducting remedial investigation/feasibility study (RI/FS) work in the U.S. DOE Hanford 1100-Area site includes the establishing of a ground-water monitoring system.

The four HRS scoring packages prepared for each of these four aggregate sites lists the more significant individual sites that make up each respective aggregate area. However, all of the individual inactive waste sites (assigned to the CERCLA portion of the Hanford Environmental Restoration Program) located on the Hanford Site are considered to be part of their respective administrative aggregate area and will be considered as such in the RI/FS process.

5.2 HRS EVALUATION RESULTS FOR THE FOUR HANFORD AGGREGATE SITES

The inventories of the individual waste sites assigned to an aggregate site were summed to establish an overall inventory for the respective aggregate site. The HRS site parameters were established for each of the four aggregate areas, and the four aggregate sites were evaluated using the HRS methodology. The HRS migration-route scores determined for each of the four aggregate area sites were then used by the EPA for proposing the Hanford Site for listing on the NPL.

The EPA technical review criteria, established by MITRE Corporation (EPA's quality assurance review contractor), did not allow use of the 10% soil-column criteria for determining release to the environment for HRS evaluations conducted on the four aggregate-area sites. Instead, actual measured upstream and downstream contaminant concentration values had to be used to show a release to the environment had occurred. Because of the complexity of the Hanford Site, it is basically impossible to determine upstream and downstream contaminant concentrations on an individual-site basis, but when sites are grouped together (e.g., forming of the four aggregate areas), such data are available. Thus, in this report, the individual site scores were produced using the 10% soil-column release to the environment criteria, and the four aggregate-area site scores were produced using actual measured contaminant concentration values representative of the respective overall aggregate site. It is important that the reader keep this difference in mind when comparing the individual-site scores with the aggregate-area site scores (i.e., the individual-site scores are more environmentally conservative, which yields slightly higher scores).

The migration-route scores for the four aggregate sites are listed in Table 5.1.

TABLE 5.1. Hazard Ranking System (HRS) Migration Route Scores for the Four Hanford Aggregate-Area Sites

Site	Waste Site Location (Area)	HRS Migration Score
U.S. DOE Hanford 100 Area	100	46.38
U.S. DOE Hanford 200 Area	200; 600	69.05
U.S. DOE Hanford 300 Area	300; 600	65.23
U.S. DOE Hanford 1100 Area	1100	36.33

6.0 CONCLUSIONS

This report addressed the results of assessment activities that occurred at the Hanford Site. These assessment activities included the following:

- scoring of 335 engineered-facility sites, using the Hazard Ranking System (HRS) (40 CFR 300) methodology - The Hanford Inactive Site Surveillance (HISS) Data Base (developed for this project) incorporated the HRS scores for these sites. Results were also sent to the managers of the Waste Information Data System (WIDS), which tracks CERCLA and non-CERCLA waste sites.
- identification, investigation, and scoring of 20 newly designated engineered-facility sites - The HRS methodology was used to score these sites, and the scores and site data were entered into the HISS Data Base and sent to the WIDS data base managers.
- identification, investigation, and evaluation of 291 unplanned-release sites - These sites were evaluated using the HRS methodology. The HISS Data Base was updated to include these sites, and the information was sent to the WIDS data base managers.
- aggregation of the Hanford inactive waste sites into four administrative sites and development of HRS evaluation packages for each of the four aggregate sites.

These activities were carried out under the direction of the DOE orders that define the U.S. Department of Energy (DOE) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Program.

The evaluation included a total of 646 individual inactive waste sites at Hanford. Of the 646 individual waste sites evaluated, only 125 (i.e., 19.3% ranked high and 80.7% ranked low) of the sites ranked above the 28.5 HRS migration route score cut-off value set by the U.S. Environmental Protection Agency (EPA). Sites scoring above the 28.5 value are to be listed on the National Priority List (NPL). However, because of the decision by the EPA to aggregate all the individual inactive waste sites into four administrative aggregate-areas sites, only the scores for the four aggregate sites were used by the EPA to propose Hanford for listing on the NPL. Figure 6.1

were used by the EPA to propose Hanford for listing on the NPL. Figure 6.1 is a categorical breakdown of the 646 individual waste sites. The figure also shows a breakdown of the 125 sites that scored greater than 28.5 on the HRS migration route. A listing of the 125 sites that scored greater than 28.5 is presented in Table 6.1.

At the request of the EPA, the inactive waste sites (CERCLA Program sites) at Hanford were combined into four administrative aggregate areas. These four areas were evaluated using the HRS methodology and scoring packages prepared for use in proposing the Hanford Site for listing on the National Priority List. Table 6.2 lists the four U.S. DOE Hanford Aggregate-Area sites and their respective scores.

Because of the relatively large number of individual sites (both CERCLA and RCRA sites) contained in each of the four Hanford administrative aggregate sites, a process is being negotiated/established with the EPA to organize the individual sites within each aggregate site into functional

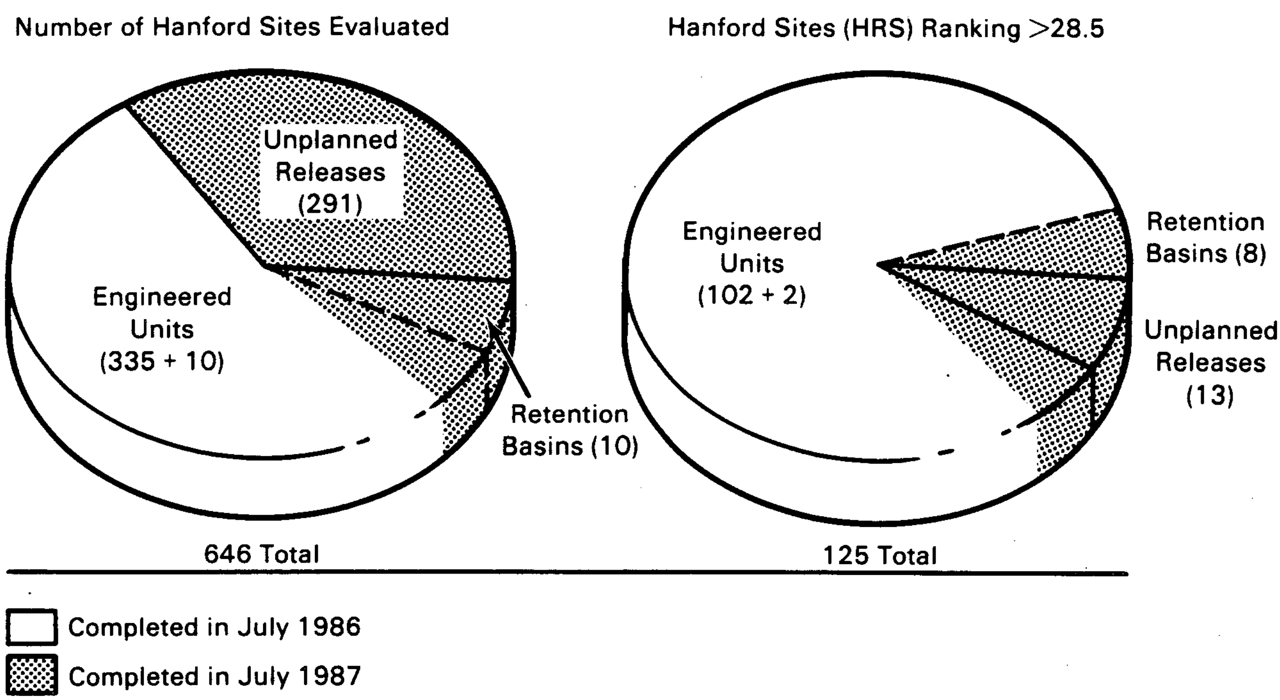

FIGURE 6.1. Categorical Breakdown of the 646 Inactive Waste Sites at Hanford and the 125 Waste Sites that Scored Greater Than 28.5 on the Hazard Ranking System Migration Route

TABLE 6.1. Hazard Ranking System (HRS) High-Scoring Sites (Score Greater Than 28.5)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
116-DR-7	100 D/DR	Crib	28.95
216-S-16P	200 West	Pond	32.71
216-U-4	200 West	Reverse well	32.71
216-A-40	200 East	Trench	32.71
UPR-1100-4	1100	Tank	34.59
White Bluffs Pickling Acid Crib	600	Crib	35.49
216-U-11	200 West	Ditches (2)	37.75
1100 Area Battery Acid Pit	1100	Sand Pit	38.54
116-DR-3	100 D/DR	Trench	40.09
116-KE-1	100 KE/KW	Crib	40.09
116-KW-1	100 KE/KW	Crib	40.09
116-B-2	100 B/C	Trench	40.09
116-B-5	100 B/C	Crib	40.09
100 KW*1	100 KE/KW	Dry well	40.09
100 KW*2	100 KE/KW	French drain	40.09
116-F-7	100 F	French drain	40.93
116-DR-1	100 D/DR	Trench	42.32
116-DR-2	100 D/DR	Trench	42.32
116-H-1	110 H	Trench	42.32
116-H-2	100 H	Trench	42.32
116-H-3	100 H	French drain	42.32
116-K-1	100 KE/KW	Crib	42.32
116-B-1	100 B/C	Trench	42.32
116-C-1	100 B/C	Trench	42.32
116-C-2	100 B/C	Crib	42.32
116-F-3	100 F	Trench	42.32
116-F-2	100 F	Trench	42.32
116-F-6	100 F	Trench	42.32
116-F-9	100 F	Trenches (2)	42.32
116-F-10	100 F	French drain	42.32
100 KE*2	100 KE/KW	French drain	42.32
116-DR-6	100 D/DR	Trench	42.32
100 KE*1	100 KE/KW	Dry well	42.32
116-D-1B	100 D/DR	Trench	42.32
UPR-300-39	300	Unplanned release	44.02
UPR-100-N-1	100 N	Unplanned release	44.37
UPR-100-N-2	100 N	Unplanned release	44.37
116-B-4	100 B/C	French drain	44.55
116-F-1	100 F	Trench	44.55
216-Z-1(D)	200 West	Ditch	45.30
216-Z-11	200 West	Ditch	45.30
216-N-2	200 North	Trench	45.30
216-N-3	200 North	Trench	45.30
216-N-4	200 North	Pond	45.30

TABLE 6.1. (contd)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
216-N-5	200 North	Trench	45.30
216-N-6	200 North	Pond	
45.30216-N-5	200 North	Trench	45.30
216-N-6	200 North	Pond	
45.30216-N-5	200 North	Trench	45.30
216-N-6	200 North	Pond	
45.30216-N-7	200 North	Trench	45.30
216-B-2-2	200 East	Trench	45.30
216-S-11	200 West	Pond	45.30
216-Z-17	200 West	Trench	45.30
216-U-4B	200 West	French	45.30
216-U-3	200 West	French drain	47.27
UPR-100-N-9	100 N	Unplanned release	47.33
216-A-4	200 East	Crib	47.81
216-A-6	200 East	Crib	47.81
216-B-4	200 East	Crib	47.81
216-B-10A	200 East	Crib	47.81
216-B-11A&B	200 East	Reverse well	47.81
216-C-10	200 East	Crib	47.81
216-S-3	200 West	French drains (2)	47.81
216-S-4	200 West	French drain	47.81
216-S-5	200 West	Crib	47.81
216-S-6	200 West	Crib	47.81
216-S-17	200 West	Pond	47.81
216-S-16D	200 West	Ditch	47.81
216-S-21	200 West	Crib	47.81
216-T-8	200 West	Crib	47.81
216-T-28	200 West	Crib	47.81
216-Z-10	200 West	Reverse well	47.81
216-A-28	200 East	French drain	47.81
216-U-4A	200 West	French drain	47.81
116-KE-2	100-KE/KW	Crib	49.00
UPR-100-N-17	100 N	Unplanned release	50.28
216-A-36A	200 East	Crib	50.33
216-B-6	200 East	Reverse well	50.33
216-B-50	200 East	Crib	50.33
216-B-57	200 East	Crib	50.33
216-C-1	200 East	Crib	50.33
216-S-9	200 West	Crib	50.33
216-S-20	200 West	Crib	50.33
216-Z-7	200 West	Cribs (2)	50.33
216-T-2	200 West	Reverse well	50.33
116-K-2	100 KE/KW	Trench	51.23
216-Z-1 & 2	200 West	Crib	52.85
UPR-100-K-1	100 KE/KW	Unplanned release	53.24
216-S-1 & 2	200 West	Cribs (2)	55.36
216-A-7	200 East	Crib	57.88

TABLE 6.1. (contd)

Site	Waste Site Location (Area)	Facility	HRS Migration Score
216-A-9	200 East	Crib	57.88
216-A-21	200 East	Crib	57.88
216-A-24	200 East	Crib	
57.88216-A-27	200 East	Crib	57.88
216-B-43	200 East	Crib	57.88
216-S-7	200 West	Cribs (2)	57.88
216-T-19	200 West	Crib and tile field	57.88
UPR-300-13	300	Unplanned release	59.74
UPR-300-40	300	Unplanned release	59.74
216-A-5	200 East	Crib	60.40
216-B-5	200 East	Reverse well	60.40
216-B-44	200 East	Crib	60.40
216-T-3	200 West	Reverse well	60.40
UPR-300-12	300	Unplanned release	62.88
UPR-300-38	300	Unplanned release	62.88
216-B-12	200 East	Cribs (3)	62.92
216-B-16	200 East	Crib	62.92
216-B-45	200 East	Crib	62.92
216-B-46	200 East	Crib	62.92
216-B-48	200 East	Crib	62.92
216-B-49	200 East	Crib	62.92
216-U-1 & 2	200 West	Crib	62.92
216-B-7A&B	200 East	Crib	65.43
216-T-7	200 West	Crib and tile field	65.43
UPR-100-N-5	100 N	Unplanned release	68.03
UPR-100-N-12	100 N	Unplanned release	70.99
UPR-100-N-3	100 N	Unplanned release	73.95
107-C	100 B/C	Retention basin	76.91
107-D	100 D/DR	Retention basin	76.91
107-DR	100 D/DR	Retention basin	76.91
107-F	100 F	Retention basin	76.91
107-H	100 H	Retention basin	76.91
107-KE	100 KE/KW	Retention basin	76.91
107-KW	100 KE/KW	Retention basin	76.91
107-B	100 B/C	Retention basin	76.91
316-1	300	Pond	79.28
316-2	300	Pond	79.28
316-3	300	Trench	79.28

TABLE 6.2. Hazard Ranking System (HRS) Migration-Route Scores for the Four U.S. DOE Hanford Aggregate-Area Sites

Aggregate Site Name	Location (Hanford Operational Area)	HRS Migration Score
U.S. DOE Hanford 100 Area	100	46.24
U.S. DOE Hanford 200 Area	200; 600	69.05
U.S. DOE Hanford 300 Area	300; 600	65.23
U.S. DOE Hanford 1100 Area	1100	36.33

groups (i.e., operable units), which can then be prioritized and fitted into an overall plan for cleaning up the Hanford Site. Figure 6.2 presents a proposed logic diagram of such a process. This process is expected to include the following major steps for the defining of operable units within each aggregate site:

- organization of individual sites by facility/process (i.e., waste area groups)
- preliminary identification of operable units
- initiation of RI/FS process for operable units (considering priority)
- implementation of a scoping study for waste area groups (i.e., facility/process groups)
- final identification and prioritization of operable units
- prioritized implementation of RI/FS process
- generation of a Record of Decision for remedial response.

The 646 individual waste sites identified in this report represent those Hanford CERCLA (pre-1980) sites for which an existence/status has been discovered and documented. However, because of the long waste management history of the Hanford Site, potential new sites may be discovered as

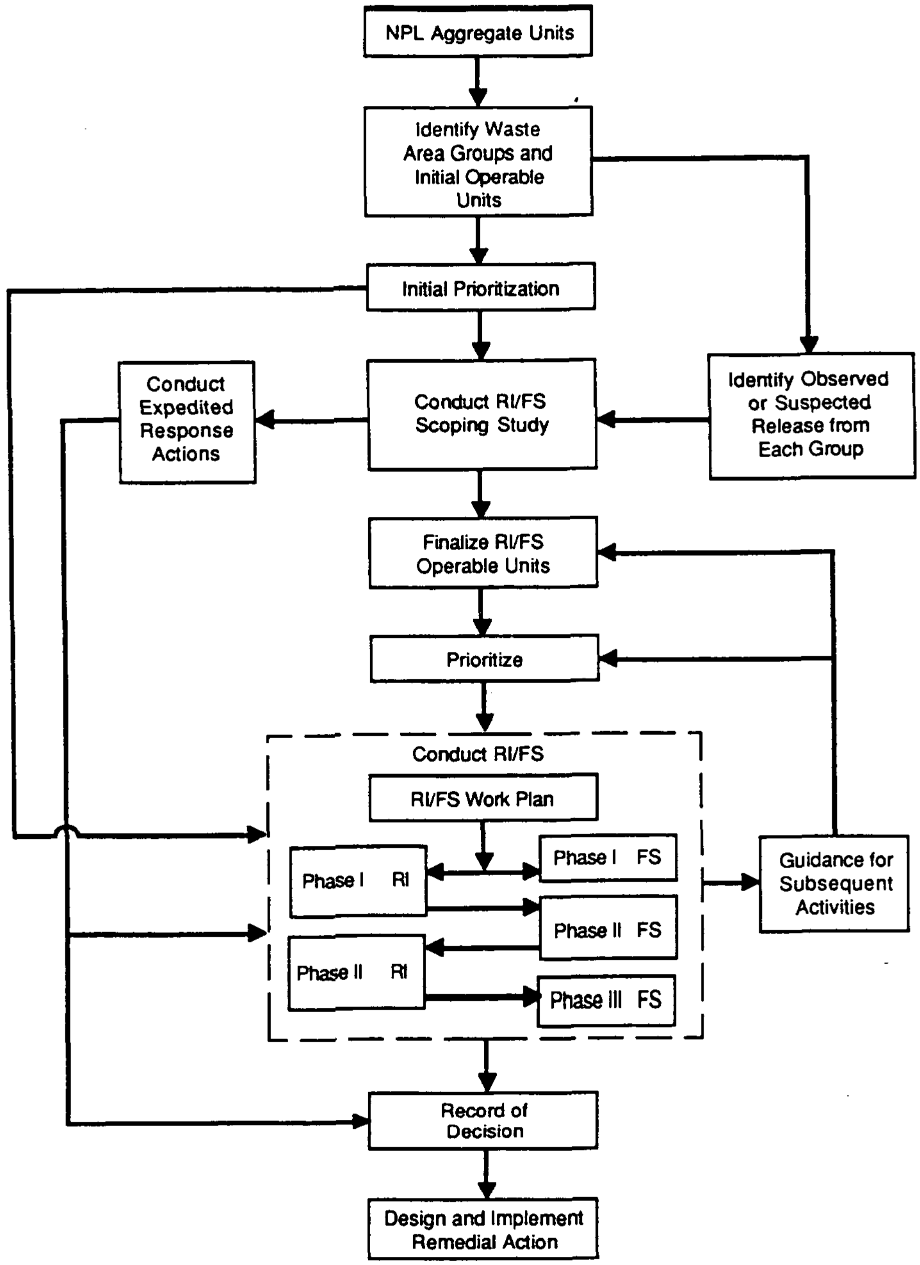

FIGURE 6.2. Organization Process for Individual Sites Within Each Aggregate Site

remedial investigation work progresses (e.g., as the existing individual aggregate sites are researched for more detailed information or evidence is discovered that suggests the possible existence of a new waste site). As of this writing, there are four such sites (i.e., NIKE Missile Site - Rattlesnake Mountain, NIKE Missile Site - Saddle Mountain, Old Central Shops Area, and Riverland Ash Disposal Pit) that are currently under investigation to determine if they need to be added to the list of hazardous waste sites at Hanford. The PA/SI process will be applied to each potentially new site that is discovered, and if it is deemed to be a new hazardous waste site, it will be incorporated into one of the four Hanford administrative aggregate sites. As a result of being included in one of the four administrative aggregate sites, it will then be included, along with all the other individual sites in that aggregate site, in the process of assigning it to an operable unit that will then be investigated under the Remedial Investigation/Feasibility Study (RI/FS) process. The individual hazardous waste sites at Hanford (i.e., CERCLA and RCRA sites, and any new sites assigned as either CERCLA or RCRA sites) will all be reported and tracked in the Hanford Site Waste Management Units Report (DOE 1987).

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APPENDIX A

GLOSSARY, ACRONYMS, AND INITIALISMS

APPENDIX A

GLOSSARY, ACRONYMS, AND INITIALISMS

Air Route Score - assesses the impact of the release of hazardous or radioactive material from a waste-disposal site to the air

Alpha Radiation - an emission of particles (helium nuclei) from a material undergoing nuclear transformation; the particles have a nuclear mass number of four and a charge of plus two

Aquifer - a subsurface formation containing sufficient saturated permeable material to yield significant quantities of water

Burial Ground - an area specifically designated for the subsurface disposal of solid waste or excess materials; at Hanford, such sites are used to temporarily isolate the material from the environment

Caisson - a vertically oriented cylindrical structure used for the subsurface disposal or storage of materials

Confined Aquifer - a subsurface water-bearing region having defined, relatively impermeable upper and lower boundaries and whose pressure throughout is significantly greater than atmospheric pressure

Contamination (contaminated material) - the deposition, solvation, or infiltration of radionuclides on or into an object, material, or area, whereupon the object, material, or area is considered "contaminated"

Controlled Area - any area at a facility to which access is controlled to protect individuals from exposure to radiation or radioactive material

Crib - a linear excavation about 4.6 m (15 ft) deep along the bottom of which is laid a perforated pipe, over which the ditch is backfilled with broken rock or other loose material and then covered with soil and a membrane that is impermeable to liquids; the pipe is then used to distribute intermediate-level liquid wastes along the crib

Curie (Ci) - a unit of radioactivity defined as the amount of a radioactive material that has an activity of 3.7 x 10^{10} disintegrations per second (d/s); millicurie (mCi) = 10^{-3} curie; microcurie (μCi) = 10^{-6} curie; nanocurie (nCi) = 10^{-9} curie; picocurie (pCi) = 10^{-12} curie; femtocurie (fCi) = 10^{-15} curie

Decommissioning - the process of removing a facility or area from operation and decontaminating or disposing of it, or placing it in a standby condition with appropriate controls and safeguards

Decontamination - the selective removal of radioactive material from a surface or from within another material

Direct-Contact Route Score - assesses the potential for harm from direct contact with hazardous or radioactive substances at the facility; score is not used for planning remedial action, but could be used to identify those sites needing immediate attention

Disposal - the engineered release or placement of waste in a manner that precludes recovery

Ditch - a linear excavation often used for the temporary diversion or disposal of process-water streams

Dry Well - a borehole that does not sink deep enough to reach ground water; used to monitor the movement of liquid waste released near the surface and to check for possible leaks in underground waste-storage tanks

Environmental Monitoring - a program to monitor the impact of the discharges from industrial operations on the surrounding region

Fire and Explosion Evaluation - assesses the threat of fire or explosion to the public or to sensitive environments

French Drain - a rock-filled encasement with an open bottom that allows liquid waste to seep into the ground

Gamma Radiation - electromagnetic energy emitted during a nuclear transition

Ground Water - water that exists or flows below the surface, within the zone of saturation

Ground-Water Migration Route Score - assesses the potential for migration of hazardous or radioactive material from a waste site via the ground water

Half-Life - the time required for the activity of a radionuclide to decay to half its value; used as a measure of the persistence of radioactive materials; each radionuclide has a constant, characteristic half-life

Hazard Ranking System - a ranking system that assigns scores to waste-disposal sites based on their relative potential for releases that pose a hazard to health or the environment

Hydraulic Conductivity - the parameter relating the volumetric flux to the driving force in flow through a porous medium, particularly water through soil; a function of both the porous medium and the properties of the fluid

Inactive - the condition of a facility or disposal site that is not currently being operated or to which materials are not currently being added

Low-Level Liquid Waste - fluid materials disposed of at Hanford that are contaminated by less than 5 x 10^{-5} μCi/mL of mixed fission products

Modified Hazard Ranking System - a system that adds a subcategory to the waste characteristics section of the Hazard Ranking System, reflecting more accurately the potential hazards of radionuclides at abandoned waste sites

Nuclear Reactor - a device containing fissionable material such that a chain of fission events can be maintained and controlled to meet a particular purpose

Nuclide - a species of atom having a specific mass, atomic number, and nuclear energy state

Radioactive Solid Wastes - either solid radioactive material or solid objects that contain radioactive material or bear surface radioactive contamination

Retention Basin - an excavated and lined area used to hold contaminated fluids until radioactive decay reduces activities to levels permissible for release

Retired Facility - a facility that has been shut down with no intentions of restarting and that has had appropriate controls and safeguards placed on it

Standby - the condition of a facility or burial ground, etc., that is not operating but is maintained in readiness for operation

Surface-Water Migration Route Score - assesses the potential for migration of hazardous or radioactive material from a waste site via surface water

Tank - a large metal container located underground, for storage of liquid wastes

Tank Farm - an installation of interconnected underground containers (tanks) for storage of high-level waste

Trench - a ditch used for the disposal of solid radioactive waste or low-level liquid waste

Unconfined Aquifer - an aquifer that has a water table or surface at atmospheric pressure

Vadose Zone - the unsaturated zone of soil between the ground surface and the water table

Visitant - a migratory bird that appears at intervals for a limited period

V-Trench - a concrete-lined, earth-covered excavation for storing drums containing transuranic-bearing solid radioactive waste

Water Table - upper boundary of an unconfined aquifer surface below which saturated ground water occurs; defined by the levels at which water stands in wells that barely penetrate the aquifer

AEC - Atomic Energy Commission

AFAN - Ammonium fluoride-ammonium nitrate

ALE - Arid Lands Ecology

BWIP - Basalt Waste Isolation Project

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act cpm - counts per minute

DBBP - dibutyl butyl phosphonate

DOE - U.S. Department of Energy

DOE/RL - U.S. Department of Energy/Richland Operations Office

dpm - disintegrations per minute

EPA - U.S. Environmental Protection Agency

ERDA - Energy Research and Development Administration

FFTF - Fast Flux Test Facility

HISS - Hanford Inactive Site Surveillance

HMS - Hanford Meteorological Station

HRS - Hazard Ranking System

LLW - Low-level waste

LMFBR - Liquid-metal fast-breeder reactor

mHRS - Modified Hazard Ranking System

MIBK - Methyl isobutyl ketone

MSL - Mean sea level

NEPA - National Environmental Policy Act

NPL - National Priorities List

PA/SI - Preliminary Assessment/Site Inspection

PNL - Pacific Northwest Laboratory

PPF - Plutonium Processing Facility

PUREX - Plutonium and Uranium Extraction

RCRA - Resource Conservation and Recovery Act

REDOX - Reduction Oxidation

RI/FS - Remedial Investigation/Feasibility Study

TRU - Transuranic

UNH - Uranium nitrate hexahydrate

APPENDIX B

LOCATIONS AND DESCRIPTIONS OF WASTE-DISPOSAL SITES

APPENDIX B

LOCATIONS AND DESCRIPTIONS OF WASTE-DISPOSAL SITES

This appendix provides an explanation of the numbering system used for designating inactive waste sites; maps are also provided to locate inactive sites in each of Hanford's operational areas. In addition, the several types of facilities constructed at these sites (e.g., trenches, cribs, reverse wells) are discussed and depicted. The information given can be applied to Chapter 3.0, which presents findings for numbered site locations and makes reference to specific types of facilities at each site.

B.1 WASTE SITE DESIGNATIONS AND LOCATIONS

Waste sites are numbered to provide information on the site's location and history. In the 100 and 200 Areas, sites are designated in the following way (with a few exceptions):

AC-P-n

where A = first digit of area number (1 = 100 Area, 2 = 200 Area, etc.)

C = physical characteristic of waste disposed (16 and 17 = liquids; 18 = solids)

P = letter designating origin/location of waste

B = B Area[a]
C = C Area[a]
D = D Area[a]
DR = DR Area[a]
F = F Area
H = H Area
K = K Area
KE = KE Area[a]
KW = KW Area[a]
N = N Area

} 100 Areas

(a) May be shown as combined (e.g., 100-B/C or 100-D/DR), because these areas share a common border.

where			
	A = PUREX Plant		
	B = B Plant		
	C = C Plant (Semiworks)		
	S = REDOX		
	T = T Plant	}	200 Areas
	U = U Plant		
	Z = Z Plant		
	E = East Area		
	N = North Area		
	W = West Area		

n = sequential number of the waste site.

Therefore, considerable information can be gained from a site number. For example, 216-Z-2 was a liquid-waste disposal site (in this case, a crib) servicing Z-Plant in the 200-West Area; it was installed relatively early in the Z-Plant history.

The 300- and 600-Area sites are generally sequentially numbered. For instance, 618-10 was the tenth solid-waste burial ground in the 600 Area; 316-1 was the first pond servicing the 300 Area.

The following area maps (Figures B.1 to B.10) show the locations of Hanford's inactive waste-disposal sites, which are designated by the numbering systems described above.

B.2 WASTE-DISPOSAL FACILITIES

Various types of facilities have been constructed to accommodate waste disposal at Hanford's inactive waste-disposal sites. These facilities are discussed below according to the type of waste (solid or liquid) they contain.

B.2.1 Solid-Waste Disposal Facilities

Contaminated solid wastes have been generated at the Hanford Site since 1944 (ERDA 1975). These wastes have been placed underground in trenches, caissons, and tunnels, and on retrievable storage pads. Most of these solid-waste facilities were backfilled trenches of differing sizes and shapes. A typical solid-waste trench is illustrated in Figures B.11 and B.12.

FIGURE B.1 100-B & 100-C AREA WASTE SITES

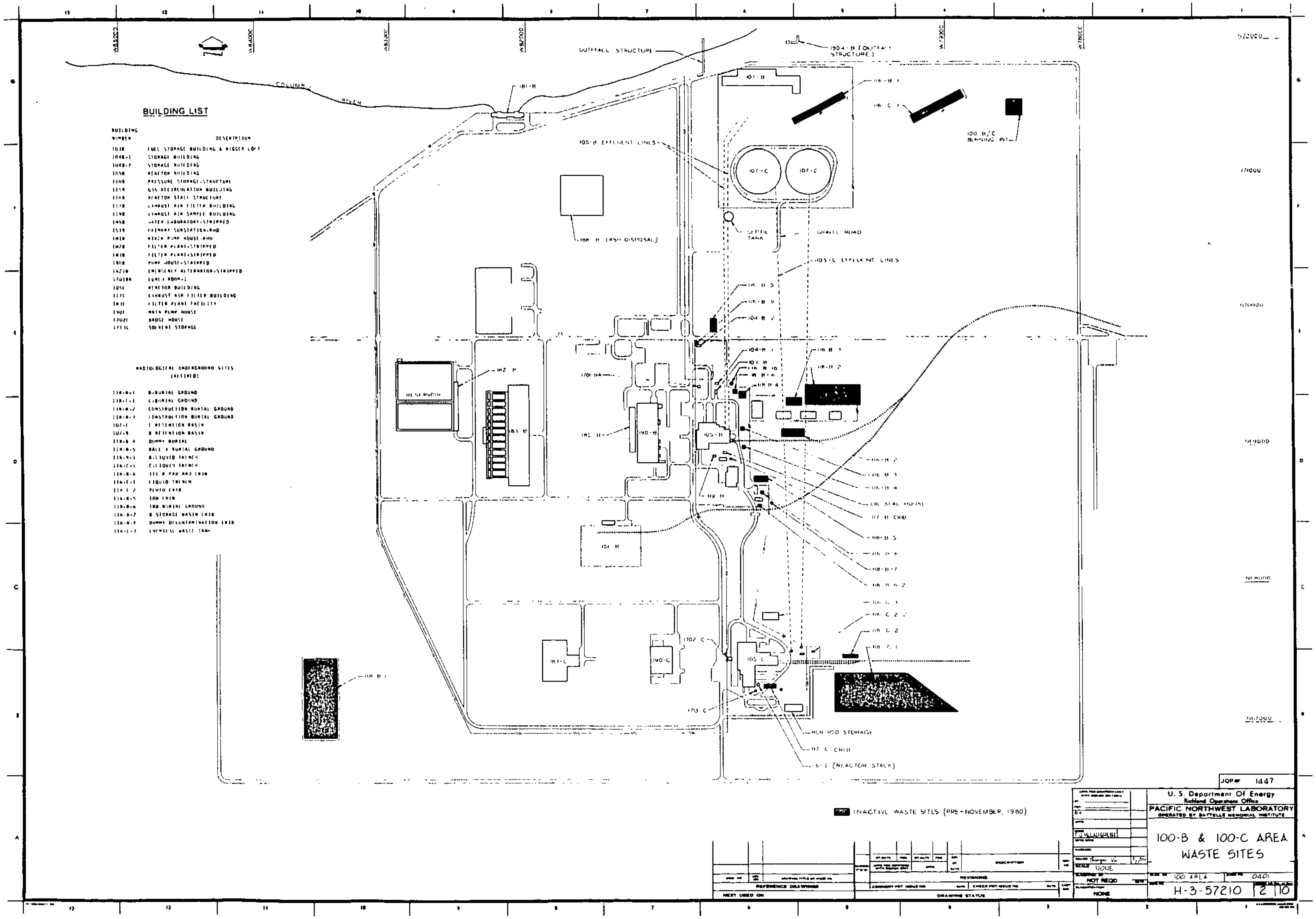


FIGURE B.2 100-D & 100-DR AREA WASTE SITES

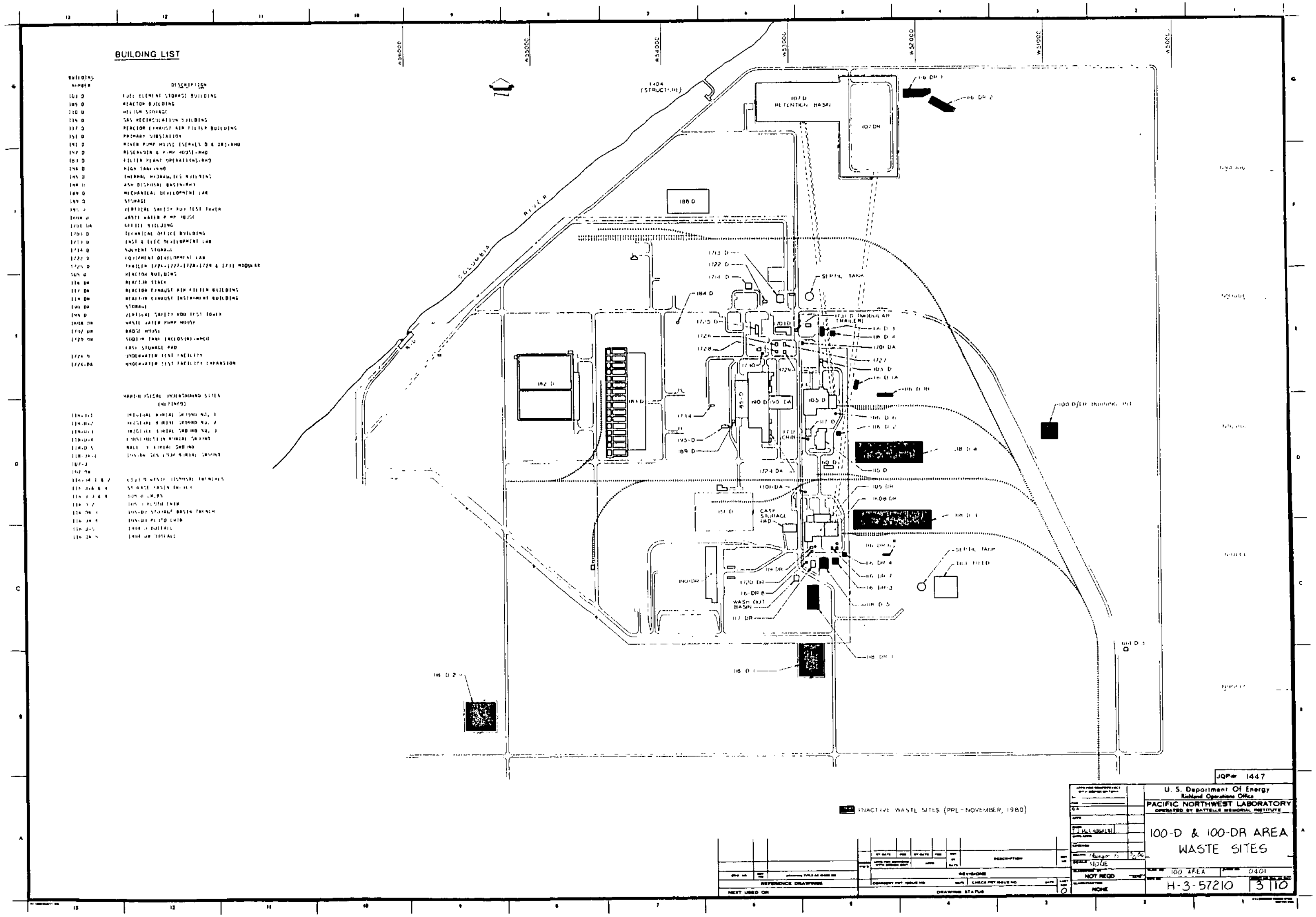


FIGURE B.3 100-F AREA WASTE SITES

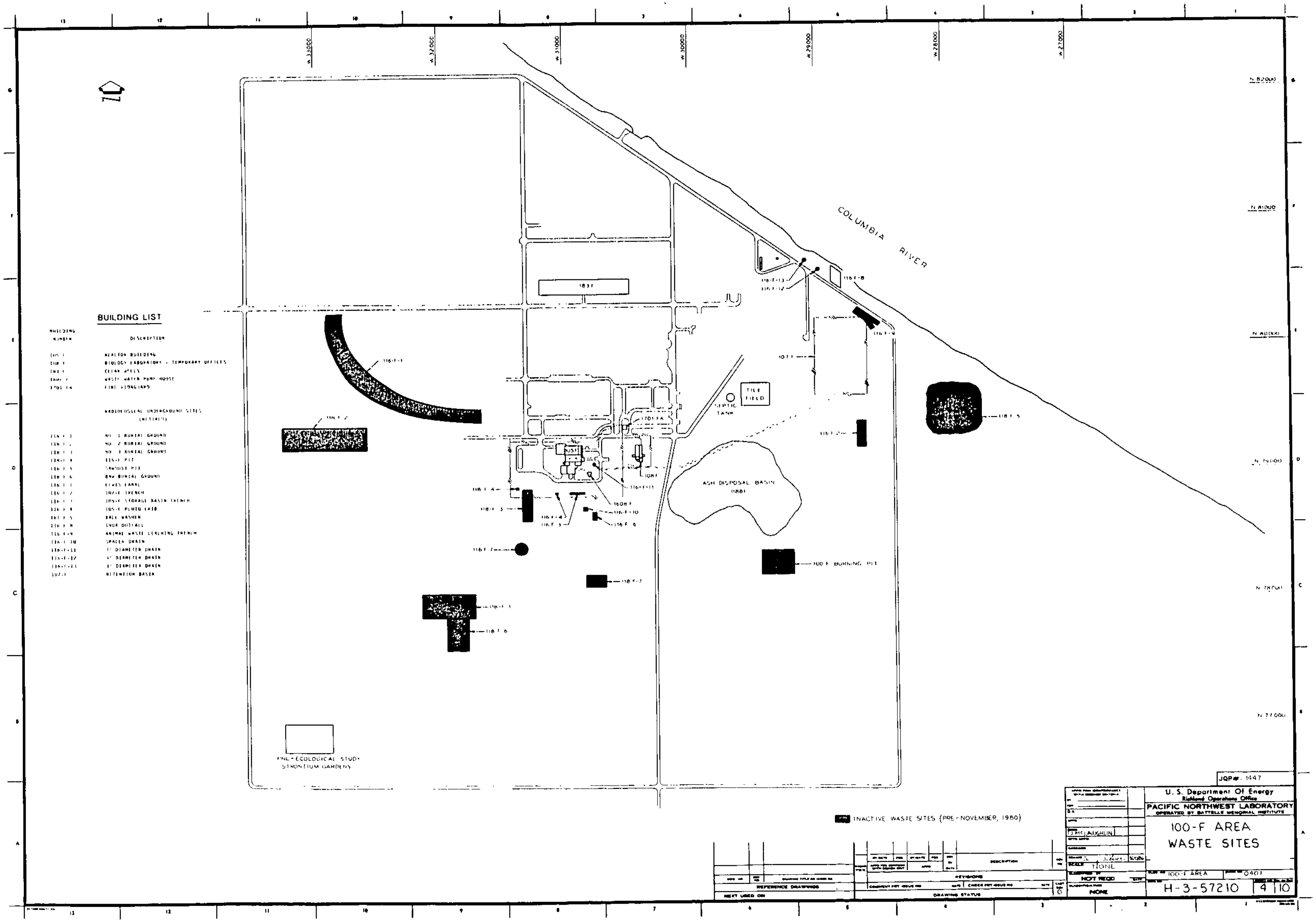


FIGURE B.4 100-H AREA WASTE SITES

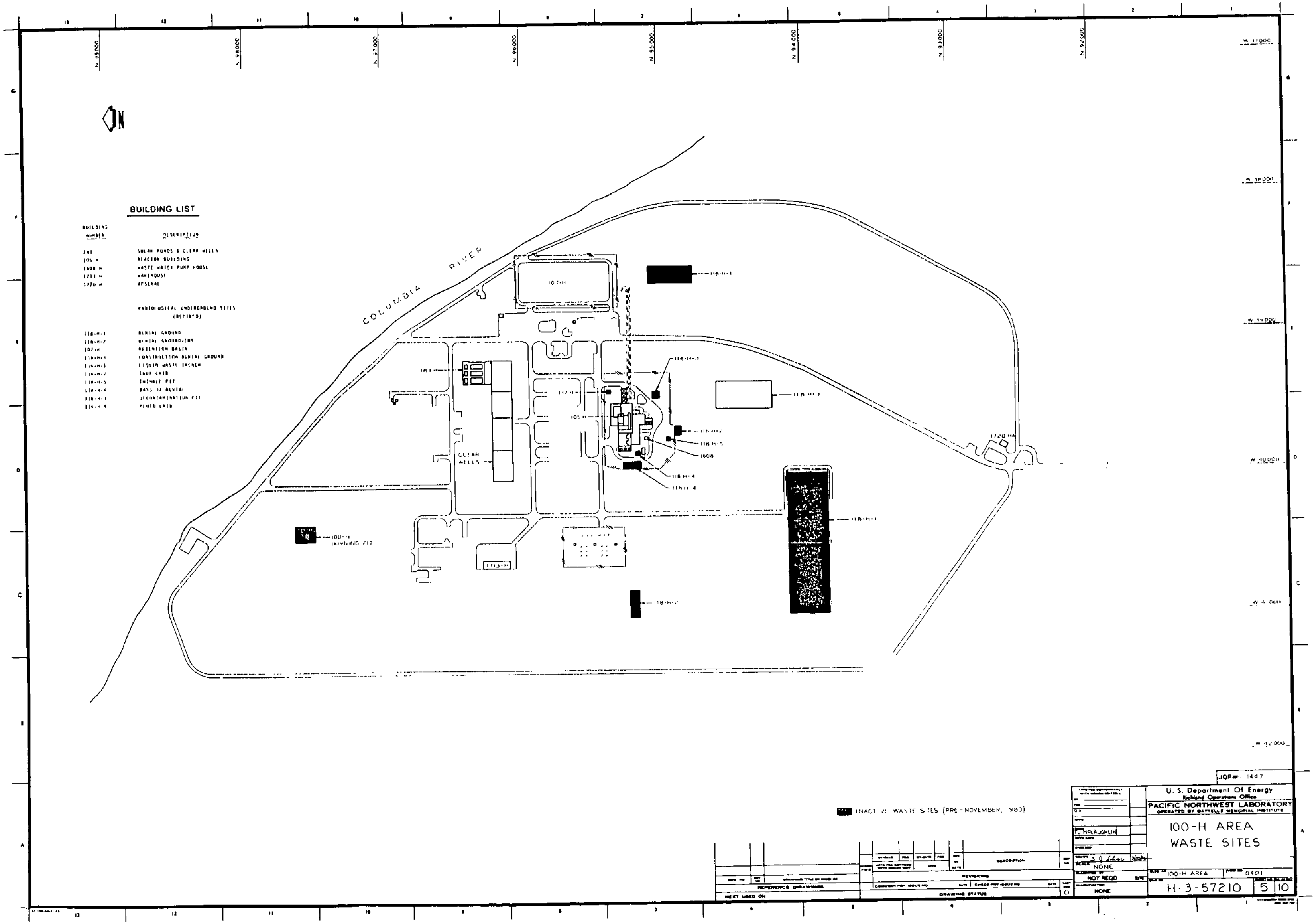


FIGURE B.5 100-K AREA WASTE SITES

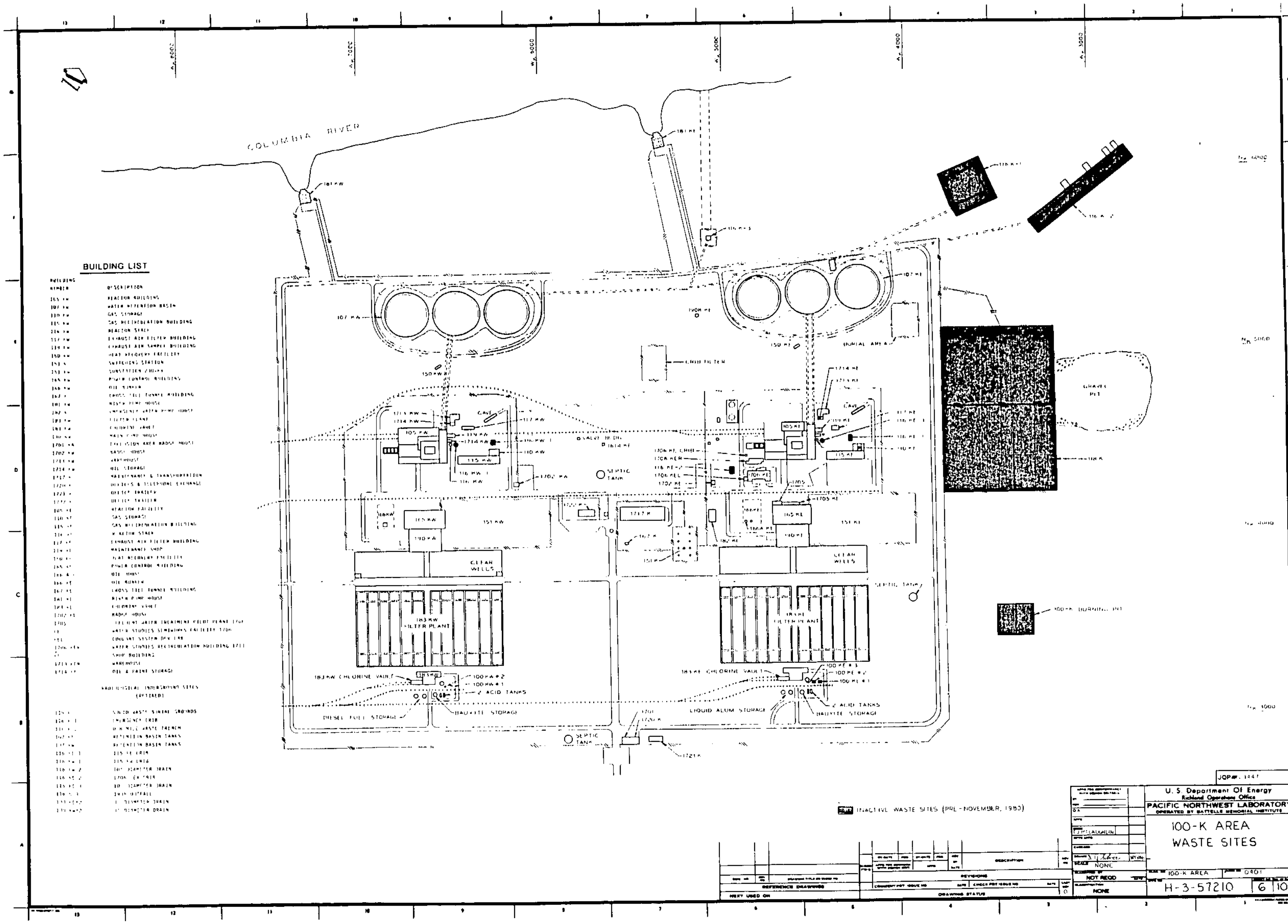


FIGURE B.6 100-N AREA WASTE SITES

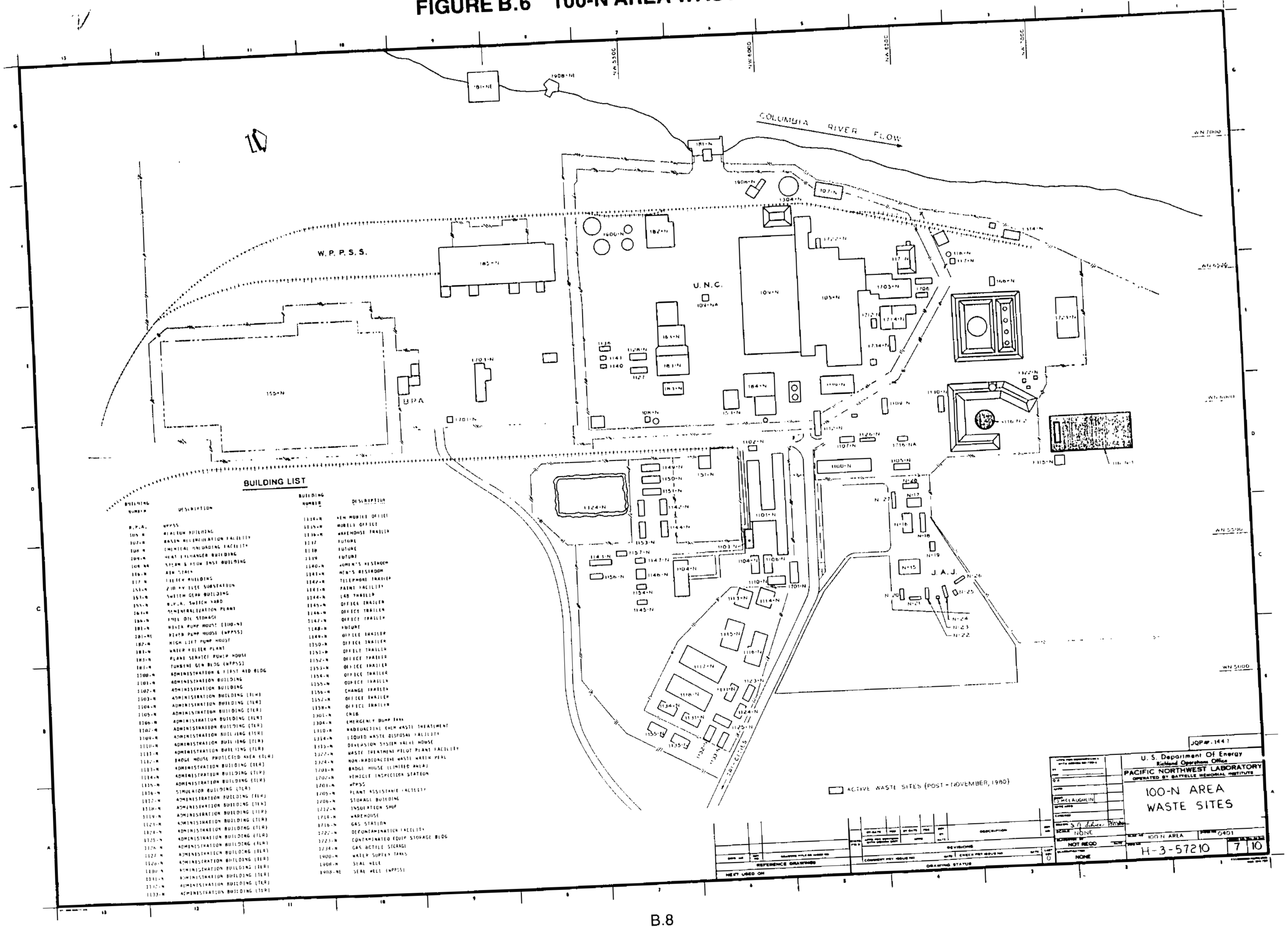


FIGURE B.7 200-EAST AREA WASTE SITES

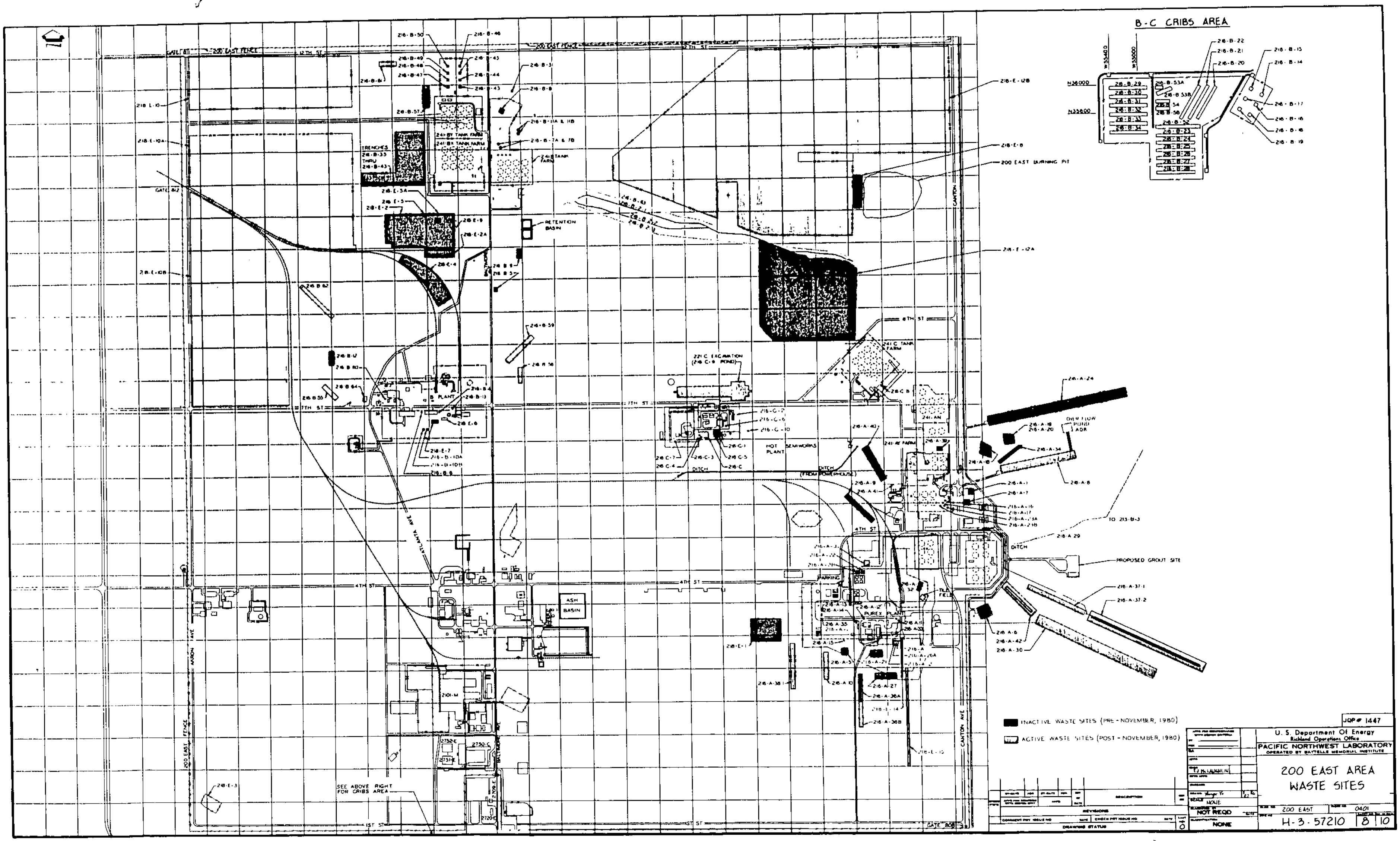


FIGURE B.8 200-WEST AREA WASTE SITES

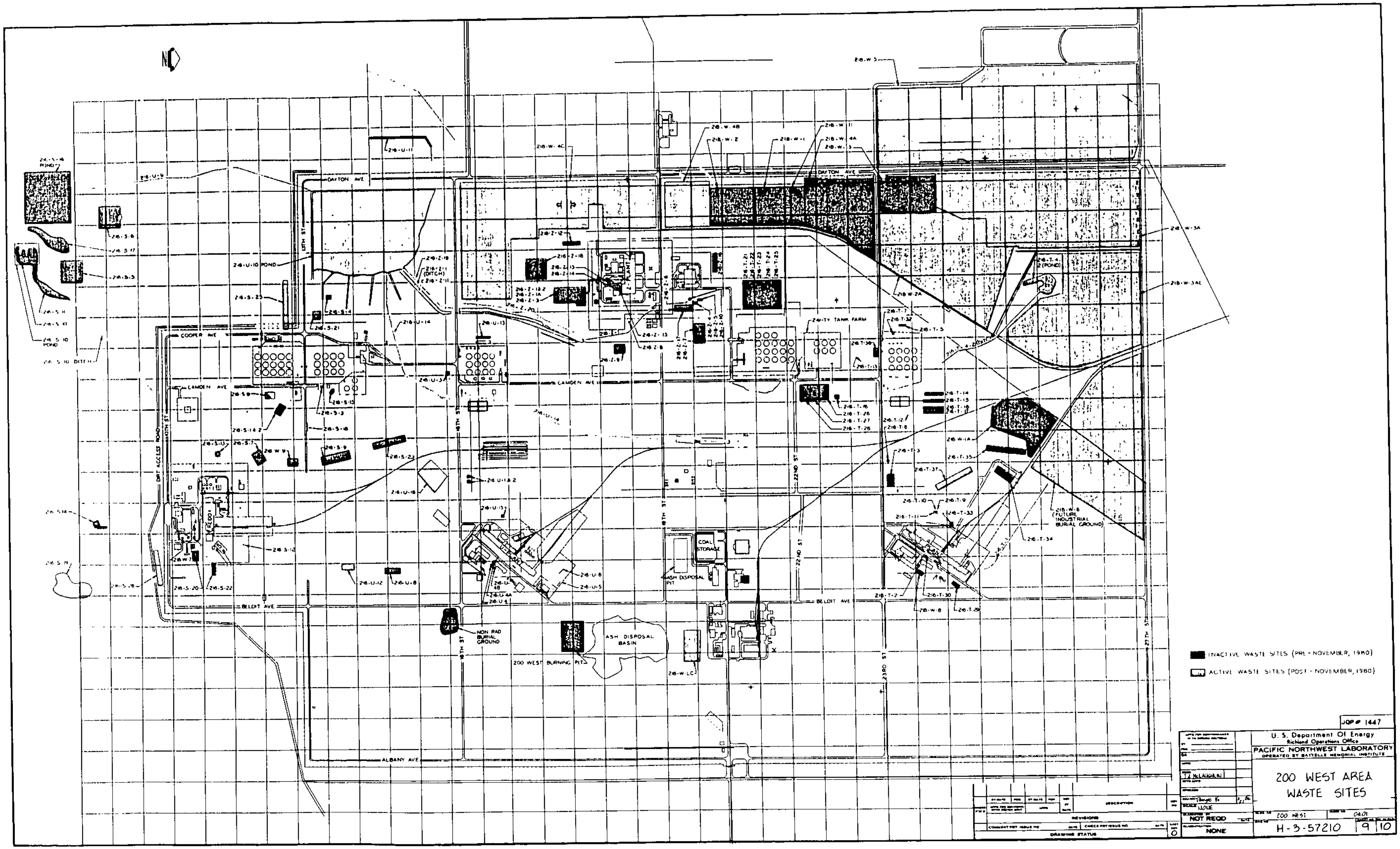


FIGURE B.9 300 AREA WASTE SITES

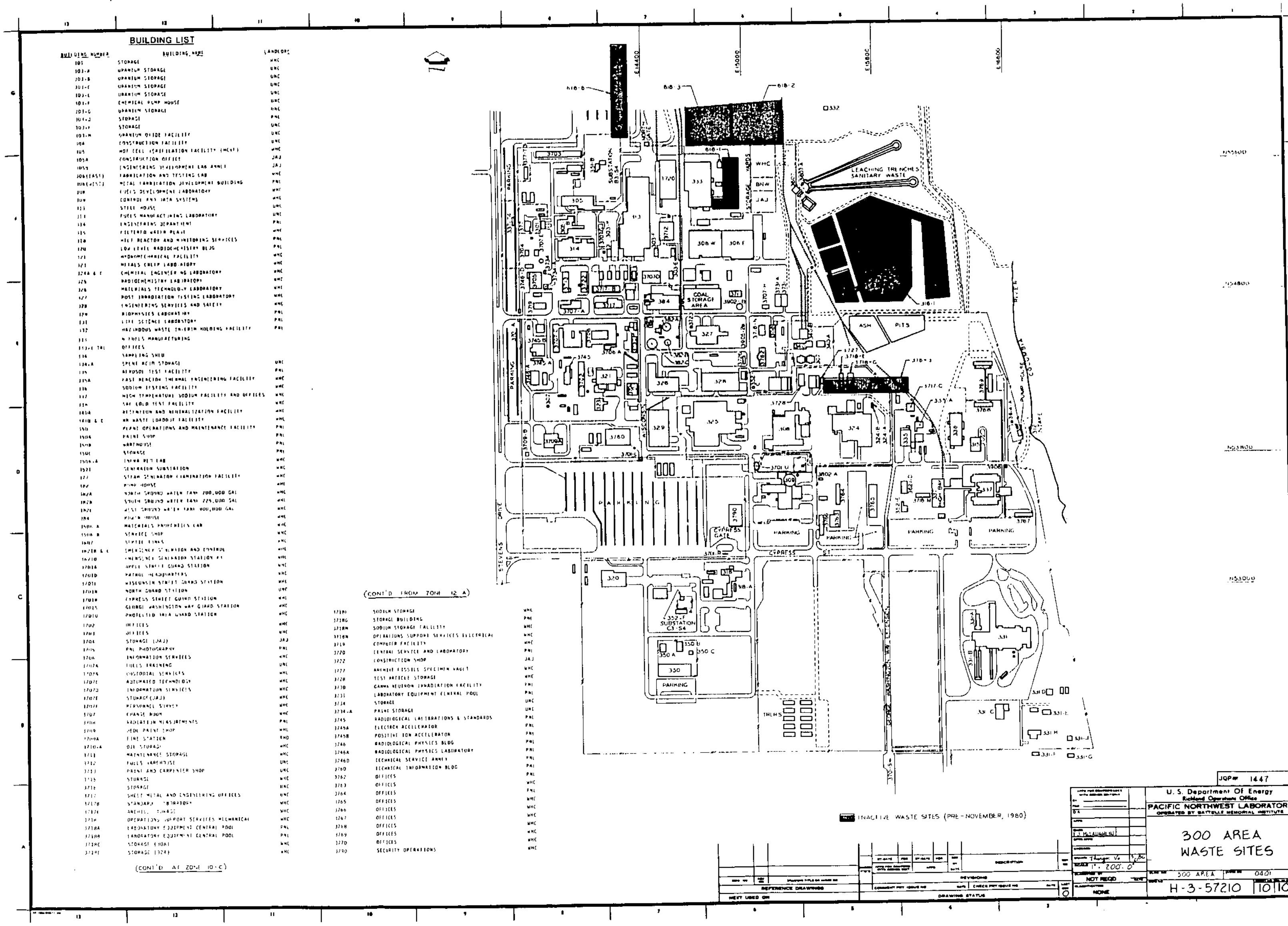
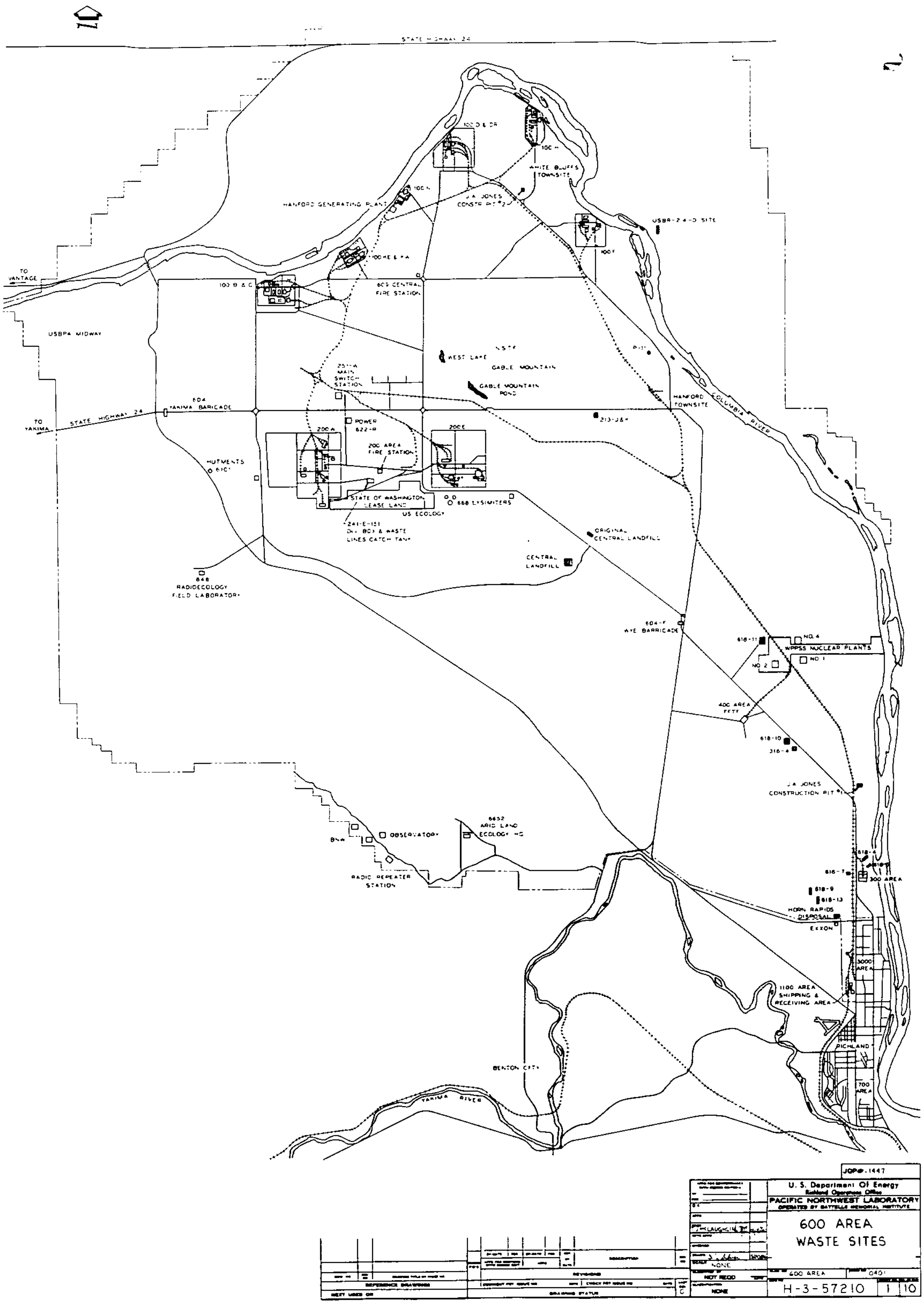
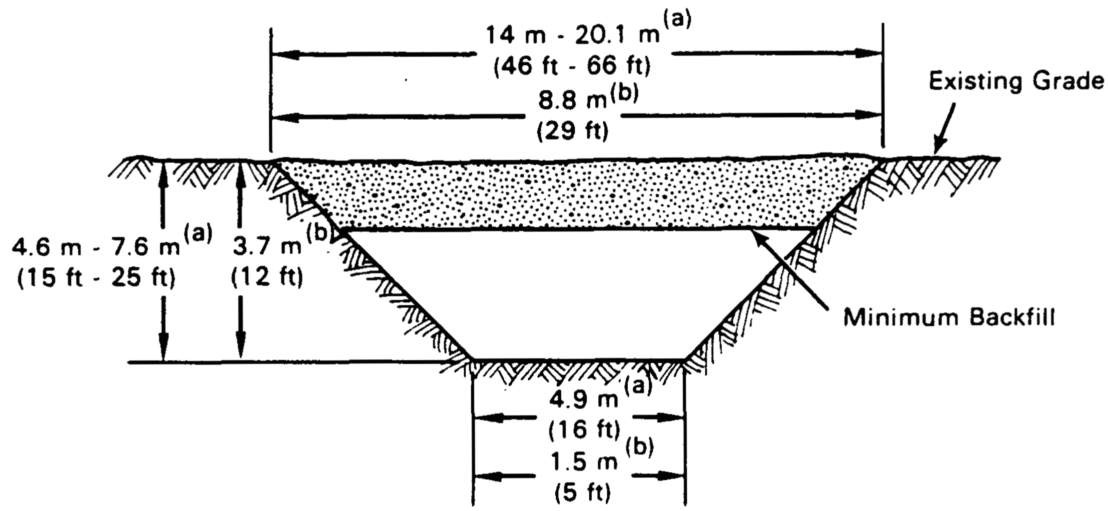


FIGURE B.10 600 AREA WASTE SITES





(a) Larger dimensions are for a trench for contaminated "industrial" solid waste (failed process equipment in large metal or concrete boxes).
(b) Smaller dimensions are for typical trench for "dry waste" (cardboard boxes, barrels, etc.)

FIGURE B.11. Typical Solid-Waste Disposal Trench

Trenches primarily contained pieces of failed equipment placed in concrete, wooden, or metal boxes. Dry waste consisted of contaminated rags, paper, filters, disposable supplies, soil, small pieces of equipment, and the like, and was generally packaged in 0.13-m^3 (4.5-ft^3) cardboard boxes before burial. Approximately 2.4 m (8 ft) of soil was then placed over the boxes.

The noncontaminated solid wastes were disposed of in three types of facilities: landfills, construction pits, and burning grounds. These unlined sites are all pits of various dimensions. The construction pits were used exclusively for concrete and wood scraps, paint cans, unusable tools, and plasterboard scraps. These wastes were generated from the various construction projects that have been undertaken throughout the history of Hanford operations. Similarly, landfills were used to dispose of office and laboratory wastes, glass, and electrical, metal, and chemical wastes. The burning grounds were used for the disposal of combustible materials, such as paper wastes, and a minimal amount of wood scraps.

FIGURE B.12. Surface View of Typical Solid-Waste Disposal Trench

B.2.2 Liquid-Waste Disposal Facilities

Contaminated liquid wastes have also been generated at the Hanford Site since 1944 (ERDA 1975). These wastes have been discharged to ponds, french drains, cribs, ditches, trenches, and reverse wells. The several different types of facilities and their functions are discussed below.

Cribs are soil-covered, liquid-waste disposal facilities, usually rock-filled and equipped with a liquid-dispersion system. Various designs have been used in the construction of cribs. A number of older timbered cribs were built like boxes, open only at the bottom and buried at depths great enough to preclude their causing radiation problems at the surface. The liquid waste was discharged into the ground inside the box, which was also equipped with a vent line. Some cribs were dual structures, with a second cavity catching any overflow from the first via an overflow pipe. Tile fields were also used in conjunction with box-like cribs to disperse the liquid wastes over a wider area (see Figure B.13 for an illustration of a box-like crib).

Several cribs were built by partly filling an excavation with sorted rock or gravel topped by an impermeable membrane or layer of asphalt. A distribution pipe was placed in the rock or gravel to provide uniform flow of the liquid over the crib bottom. The top of the crib was backfilled with soil to provide radiation protection and prevent dispersal of potentially contaminated soil just above the crib (see Figures B.14 and B.15 for illustrations of a typical crib).

French drains are covered or buried rock-filled encasements with the bottom end open to allow seepage of liquid into a gravel-filled excavation. French drains are very similar to cribs but their volume capacity is much

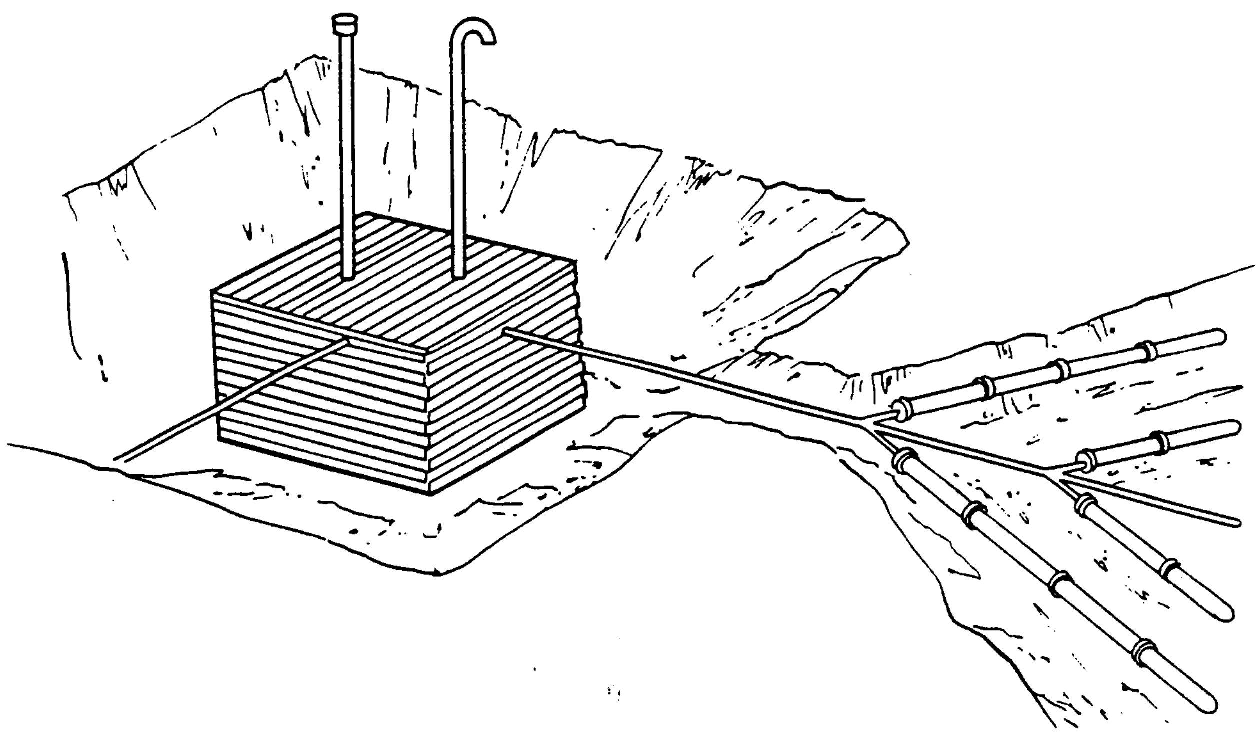


FIGURE B.13. Box-Like Cribs with Tile Field (ready for dirt backfill)

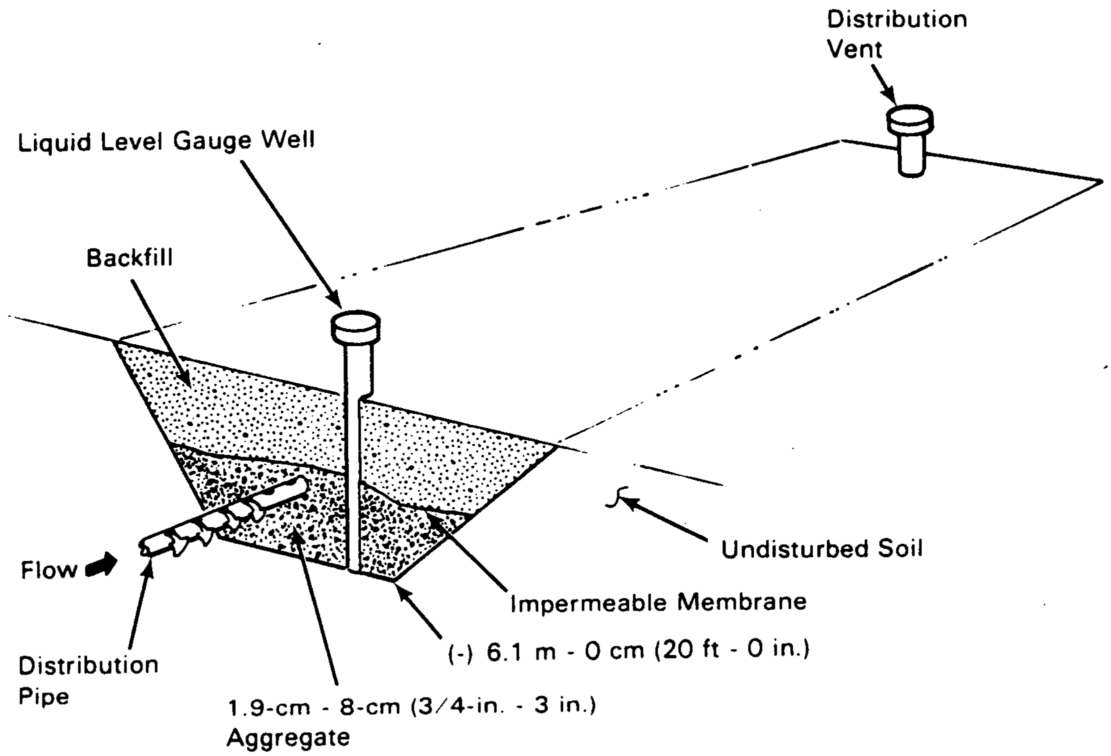


FIGURE B.14. Typical Crib

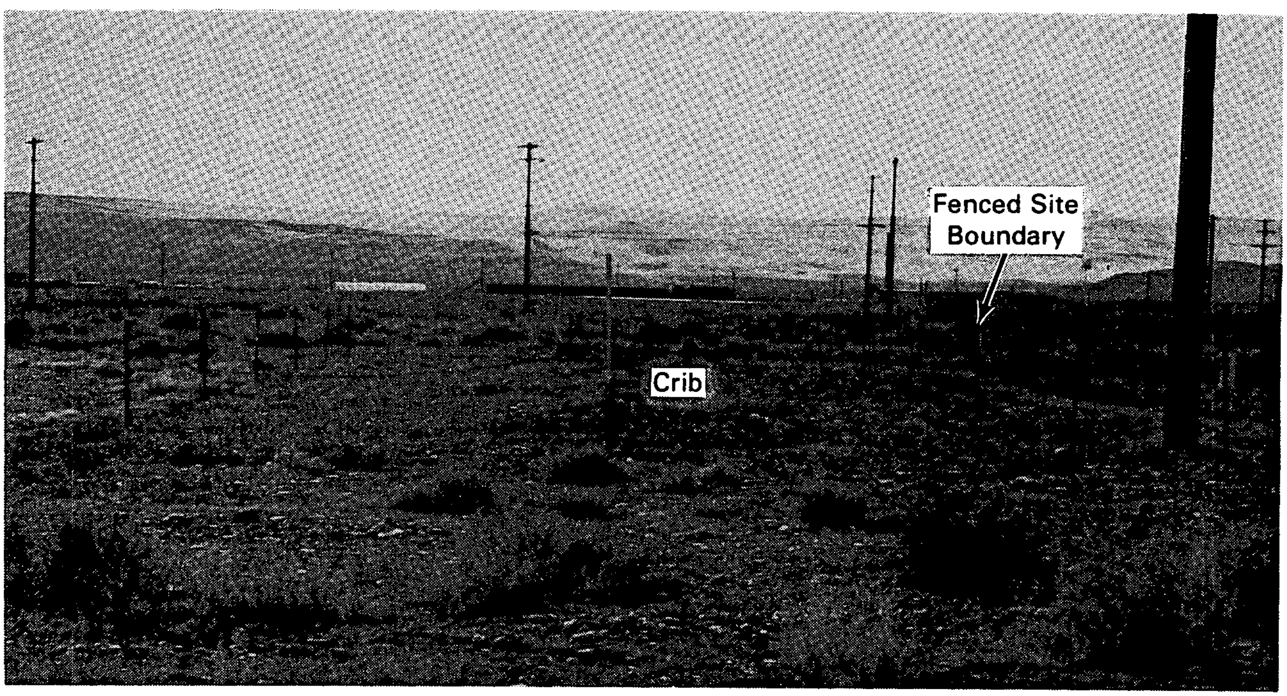


FIGURE B.15. Surface View of a Typical Crib smaller; they were used primarily for small volume waste streams (see Figures B.16 and B.17 for illustrations of a typical french drain).

Ponds are bodies of water enclosed in a natural or diked surface depression used for the disposal of high-volume, low-level liquid effluents. As the liquid soaked into the ground, many of the radionuclides were absorbed by the soil and were concentrated to the extent that subsequent drying of the pond muds could result in significant dispersal of activity by wind erosion. Therefore, the pond bottoms were covered with clean soil and stabilized after deactivation (Figures B.18 and B.19).

Ditches are long, narrow, unlined excavations in the ground used for conveying large volumes of liquid to a pond. Ditches have essentially the same levels of contamination as ponds and were also covered on deactivation.

Reverse wells are buried or covered, encased, drilled holes with the lower end of the pipe perforated or open to allow liquid to seep to the ground. Reverse wells were used to a limited extent early in Hanford Site history for some low-level wastes, but proved unsatisfactory because they plugged easily and introduced the waste into the ground close to the water table. See Figures B.20 and B.21 for interior and exterior (surface) views of a typical reverse well.

Liquid-waste trenches are long, narrow, unlined excavations used for disposal of low-level liquid wastes. The 100-Area trenches were usually used over long periods for disposal of reactor-coolant water containing fuel failure debris. The 200-Area trenches were generally used over short periods for disposal of limited quantities of liquid on a specific-retention basis. Both open and covered trenches were employed for disposal of liquid wastes (see Figure B.22).

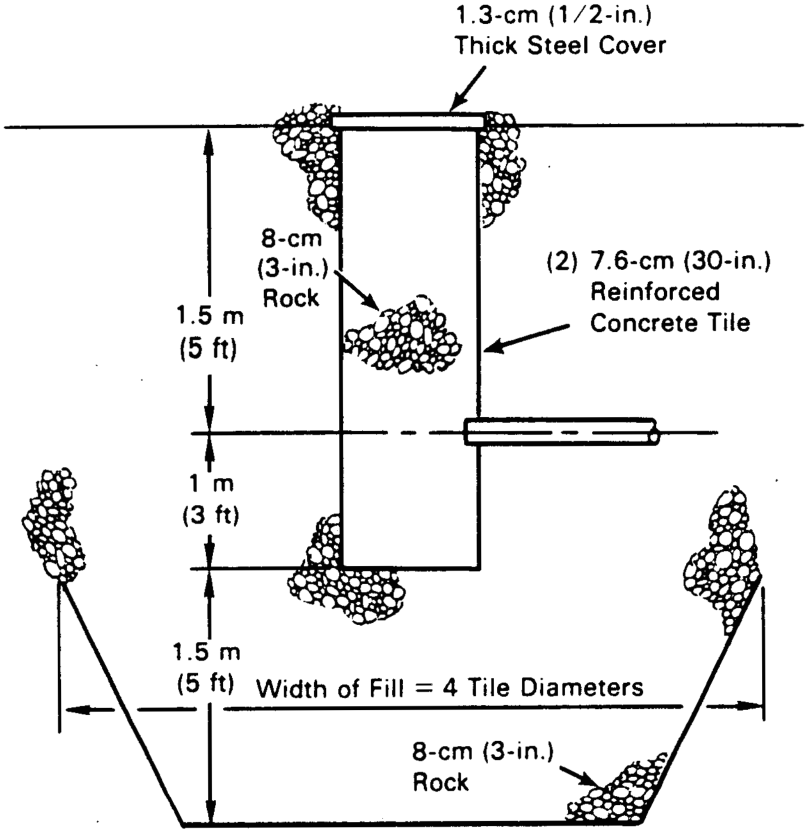


FIGURE B.16. Typical French Drain

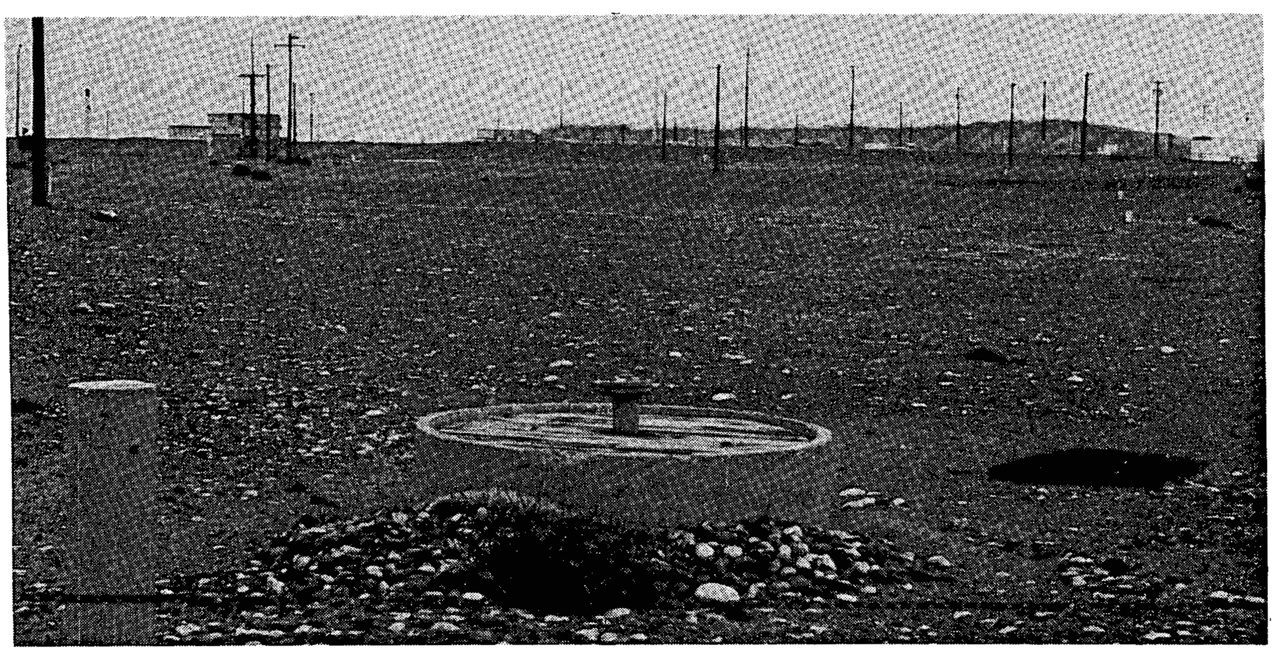


FIGURE B.17. Surface View of a Typical French Drain

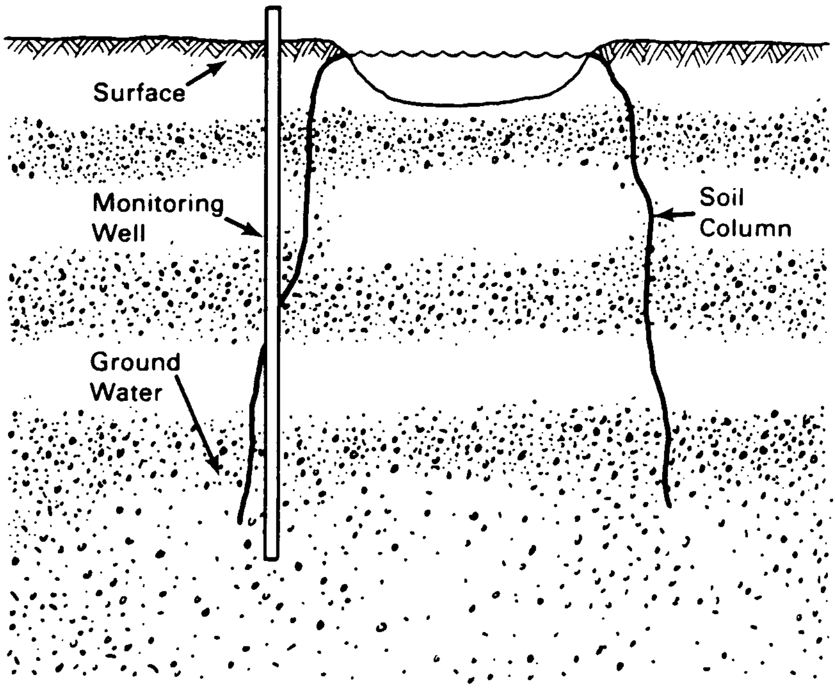


FIGURE B.18. Typical Pond

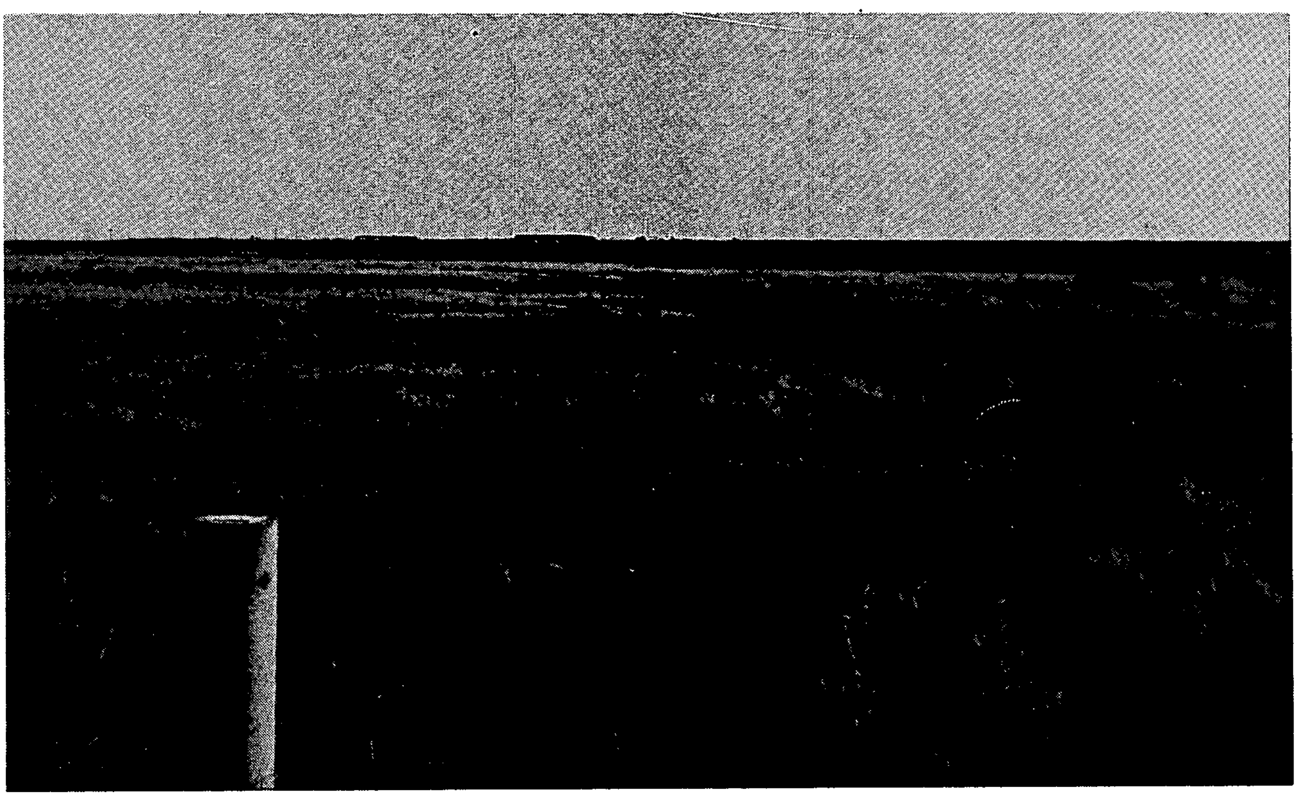


FIGURE B.19. Typical Back-Filled Pond

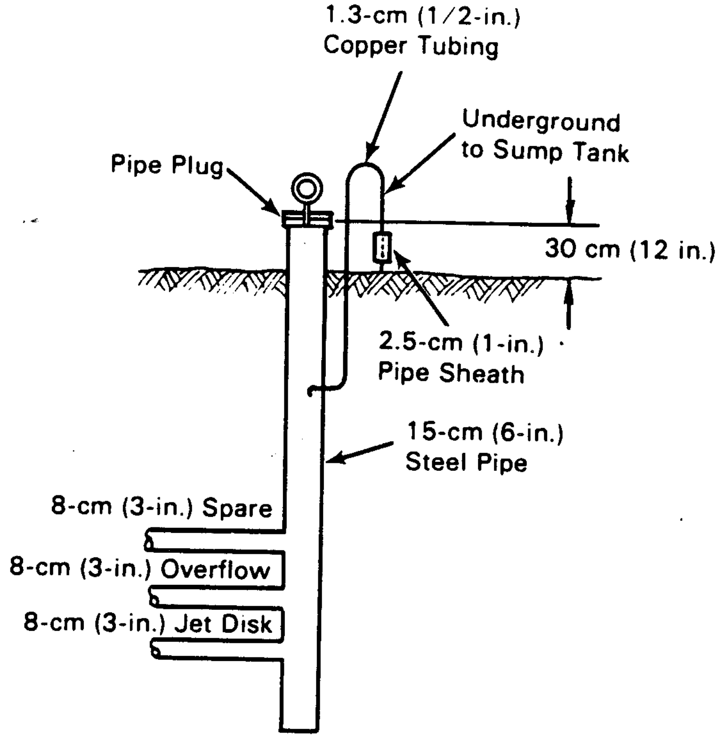


FIGURE B.20. Typical Reverse Well

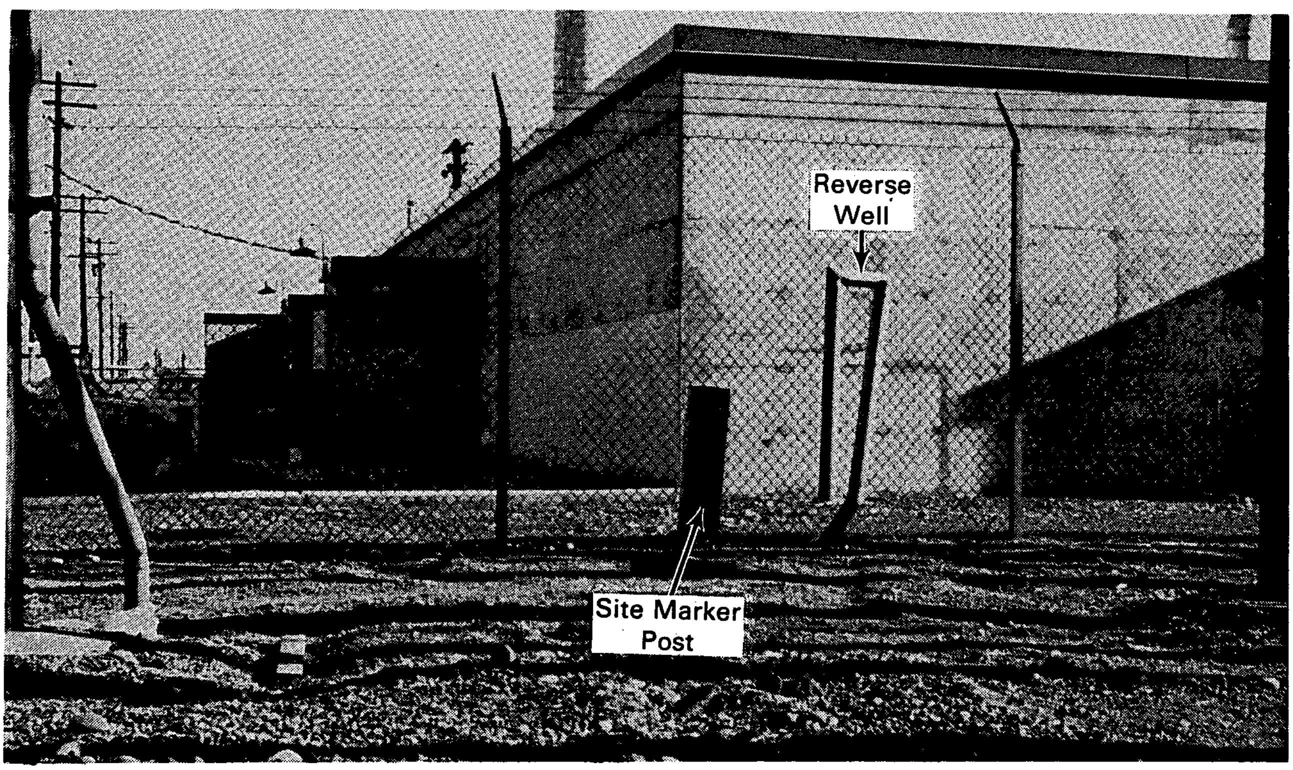


FIGURE B.21. Surface View of a Typical Reverse Well

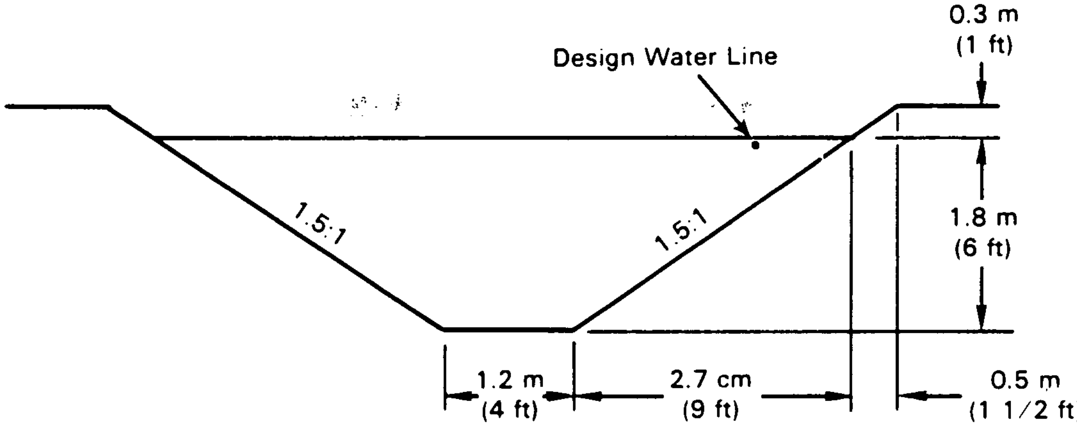


FIGURE B.22. Typical Liquid-Waste Trench

B.3 REFERENCES

U.S. Energy Research and Development Administration (ERDA). 1975. Final Environmental Statement Waste Management Operations, Hanford Reservation Richland, Washington, 2 Volumes. ERDA-1538, Washington, D.C.

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