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UNITED STATES DEPARTMENT OF ENERGY

ASSISTANT SECRETARY FOR
ENVIRONMENT, SAFETY AND HEALTH

PRELIMINARY
ENVIRONMENTAL SURVEY REPORT

FOR THE
HANFORD SITE

RICHLAND, WASHINGTON

JULY 1987

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Preface to
The Department of Energy
Hanford Site
Environmental Survey Preliminary Report

This report contains the preliminary findings based on the first phase of an Environmental Survey at the Department of Energy's (DOE) Hanford Site, located at Richland, Washington. The Survey is being conducted by DOE's Office of Environment, Safety and Health.

The Hanford Site Survey is a portion of the larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary of Energy John S. Herrington, to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no fault" baseline Survey of all the Department's major operating facilities, environmental problems, and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1988.

The findings in this report are subject to modification based on the results from the sampling and analysis phase of the Survey. The findings are also subject to modification based on comments from the Richland Operations Office concerning the technical accuracy of the findings. The modified preliminary findings and any other appropriate changes will be incorporated into an Interim Report. The Interim Report will serve as the site-specific source for environmental information generated by the Survey, and ultimately as the primary source of information for the DOE-wide prioritization of environmental problems in the final Survey Report.

August 1987
Washington, D.C.

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Executive Summary

Introduction

This report presents the preliminary findings from the first phase of the Environmental Survey of the United States Department of Energy (DOE) Hanford Site, conducted August 18 through September 5, 1986.

The Survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team components are being supplied by a private contractor. The objective of the Survey is to identify environmental problems and areas of environmental risk associated with the Hanford Site. The Survey covers all environmental media and all areas of environmental regulation. It is being performed [redacted] This phase of the Survey involves the review of existing site environmental data, observations of the operations carried on at the Hanford Site, and interviews with site personnel.

The Survey Team developed a Sampling and Analysis Plan to assist in further assessing certain of the environmental problems identified during its on-site activities. The Sampling and Analysis Plan will be executed by a DOE National Laboratory or a support contractor. When completed, the results will be incorporated into the Environmental Survey Interim Report for the Hanford Site. The Interim Report will reflect the final determinations of the Hanford Site Survey.

Site Description

The Hanford Site occupies a 570 square mile area which is located in the southeastern section of the State of Washington near the Tri-Cities (Richland, Pasco, and Kennewick). The facilities on the Hanford Site are currently operated by five principal operating contractors for DOE. The primary function of the Hanford Site is the production of plutonium for nuclear weapons for the national defense effort.

A wide variety of hazardous and radioactive wastes are generated by Hanford Site activities. The accumulated releases of the wastes into the environment over 44 years of past and current operations have resulted in contamination of soil, groundwater, surface water, and air. The site management has initiated a number of ongoing actions intended to address these conditions.

Summary of Findings

The major preliminary findings of the Environmental Survey at the Hanford Site are:

- Disposal methods of applying liquid effluents into and on top of the ground have had measurable impacts on the groundwater regime. These impacts consist of changes in the piezometric head in the unconfined aquifer and radioactive and chemical contamination in both the unconfined and upper confined aquifers.

- Numerous aqueous process waste streams, some containing hazardous, radioactive, and/or mixed waste, are discharged directly to land-based disposal units (e.g., cribs, ponds, dry wells, etc.) throughout the site. These wastewater streams have seeped through the soil and into groundwater in considerable quantities over an extended time.

- The groundwater beneath the Hanford Site has been degraded with tritium, nitrates, iodine-129, and other contaminants. The tritium plume covers a significant areal extent (i.e., 60 square miles) and if used for drinking purposes, the tritium concentration would exceed drinking water standards.

- The potential exists for contaminants in the confined aquifer to reach residential and industrial pumping wells across the Columbia River.

- All inactive waste sites on the Hanford Site have been identified. Spills, unplanned releases, and sites closed since November 1980 were not included in the Phase I (CERCLA) study. In addition, all solid and dry waste sites have been categorically dismissed from further study.

- Potential health risks from toxic chemicals released to the air cannot be reliably assessed because emissions from the Z-Plant and other facilities of carbon tetrachloride, tributyl phosphate, and nitrogen oxides have not been adequately quantified.

Overall Conclusions

The Survey found no environmental problems at the Hanford Site that represent an immediate threat to human life. The environmental problems identified at the Hanford Site by the Survey do confirm that the site is affected by a number of substantial and chronic environmental concerns. These problems vary in terms of their magnitude and risk, as described in this report. Although the sampling and analysis performed by the Hanford Site Survey will assist in further identifying environmental problems at the site, a complete understanding of the significance of some of the environmental problems identified requires a level of study and characterization that is beyond the scope of the Survey. Response actions currently under way or planned at the site will contribute toward meeting this requirement.

Transmittal of Results

The findings of the Environmental Survey of the Hanford Site were shared with the DOE Richland Operations Office, and the site contractors, at the Survey close-out briefing held September 5, 1986. By letter of January 29, 1987, the Operations Office directed the site contractor to develop an action plan to address the Category IV findings. Those problems that involve extended studies and multi-year budget commitments will be the subject of the Environmental Survey Summary Report and the DOE-wide prioritization.

Within the Office of Environment, Safety and Health, the Office of Environmental Guidance and Compliance has immediate responsibility for monitoring environmental compliance and the status of the Hanford Site Survey findings. The Office of Environmental Audit will continue to assess the environmental problems through the program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1988.

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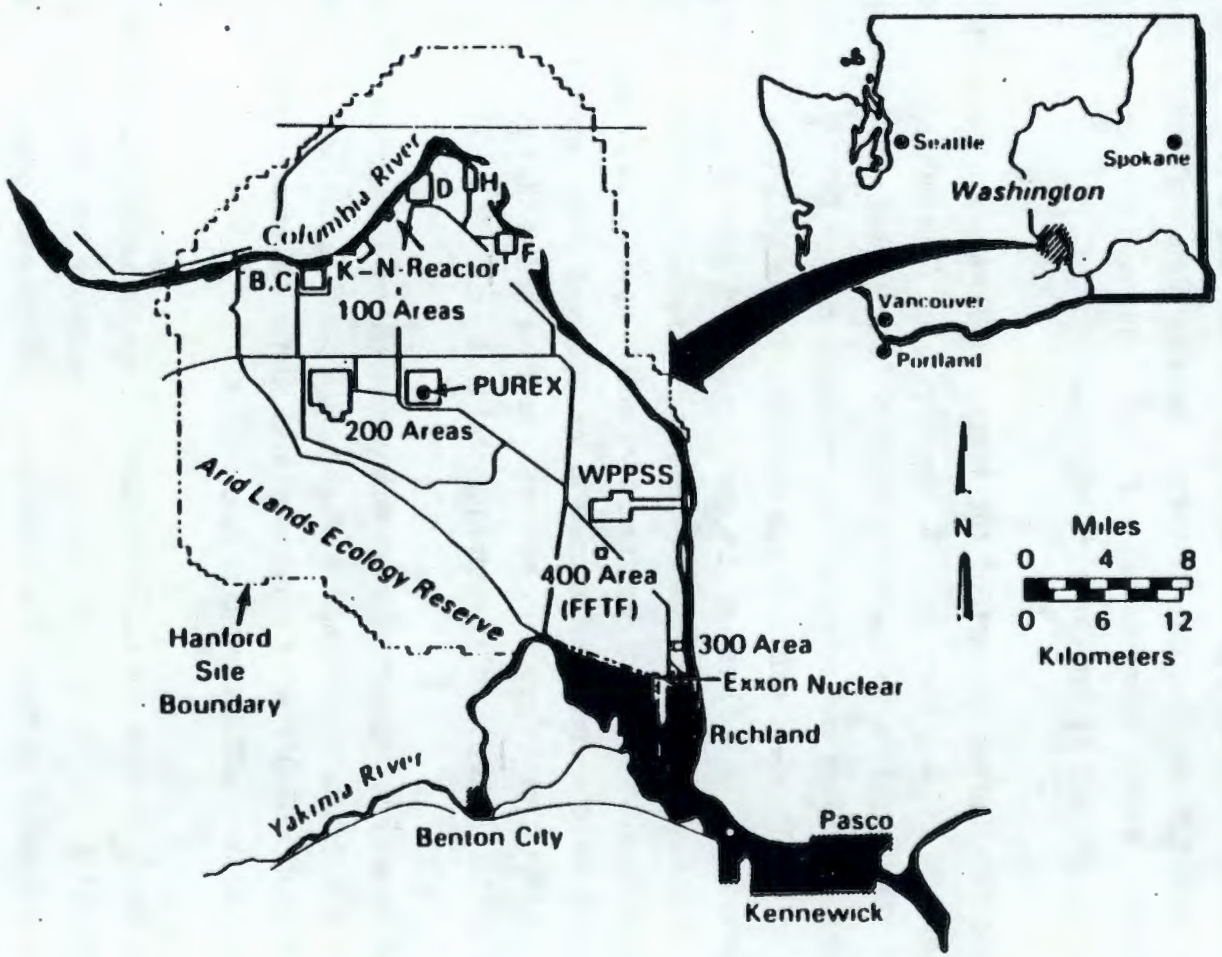
1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings and observations made during the Environmental Survey, August 18 through September 5, 1986, at the Department of Energy's (DOE) Hanford Site, located near Richland, Washington (Figure 1-1). The Hanford Site is operated for DOE by several major contractors, including Rockwell Hanford Operations, United Nuclear Corporation (UNC) Nuclear Industries, Westinghouse Hanford Company, Battelle Memorial Institute, Hanford Environmental Health Foundation, J. A. Jones Construction, Kaiser Engineers/Hanford, and Boeing Computer Services.

The Hanford Site Survey is part of the larger DOE-wide Environmental Survey effort announced by Secretary John S. Herrington on September 18, 1985. The purpose of this effort is to identify, via "no fault" baseline Surveys, existing environmental problems and areas of environmental risk at DOE facilities, and to rank them on a DOE-wide basis. This ranking will enable DOE to more effectively establish priorities for addressing environmental problems and to allocate the resources necessary to correct these problems. Because the Survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance, or to analyze environmental management practices. Such incidents and/or management practices will, however, be used in the Survey as a means of identifying existing and potential environmental problems.

The Hanford Site Environmental Survey was conducted by a multi-disciplinary team of technical specialists headed and managed by a team leader and assistant team leader from the DOE Office of Environmental Audit. A complete list of Survey participants and their affiliations is in Appendix A.

The Survey Team focused on all environmental media using Federal, State, and local environmental statutes and regulations, accepted industry practices, and professional judgment to make the preliminary findings and observations included in this report. The team carried out its activities in accordance with the guidance and protocols in the DOE Environmental Survey Manual. Substantial use of existing information, and interviews with knowledgeable field office and site-contractor personnel accounted for a large part of the on-site effort. A summary of the site-specific Survey activities is presented in Appendix B.



Source: PNL, 1986

DOE'S HANFORD RESERVATION SITE

FIGURE 1 - 1

The preliminary Survey findings and observations, in the form of existing and potential environmental problems, are presented in Chapters 3 and 4. Chapter 3 includes those findings and observations that pertain to a specific environmental medium (e.g., air or soil) while Chapter 4 includes those that are non-media-specific (e.g., hazardous waste management, direct radiation, and quality assurance). Because the findings and observations are highly varied in terms of magnitude, risk, and characterization, and consequently require different levels of management attention and response, they are further subdivided into four categories within each of the sections in Chapters 3 and 4.

The criteria for placing a finding into one or more of the four categories are as follows:

- Category I findings are those environmental problems where the risk is highest, the confidence in the findings based on the information is the strongest, and the appropriate response to the finding is the most restrictive in terms of alternatives. Therefore, Category I findings include only those findings which, based upon the information available to the Team Leader, involve an immediate threat to human life. In these situations, response or remedial action by the Operations Office to rectify the situation must be taken immediately.

- Category II findings are those environmental problems where the risk is high but where the definition of risk is broader than in Category I. The information available to the Team Leader is adequate to identify the problem but may be insufficient to fully characterize it. In this category, more discretion is available to the Operations Office in terms of an appropriate response; however, the need for that response is such that management should not wait for the completion of the entire DOE-wide Survey to respond. Therefore, unlike Category I findings, a sufficient near-term response by the Operations Office may include further characterization prior to taking action to rectify the situation. Situations that constitute Category II findings include:

- Multiple or continuing exceedances, past or present, of a health-based environmental standard where there is immediate potential for human exposure, or a one-time exceedance where residual impacts pose an immediate potential for human exposure.

- The evidence indicates that a health-based environmental standard may be exceeded, as discussed in the above criteria, within the timeframe of the DOE-wide Survey.

- Evidence that there is great likelihood for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other environmental management practices.

- Noncompliance with significant regulatory procedures (i.e., those substantive technical regulatory procedures designed to directly or indirectly minimize or prevent risks) such as inadequate monitoring or failure to obtain required permits).

o Category III findings are those environmental problems with the broadest definition of risk. As in Category II, the information available to the Team Leader may not be sufficient to fully characterize the problem. Under this category, the range of alternatives available for response and the corresponding timeframes for response are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, and multiyear budget commitments. These problems will be included in the DOE-wide prioritization to ensure that DOE's resources are used effectively. Situations that constitute Category III findings include:

- The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.

- The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

- In general, the levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, State, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the presence of some nonregulated material is in a concentration that presents sufficient concern for local populations or the environment to be included as an environmental problem. Likewise, the presence of regulated materials, in concentrations below those established by regulatory authorities, that present a potential for hazard or concern may be classified as an environmental problem.

  Conditions that pose or may pose a hazard are generally those which are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazard to human health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem. The definition of the term "environmental problem" is broad and flexible to allow for the wide variability among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

- Category IV findings do not necessarily involve environmental risk; rather they include instances of administrative noncompliance and management practices that relate to, but are not as significant as, Category I - III findings. Such findings can be based upon any level of information available to the Team Leader including direct observations by the team members. Findings in this category lend themselves to relatively simple, straightforward resolutions without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization, will be passed along to the Operations Office for appropriate action.

Based on the professional judgment of the Team Leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report is only the first step in a multistep iterative process to prioritize DOE's problems.

The next phase of the Hanford Site Survey is sampling and analysis. Idaho National Engineering Laboratory (INEL), the sampling and analysis team for the Hanford Site, will be taking samples over a 6 to 10 week period beginning in April 1987. Prior to sampling, a sampling and analysis plan will be prepared by DOE and INEL in accordance with the protocols in the DOE Environmental Survey Manual (1986). The sampling and analysis plan will be designed to fill existing data gaps or weaknesses. The results generated by the sampling and analysis will be used to assist the Survey Team in further defining the existence and extent of potential environmental problems identified during the Survey.

An Interim Report will be prepared 8 to 12 weeks after the completion of the sampling and analysis. The Interim Report incorporates the results of the sampling and analysis as well as any changes or comments resulting from the review of the Preliminary Report. Based on the results of sampling and analysis, the preliminary findings and observations made during the on-site Survey may be modified, deleted, or moved within or between categories. The Interim Report will serve as the site-specific source for information generated by the Survey and ultimately as the site-specific source of information for the DOE-wide prioritization of environmental problems in the Survey Summary Report.

It is clear that certain of the findings and observations contained in this report, especially those in Category II, can and should be addressed in the near term (i.e., prior to the DOE-wide prioritization). It is also clear that the findings and observations in this report are highly varied in terms of magnitude, risks, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses require careful planning to ensure appropriate and effective action. The information in this Survey Preliminary Report will assist the Richland Operations Office in the planning of these near-term responses.

2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Hanford Site is located in the southeastern section of the State of Washington, with the facility boundaries encompassing a 570-square-mile area. The Hanford Site exists in a semiarid environment due to its geographical location in the rainshadow of the Cascade Mountains. The Columbia River bisects the northern end of the site and forms the eastern border as shown in Figure 1-1. Much of the Hanford Site particularly along the river, has a very low topographic relief and various species of sagebrush sparsely cover the dry sandy soils. Near the center of the site, a gentle rise in elevation occurs and forms a plateau approximately 7 miles from the river. Two distinctive outcroppings, Gable Mountain and Gable Butte, also exist on the facility with an east-west orientation.

The Hanford Site is situated in the Tri-Cities (Richland, Pasco, Kennewick) area of Washington State, from which it draws upon about 12,000 people for employment related to U.S. Department of Energy (DOE) activities. Richland, with a population of about 34,000, is the closest city and is 3 miles south of the southernmost site boundary. The estimated 1980 population within a 50-mile radius of the Hanford Site was approximately 341,000 with a projected increase of about 75,000 by 1990. Table 2-1 presents the distribution of the population around the Hanford Site in this 50 mile radius. Spokane, located approximately 125 miles northeast of the Hanford Site, is the nearest large metropolitan center.

Land surrounding the Hanford Site is largely used for agricultural purposes, including both dryland and irrigated crops, and for livestock grazing. Several industrial facilities also exist in the region and vary from food-processing plants to pulp and paper mill support facilities. Access to the region is provided by numerous means including major highways, rail, the Columbia River, and two airports suitable for small commercial jet aircraft.

In general, Hanford's climate is characterized by relatively cool, mild winters and long, warm summers. January is the coldest month with an average minimum temperature of 22°F, and July is the warmest month with an average maximum temperature of 92°F. The average precipitation at Hanford is 6.3 inches, about 40

TABLE 2-1

POPULATION DISTRIBUTION AROUND THE HANFORD SITE

Compass Direction	Number of People					
	0-16 km	16-32 km	32-48 km	48-64 km	64-80 km	Totals
NORTH	0	174	1,124	772	1,957	4,027
NNE	0	92	656	5,547	14,822	21,117
NE	0	262	5,930	2,963	596	9,751
ENE	0	235	773	2,366	435	3,809
EAST	0	340	1,329	1,659	588	3,916
ESE	0	283	1,374	230	652	2,539
SE	0	6,757	48,661	50,519	3,474	109,411
SSE	0	1,997	13,161	2,717	5,218	23,093
SOUTH	0	1,532	1,489	195	1,799	5,015
SSW	0	905	5,283	652	129	6,969
SW	0	1,190	19,786	2,182	459	23,617
WSW	5	1,840	5,063	15,088	4,573	26,569
WEST	32	648	949	6,874	78,635	87,138
WNW	73	444	802	833	2,833	4,985
NW	0	555	398	493	1,454	2,900
NNW	0	246	456	864	4,521	6,087
TOTALS	110	17,500	107,234	93,954	122,145	340,943

(a) Distribution of Population in 80-km (50 mile) Radius of 200 Area Hanford Meteorological Tower by Population Grid Sector.
(b) Based on 1980 Census Data.
(c) Source: Price, 1986

percent of which occurs between November and January. The prevailing regional winds are from the northwest, yet, as is typical of a desert area, strong inversions can occur during the night or at daybreak, which results in unstable conditions.

2.2 Overview of Major Site Operations

The Hanford Site was originally established in 1943 to produce plutonium for nuclear weapons. At one time, nine production reactors were in operation, including eight with once-through cooling. Between December 1964 and January 1971, all eight reactors with once-through cooling were deactivated. N-Reactor, the remaining production reactor, has a closed primary cooling loop. Steam from N-Reactor operation is used to drive turbine generators that produce up to 860 million watts of electrical power in the Washington Public Power Supply System's (WPPSS) Hanford Generating Plant.

Many of the remaining areas of the Hanford Site have been built around support of plutonium production. These support facilities include fuel fabrication, plutonium extraction and fabrication, and uranium recovery. Also included in the support activities are numerous laboratories and extensive areas for the management and storage of radioactive wastes.

Privately-owned facilities located within the Hanford Site boundaries include the WPPSS generating station adjacent to N-Reactor, the WPPSS power reactors and office buildings, and a low-level radioactive-waste burial site operated by U.S. Ecology.

The five principal DOE operating contractors at the Hanford Site during 1986 were:

1. Rockwell Hanford Operations (Rockwell)—responsible for fuel reprocessing, waste management, and site support services such as plant security, fire protection, central stores, and electrical power distribution

2. Battelle Memorial Institute—responsible for operating Pacific Northwest Laboratory (PNL) for the DOE. This includes research and development in the physical, life, and environmental sciences, chemistry, and advanced methods of radioactive waste management. PNL also conducts the major portion of the environmental monitoring program at the Hanford Site

3. UNC Nuclear Industries (UNC)—responsible for fabricating N-Reactor fuel, operating the N-Reactor, and decommissioning formerly used DOE facilities, including deactivated production reactors

4. Westinghouse Hanford Company (WHC)—responsible for operating the Hanford Engineering Development Laboratory (HEDL), including advanced reactor development and the Fast Flux Test Facility (FFTF) test reactor

5. Hanford Environmental Health Foundation (HEHF)—responsible for occupational medicine and environmental health support services

The major operating areas of the Hanford Site and the types of operations are briefly described in the following section.

100-Area

The 100-Area is approximately 45 kilometers north-northwest of Richland. Nine plutonium producing reactors (i.e., 105-B & C, 105-KW & KE, 105-N, 105-D & DR, 105-H, and 105-F) are contained in the 100-Area. Only one reactor, N-Reactor (105-N), remains in operation. The main operating facilities in the 100-Area include the N-Reactor and the 1706-Laboratory.

N-Reactor. The N-Reactor is a graphite-moderated, light-water-cooled, pressurized reactor with a rated capacity of 4000 megawatts-thermal. The reactor is used for plutonium production and electric power generation. The fuel is cooled by the recirculating primary coolant system, which transports heat to the steam generators located in an adjacent building. The heat is removed from the primary coolant system by boiling secondary system water in the steam generators. This steam is sold to WPPSS Hanford Generating Project for the production of electricity.

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The N-Reactor is housed in the 105-N Building, and the reactor complex includes several adjacent buildings which provide support operations. The 109-N Building contains the heat exchangers/steam generators. The 181-N River Pump House provides the primary process water source for the N-Reactor. Filtered and demineralized water is produced at the 183-N and 163-N Buildings, respectively. The 184-N Building contains the power house and boilers for plant electrical needs.

1706-Laboratory. The 1706-Laboratory is located in the 100K-Area and conducts studies of water quality, filtration, and corrosion in support of N-Reactor operations. Small-scale decontamination studies are also performed at the laboratory.

200-Area

The 200-Area is divided into the 200-East Area and the 200-West Area. The 200-East Area is located in the center of the Hanford Site, approximately 15 kilometers from the east and west site boundaries and 35 kilometers north-northwest of Richland. Activities conducted in this area include irradiated fuel processing, waste management and storage, and laboratory research. The 200-West Area activities include waste treatment and storage, equipment decontamination, plutonium and uranium processing, and laboratory research.

200-East. The Plutonium-Uranium Extraction (PUREX) Plant, located in the 200-East Area, is the fuel reprocessing and plutonium separation facility at the Hanford Site. The PUREX Plant recovers uranium, plutonium, and neptunium from irradiated uranium fuels. The uranium solution is transferred to the UO_3 Plant for processing to fuel. Plutonium is transported to the Z-Plant for plutonium finishing operations. Neptunium is packaged for shipment off the site.

The B-Plant was originally constructed for plutonium recovery using the Bismuth-Phosphate process. It is currently being used for cesium and strontium recovery from wastes.

The Semiworks or C-Plant was initially used for demonstration of the Reduction-Oxidation (REDOX) and PUREX processes. The Semiworks is inactive and undergoing decontamination and decommissioning.

The Critical Mass Laboratory is used for research on the criticality safety of plutonium in its various forms and combinations with other elements. There are several radioactive waste management facilities (i.e., burial grounds, cribs and storage tanks) in the 200-East Area.

200-West. Major facilities in the 200-West Area include the Uranium Trioxide (UO_3) Plant, the Z-Plant or Plutonium Finishing Plant (PFP), the REDOX Plant, and the T-Plant. Uranyl nitrate hexahydrate (UNH) solution is converted to uranium trioxide at the UO_3 Plant (also called the U-Plant).

The Z-Plant is used to finish the processing of plutonium separated during the PUREX process. The Z-Plant also presently reclaims plutonium from scrap and liquids.

The Reduction-Oxidation (REDOX) Plant currently houses Laboratories 222S and 219S, which conduct studies in support of B-Plant operations and waste management processes. It was originally designed to perform fuel separation through the Reduction-Oxidation process.

The T-Plant was one of the original Bismuth-Phosphate plants built at Hanford. It is no longer in use for that purpose, but functions as a plutonium storage and decontamination facility.

Radioactive waste management facilities, including storage tanks, cribs, and burial grounds are located in various portions of the 200-West Area.

300-Area

The 300-Area, in the southeast corner of the site, is the location of most of the laboratory and research facilities at Hanford. This area is 8 kilometers north of Richland and adjacent to the eastern site boundary. The major facilities are the Hanford Engineering Development Laboratory (HEDL), the Fuel Fabrication Facility, and the Life Sciences Laboratory.

HEDL. The HEDL consists of numerous laboratories, testing and fabrication facilities, and storage areas utilized in support of the Liquid Metal Fast Breeder Reactor (LMFBR) program at the Hanford Site. These facilities are operated by WHC for the DOE.

Life Sciences Laboratory. The Life Sciences Laboratory is operated by PNL; current programs include biophysical and biomedical research. Studies on the inhalation of plutonium, which were formerly conducted in the 100-Areas, were transferred to this facility in 1975. In addition, PNL operates two laboratories that conduct research in advanced waste management techniques and metallurgical techniques. These laboratories are the Metal Fabrication Laboratory and the 3720 Laboratory.

Fuel Fabrication Facility. The Fuel Fabrication Facility is operated by UNC. Zirconium clad uranium is cleaned and extruded into fuel elements. These elements are cut to the appropriate length, end caps are welded in place, and further inspection and cleaning are performed prior to the finished fuel element being shipped to N-Reactor.

400-Area

The 400-Area is the newest of the operational areas to be developed at the Hanford Site. The area is approximately 9 kilometers northwest of the 300-Area and 5 kilometers from the southern and eastern site boundary. At present, the FFTF is in operation in the 400-Area and the Fuel Materials Examination Facility (FMEF) is under construction in the 400-Area. When both of these facilities are in operation, the 400-Area will be the center for the Liquid Metal Fast Breeder Reactor development program at Hanford Site.

600-Area

The 600-Area includes all areas of the Hanford Site not covered specifically by other designations (such as the 100-Area, 200-Area, etc.). This area includes the Arid Land Ecology Headquarters, Central Landfill, and Basalt Waste Isolation Project (BWIP).

700-Area

The 700-Area is located in downtown Richland and is not actually a part of the Hanford Site. This area includes the Federal building, which houses offices for the DOE Richland Operations Office staff; motor pool dispatch; records center; bioassay laboratory; whole-body counter; and the radiosurgery building.

1100-Area

The 1100-Area is located just outside the City of Richland in the southern corner of the site. The shipping and receiving area is located there, as well as the vehicle maintenance shop and wash station.

3000-Area

The 3000-Area is located directly north of and adjacent to the 1100-Area. This area includes the Rockwell Radio Maintenance Shop, service station, automotive shops, warehouse facilities, and office trailers.

2.3 State/Federal Concerns

Prior to conducting the on-site Survey, representatives from the Survey Team met with U.S. Environmental Protection Agency (EPA) Region X officials and personnel from both the State of Oregon and the State of Washington to discuss specific environmental concerns that these agencies have with the Hanford Site.

The State of Oregon representative met on July 16, 1986, at the Richland Operations Office, Richland, Washington, with the DOE Team Leader, Assistant Team Leaders, and NUS Coordinators. The same Survey Team representatives met jointly with EPA Region X and the State of Washington personnel in the State offices in Olympia, Washington, on July 17, 1986.

The following is a summary of the major environmental concerns raised at these two meetings:

- Localized surface contamination may exist near the radioactive-waste tank farms in the 200-Area.

- Groundwater contamination caused by leaks in radioactive-waste tanks may exist in the 200-Area.

- Transit time to the Columbia River for movement of contaminants in groundwater may actually be much shorter than assumed.

- Boundaries (fences) of the 600-Area Radioactive Waste Burial Grounds, northwest of the 300-Area, may not be accurately identified.

- Widespread surface radioactive contamination due to animal intrusion into burial sites may exist in the B-C Control Area (south of the 200-East Area).

- Surface soil sampling may not adequately identify radiological contamination in areas treated in the Radiation Area Reduction Program because these areas have been covered with clean soil.

- Unplanned releases in the 200-Area may be identified (fires, collapsed boxes, transuranic or TRU wastes) but documentation about cleanup is lacking.

- Strontium-90 releases from the N-Reactor cribs are contaminating the Columbia River.

- Cribs are an unacceptable means of effluent disposal for commercial operators but DOE still uses them.

- Crib surveillance programs need evaluation.

- Separation of sewers at the PUREX Plant may not be adequate (6 to 9 spills in past 18 months may have caused cross-contamination).

- Undocumented nonradiological burial grounds may exist (asbestos north side of B-Plant, burning pit near 218-E-12 B).

- Mixed-waste issues need more attention.

- Testing methods used by U.S. Testing (contractor to Hanford Reservation) may not be adequate.

- Air filter maintenance (frequency of filter changing) may not be adequate.

- Continuous air monitoring systems may not be adequate.

- Using distance to site boundary when modeling releases to the environment (i.e., PUREX stack 9 miles from site boundary) may not be valid.

- Thermal discharge to the Columbia River from the N-Reactor violates National Pollutant Discharge Elimination System (NPDES) permit requirements.

- Radioactive waste has been disposed of in the 216-C-2 Dry/Reverse Well.

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3.0 MEDIA-SPECIFIC SURVEY FINDINGS

The discussions in this section pertain to existing or potential environmental problems in the air, soil, surface water and groundwater media. The discussions include a summary of the available background environmental information related to each medium, a description of the sources of pollution and their control techniques, a review of the environmental monitoring program specific to each medium, and a categorization and explanation of the environmental problems found by the Survey team related to each medium.

3.1 Air

3.1.1 Background Environmental Information

3.1.1.1 Regulated/Hazardous Contaminants

The Hanford Site is located in a portion of the eastern Washington air basin that is administered by the Benton-Franklin-Walla Walla Counties Air Pollution Control Authority. Ambient concentrations of regulated air pollutants in the area are well below the National Ambient Air Quality Standards (NAAQS) except for total suspended particulates (TSP). The Hanford Site and surrounding areas are not in compliance with the national and state ambient air standards for TSP (PNL, 1979). Environmental data from 1981 and 1982 show that TSP concentrations at Kennewick and Pasco exceed the Washington State secondary standard of 150 micrograms per cubic meter for the second highest 24-hour concentration, although the concentrations in Richland are below that level.

3.1.1.2 Ambient Air Radionuclide Concentrations

Background data for gross beta, plutonium, and uranium in ambient air are available for Spokane, Washington, which is located approximately 150 miles northeast of Richland. The values are as follows (EPA, 1985):

Parameter	Activity (pCi/m^3)
Gross beta	0.01
Pu-238	7.0×10^{-7}
Pu-239	5.0×10^{-7}
U-234	2.29×10^{-5}
U-235	1.0×10^{-6}
U-238	2.34×10^{-5}

Washington Public Power Supply System (WPPSS) also provides data on concentrations of radionuclides in air (WPPSS, 1986). For control locations, the average gross beta activity for 1985 was 0.023 picocuries per cubic meter. Gamma emitters and iodine-131 were also measured; however, no positive activity was detected. Pacific Northwest Laboratory (PNL) measures off-site concentrations of a variety of radionuclides. Averages of these data are provided in Table 3-1, and the values are consistent with the U.S. Environmental Protection Agency (EPA) and WPPSS data (Price, 1986).

3.1.1.3 Meteorology

The Hanford Site climate is mild and dry, with occasional periods of high winds. Summers are generally hot and dry and conducive to the production of large amounts of wind-blown dust. The most significant sources of dust are cultivated fields in the surrounding area (ERDA, 1975).

The predominant wind direction is from the northwest with local variations in direction due to topographic features such as Rattlesnake Mountain and the Columbia River. The Cascade Mountains to the west are a source of cold air drainage across the site. Wind directions adjacent to the Columbia River are influenced by the surrounding riverbanks, resulting in a more westerly flow at the 100-Area and more northerly and southerly flows at the 300-Area and WPPSS sites. The resulting wind pattern places the population centers of Richland, Pasco, and Kennewick downwind of the site approximately 40 percent of the year. Additionally, southeastern Washington has a high frequency (55 percent) of low-level inversions. The stable atmospheric conditions during inversions tend to keep airborne pollutants close to the earth and slow their dispersion in the atmosphere. Approximately 50 percent of all stable periods are associated with northwesterly winds (ERDA, 1973).

TABLE 3-1

OFF-SITE MEASUREMENTS OF RADIONUCLIDES IN AIR(1), 1985

Parameter	Average Offsite Activity, pCi/m^3 $\pm$ 2S (2)
Gross Alpha	0.0011 $\pm$ 0.0001
Gross Beta	0.032 $\pm$ 0.004
H-3	1.8 $\pm$ 0.9
C-14	1.3 $\pm$ 0.3
Kr-85	58 $\pm$ 28
Sr-90	$2.1 \times 10^{-4} \pm 1.2 \times 10^{-4}$
Ru-106	$-1.0 \times 10^{-3} \pm 3.0 \times 10^{-3}$
I-129	$7.2 \times 10^{-6} \pm 9.1 \times 10^{-6}$
I-131	$-6.0 \times 10^{-4} \pm 2.0 \times 10^{-3}$
Cs-137	$0 \pm 3 \times 10^{-4}$
Total U	$7.7 \times 10^{-5} \pm 4.0 \times 10^{-5}$
Pu-238	$1.3 \times 10^{-6} \pm 1.2 \times 10^{-6}$
Pu-239, 240	$2.9 \times 10^{-6} \pm 2.1 \times 10^{-6}$

(1) Data from distant communities: Moses Lake, Washtucna, Walla Walla, McNary Dam, and Sunnyside.

(2) 2 times the Standard Error of the calculated mean

Reference: Price, 1986

3.1.2 General Description of Atmospheric Emission Sources and Controls

3.1.2.1 Summary of Major Pollutant Emissions

There are several facilities within the production areas that emit radionuclides and hazardous effluents to the atmosphere. Many of these facilities have more than one emission point and emit more than one type of radionuclide and/or regulated/hazardous air pollutant. Table 3-2 presents a summary of the regulated/hazardous air pollutants emitted by major power and production facilities during 1985 by each area. Similarly, Table 3-3 presents, by area, a summary of the activity level for each radionuclide emitted during 1985. These data show that the 200-Area emits the largest portion of regulated pollutants and radionuclides at Hanford. The following sections contain a description of the major sources of regulated/hazardous pollutants and radionuclides. The descriptions include identification of specific processes that generate pollutants, the types of pollutants generated and their emission points, any controls or monitoring equipment, and any special air permit requirements.

3.1.2.2 Fuel Burning Facilities

100-Area

Three oil-fired boilers located in the 100N-Area produce steam and electricity for 100N-Area operations, area heating, and for sale to WPPSS. The facility is designated 184N, and was operated by United Nuclear Corporation (UNC).

The 184N Steam Plant consists of two identical boilers rated at 400,000 pounds per hour steam (about 540 million Btu per hour), referred to as the Combustion Engineering (CE) boilers, and a third boiler rated at 625,000 pounds per hour steam (about 810 million Btu per hour) referred to as the Foster-Wheeler (FW) boiler. The two CE boilers were installed in 1968 and the FW boiler in 1962. The two CE boilers exhaust through a single stack, and the FW boiler through a separate stack. The 184N-Plant is operated as required for startup and shutdown of N-Reactor, and is not normally operated when N-Reactor is operating. It is kept on "warm standby" when N-Reactor is operating, which allows for fast startup of the boiler if required, and is operated to produce steam and electricity when N-Reactor is down.

TABLE 3-2

REGULATED GASEOUS EFFLUENTS DISCHARGED TO THE ATMOSPHERE IN 1985

Constituent	Release, kg*		
	100-Area	200-Area	300-Area
Particulates	3.7×10^4	3.9×10^5	2.5×10^4
Nitrogen oxides	1.1×10^5	1.0×10^6	1.3×10^5
Sulfur oxides	5.2×10^5	1.5×10^6	4.4×10^5
Carbon monoxide	1.0×10^4	1.1×10^5	Not Reported
Hydrocarbons	2.1×10^3	5.4×10^4	Not Reported

Reference: PNL, 1986

* As reported by area contractors.
Discharges from combustion sources in 400 Area were not reported.

TABLE 3-3
RADIONUCLIDES DISCHARGED TO THE ATMOSPHERE, 1985

Radionuclide[b]	Half-Life	Release, ci[a]			
		100-Area	200-Area	300-Area	400-Area
^{3}H	12.3 yr	1.8×10^{1}	2.0×10^{2}	(c)	
^{14}C	5730 yr	-	4.0×10^{0}		
^{24}Na	15.0 h	1.5×10^{-1}			
^{41}Ar	1.8 h	6.9×10^{4}			
^{51}Cr	27.7 d	5.9×10^{-3}			
^{54}Mn	312 d	6.3×10^{-3}			
^{56}Mn	2.6 h	4.4×10^{-1}			
^{59}Fe	44.5 d	7.5×10^{-3}			
^{58}Co	70.8 d	2.0×10^{-3}			
^{60}Co	5.3 yr	2.2×10^{-2}		5.0×10^{6}[d]	
^{76}As	26.3 h	1.2×10^{0}			
^{85m}kr	4.5 h	2.6×10^{2}			
^{85}kr	10.7 yr		7.0×10^{5}		3.5×10^{2}
^{87}kr	76.3 min	7.7×10^{2}			
^{88}kr	2.8 h	6.5×10^{2}			
^{89}Sr	50.5 d	1.7×10^{-2}			
^{90}Sr	29.1 yr	5.0×10^{-4}	8.5×10^{-3}	6.1×10^{-5}[e]	2.8×10^{-5}
^{91}Sr	9.5 h	1.8×10^{-1}			
^{95}Zr	64.0 d	5.0×10^{-3}	6.0×10^{-2}		
^{99}Mo	66.0 h	2.1×10^{-1}			
^{103}Ru	39.5 d	1.7×10^{-3}	5.2×10^{-1}		
^{106}Ru	368 d	8.7×10^{-3}	6.0×10^{-1}		
^{113}Sn	115 d		4.3×10^{-1}		
^{125}Sb	2.8 yr		1.5×10^{-2}		
^{129}I	1.6×107 yr		3.0×10^{-1}		
^{131}I	8.0 d	2.3×10^{-1}	2.0×10^{-1}	2.2×10^{-3}	8.1×10^{-6}
^{132}I	2.3 h	2.7×10^{0}			
^{133}I	20.3 h	1.8×10^{0}			
^{135}I	6.6 h	2.9×10^{0}			
^{133}Xe	5.2 d	1.8×10^{2}			
^{135}Xe	9.1 h	1.0×10^{3}			
^{134}Cs	2.1 yr	8.7×10^{-4}	7.0×10^{-4}		
^{137}Cs	30.0 yr	1.4×10^{-4}	1.0×10^{2}		
^{138}Cs	32.2 min	1.8×10^{3}			
^{140}Ba	12.7 d	1.3×10^{-1}			
^{141}Ce	32.5 d	1.1×10^{-3}			
^{144}Ce	284 d	1.7×10^{-2}	1.0×10^{-1}		
^{147}Pm	2.6 hr	7.0×10^{-2}			
^{212}Pm	10.6 h		2.0×10^{-1}		
U-Nat	4.5×10^{9} yr		1.1×10^{-4}	1.3×10^{-4}	
^{238}Pu	87.7 yr	1.9×10^{-7}	1.0×10^{-3}		
$^{239,240}Pu$	2.4×10^{4}	9.2×10^{-7}	1.0×10^{-2}	1.1×10^{-5}	2.0×10^{-6}
^{241}Pu	24.4 yr		1.0×10^{-1}		
^{241}Am	432 yr		5.0×10^{-4}		

(a) Except as noted in this table, all effluent releases are as reported by operating contractors via the DOE's Effluent Information System.
(b) The curve quantities of radioactivity are for the listed radionuclides only. For those radionuclides with radioactive daughters, the daughter activity is included in the dose calculations.
(c) Blank entry indicates no value reported by the operating contractor.
(d) Includes 2.2×10^{-7} Ci reported as mixed activation products, but assumed to be ^{60}Co for dose calculations.
(e) Includes 1.1×10^{-5} Ci reported as mixed fission products but assumed to be ^{90}Sr for dose calculations.
Reference: PNL, 1986

The boilers are sources of particulate, sulfur oxide, and nitrogen oxide emissions. All boilers are fired with residual (No. 6) fuel oil containing less than 1.75 percent sulfur. Distillate (No. 2) oil is used to start up the boilers. At the time of the Survey, the two CE boilers were operating at about 130,000 pounds per hour steam. The FW boiler was undergoing an extensive rebuilding, involving replacement of the boiler tubing, and was not operational. The FW boiler was expected to be brought back on-line in early 1987.

There are no emission controls for any of the boiler exhausts. The boiler exhaust gases are monitored by temperature sensors and continuous oxygen analyzers. Particulate emissions from the oil boilers are monitored by opacity meters, which measure the transparency of the stack gas and thereby the amount of suspended particulate. Each opacity meter consists of a light source, receptor, signal transmitter and chart recorders. The exhaust gas opacity monitors for the CE boilers are located in the exhaust gas outlet ducts close to the boiler. The opacity monitor for the FW boiler is normally located in the stack, but had been removed for realignment when the boiler was brought down for rebuilding.

At the time of the Survey, both opacity monitors on the CE boilers were operating, but one of the oxygen analyzers was not operational due to the unavailability of spare parts. The opacity and oxygen monitors are calibrated quarterly according to a written procedure (Blankenship, 1986; Jack, 1983). The monitor readings are output to the boiler control room chart recorders, which alarm at indicated opacity readings in excess of 20 percent (UNC, 1984a). The opacity of the exhaust gas during normal boiler operations is generally well below 20 percent as indicated by review of monitoring records. In general, steam boiler emissions are calculated from emission factors, and are not monitored except in response to regulatory requirements. Opacity excursions due to process upsets are infrequent, but they are monitored and reported. Sulfur and nitrogen oxide emissions are not monitored.

Emissions from the 184N Steam Plant (and 100N-Area emergency generators) are calculated annually from fuel consumption records and standard EPA emission factors. Table 3-2 lists the airborne emissions at 100N-Area resulting from the combustion of No. 6 fuel oil and No. 2 diesel oil in 1985. The weights of listed materials discharged were calculated using the factors published in "Compilation of Air Pollutant Emission Factors," by the EPA (1977).

Stack test data for all three boilers show that when firing 1.75 percent sulfur coal, particulate, sulfur, and nitrogen oxide emissions are within the normal operating range for oil-fired boilers (Maas, 1981a; Maas, 1984a). Sulfur oxide and particulate emissions are substantially lower than the respective Washington State standards of 1000 ppm and 0.1 grains/dry standard cubic foot of exhaust gas, respectively. The most recent stack results are summarized below:

Boiler	Particulate Loading (Grains/Dry scf)	Sulfur Dioxide (ppm)	Nitrogen Oxides (ppm)
CE #1 and #2	0.034	375-471	210-230
FW #1	0.052	572-613	Not tested

Source: Maas 1981a, Maas 1984a

200-Area

Each of the 200-Areas has a coal- and oil-fired steam plant, which provide steam for process and heating applications. The 200-East Area Steam Plant is designated 284E, and the 200-West Plant 284W. The plants were operated by Rockwell International.

The 284E Steam Plant consists of five coal-fired boilers, each rated at 80,000 pounds per hour steam output (equivalent to 550 million Btu per hour), and one auxiliary oil-fired boiler rated at 75,000 pounds per hour steam output (100 million Btu per hour). Three of the five coal-fired boilers are original plant equipment and were installed in 1943. Two coal boilers were added to the 284E Steam Plant in 1954, and an oil-boiler was installed in 1983. The 284W Steam Plant has four coal-fired boilers, each rated at 80,000 pounds per hour steam, and one oil-fired boiler. Each facility has two stacks to which the coal boilers discharge. The oil boilers have separate stacks.

Both steam plants operate throughout the year, and each plant operates at a maximum load of approximately 300,000 pounds per hour of steam (350 tons of bituminous coal per day) during the winter months. The oil boilers are not normally

used except when one or more of the coal boilers is not operational. The 284E and 284W Steam Plants are supplied with coal from coal piles located near each of the main boiler buildings. Residual (No. 6) fuel oil for the auxiliary oil-fired boilers is stored in outdoor, above-ground tanks at each facility. Fuel oil is not used to start up the coal-fired boilers; this is normally done by transferring burning coal from an operating boiler to the unit being started.

The steam plants are sources of particulate, sulfur oxide, and nitrogen oxide emissions from the combustion process, and also fugitive particulate emissions from coal and ash storage and handling areas. At each facility, particulate emissions from the coal boilers are controlled by fabric filters that collect the particulates on the surface of porous fabric bags. The cleaned exhaust gas flows through the bags and exhausts to the two stacks.

The particulate emissions from the 284E Coal Boilers are controlled by three fabric filter units, each consisting of six separate modules containing Teflon-coated fiberglass bags. The control system for the 284W Coal Boilers is similar, but consists of only two fabric filter units, each with five modules. The fabric filters are of reverse-air cleaning cycle design, and the cycle time is controlled by monitoring the pressure drop through each module. During a cleaning cycle, the air flow through the module reverses, causing the collected ash to fall from the bags into hoppers.

The fly-ash collected by the fabric filters is conveyed to an ash pond at each facility using water. After the water evaporates, the ash is transferred from the ash ponds to ash piles by front-end loaders and dump trucks. Water is used on the ash piles as a dust suppressant. The oil boilers are exhausted separately from the coal boilers, and particulate emissions are not controlled. Sulfur and nitrogen oxide emissions are not controlled from either the coal or oil boilers. The plants use low-sulfur coal and oil only; coal sulfur content is normally about 0.6 percent, and the residual fuel oil normally contains 1.5 percent sulfur.

Particulate emissions from the coal boilers are monitored by opacity meters, which measure the transparency of the stack gas and thereby the amount of suspended particulate. Each opacity meter consists of a light source, receptor, signal transmitter, and strip-chart recorders. The opacity meters are located in the

fabric filter outlet ducts before the stacks. Each meter outputs to the boiler control panel (digital readout and strip-chart recorder) and alarms at indicated opacity readings above 20 percent. The 284E-Plant opacity meters were operating at the time of the Survey. The 284W-Plant opacity meters were not operational. No opacity standard violations occurred in 1985 (Boothe, et al., 1986).

The most recent stack tests of the 200-Area coal-fired boilers (Maas, 1982) show that sulfur oxide exhaust gas concentrations ranged from about 400 to 550 parts per million (corrected to 7 percent oxygen in the exhaust gas) when burning coal with 0.6 to 0.75 percent sulfur. These concentrations are well within the normal operating range for a coal boiler, and are less than 50 percent of the Washington State performance standard. Nitrogen oxide concentrations ranged from about 100 to 150 parts per million, also within normal boiler operating limits. There are presently no State or Federal standards for nitrogen oxide emissions from small industrial boilers. Total sulfur dioxide and nitrogen oxide emissions from the 200-Area boilers in 1984 were 1570 and 885 tons, respectively (Gerton, 1985a).

Exhaust gas particulate concentrations, measured in 1982, shortly after installation of the fabric filters, were less than 0.05 grains per cubic foot (at 7 percent oxygen and standard condition), about half the Washington State standard, and within normal operating limits. Total particulate emissions from the 200-Area Coal Boilers were 422 tons in 1984 (Gerton, 1985a). Particulate emissions from wind erosion of coal and ash storage areas have not been estimated. Visible emissions were observed in these areas during the Survey.

300-Area

A steam plant, fired by coal and oil, is located in the 300-Area. It supplies steam to the 300-Area for process and heating applications. The 300-Area Steam Plant is designated 384 Building, and is operated by Westinghouse.

The steam plant consists of two oil-fired boilers, designated numbers 2 and 6, and three coal-fired boilers, designated numbers 3 through 5 (Boiler number 1, a coal-fired unit, is no longer in service). Boilers number 3, 4, and 5 were first placed in operation in January 1986, and replaced the original plant boilers. Each is rated at

40,000 pounds per hour steam (about 55 million Btu per hour). The number 6 boiler, originally a coal-fired unit, was converted to oil in 1972, and is rated at 80,000 pounds per hour steam (110 million Btu per hour). The number 2 boiler, rated at 180,000 pounds per hour steam (140 million Btu per hour) was installed in 1971. The three coal boilers each operate at a capacity of approximately of 2.2 tons per hour coal. Operation of all five boilers may be necessary in winter; generally, operation of only one boiler is required in summer.

The coal boilers are supplied with coal from a coal pile located near the 384 Building. Coal is moved by conveyor into coal bunkers in the boiler building, from which it is fed to the boilers. Water is applied to the pile as required for dust control. Residual (No. 6) fuel oil is stored in tanks near the boiler building. Fuel oil is generally not used to start up the coal-fired boilers; this is normally done by transferring burning coal from one unit to another.

Particulate emissions from the 384 Coal Boilers are controlled by two fabric filter units operated in parallel. One unit was installed along with the new coal boilers, the other is an older unit installed in the early 1970s. Both units exhaust to a single stack, also recently installed. The filters are fiberglass bags, which are inspected annually as scheduled by written procedure (HEDL, 1985a). The new filter bags were inspected after installation, and some deficiencies in the installation were corrected at that time. The fabric filter units have internal opacity sensors to detect broken bags; the sensors output to alarms in the boiler control room. The bag cleaning cycle is reverse-air, as is that for the 200-Area Boilers. The collected fly-ash is conveyed pneumatically to an ash bin, and transferred from the bin to an ash pond using water.

The oil boilers are exhausted separately from the coal boilers, and particulate emissions are not controlled. Sulfur and nitrogen oxide emissions are not controlled from either the coal or oil boilers. The plant uses low-sulfur coal and oil only; coal sulfur content is normally about 0.6 percent, and the residual fuel oil normally contains 1.5 percent sulfur.

The opacity of the oil and coal boiler exhausts is monitored by opacity meters located in the oil boiler and fabric filter outlet ducts respectively. The coal boiler opacity meters output to the boiler control room, but the oil boiler meters are outside the control room. Both opacity meters output to chart recorders and alarm when opacity readings exceed 20 percent. The meters are calibrated quarterly by written procedure (HEDL, 1985b). The opacity readings for both the coal and oil boilers are generally significantly lower than 20 percent under normal emissions. The coal boiler opacity shows a slight increase during the fabric filter bag-cleaning cycle.

The emissions from the recently installed coal-fired boilers have not yet been determined by stack testing, but are expected to be within normal boiler operating limits and well below standards. The emissions from the oil boilers, last tested in 1981, were within normal operating limits and below standards.

Diesel Generator

The site maintains over 100 small diesel generator sets, most of which are on emergency standby to be used in the event of a loss of electric power. The engines are periodically tested to ensure their operability. The diesel engines are very minor sources of sulfur oxides, nitrogen oxides, and particulates, but they do contribute to the site-wide inventory of emissions of these pollutants. The emissions are relatively small with respect to other fuel burning sources on-site, and do not require controls. Proposed regulations requiring control of nitrogen oxide emissions from recently installed diesel generators have not been promulgated.

Gas Turbine

The Fast Flux Test Facility (FFTF) in the 400-Area includes an emergency gas turbine, which is a source of sulfur oxides and nitrogen oxides. Emissions from this unit have not been measured, but are expected to be insignificant in relation to other fuel burning sources on-site. Recently promulgated New Source Performance Standards (NSPS) for nitrogen oxide emissions require compliance testing and emission controls for new gas turbines. The FFTF, however, was constructed prior to the applicability date of these regulations, and the gas turbine has therefore not

undergone compliance testing and is not equipped with an emission control system. Stationary gas turbines generally do not meet the NSPS emissions limits without controls.

3.1.2.3 Fuels Fabrication Facilities

The Fuels Fabrication Facilities, operated by UNC, use a variety of mechanical, chemical, and electrical processes in the conversion of uranium billets and assorted components to finished fuel elements ready for N-Reactor. The majority of emissions from fuel fabrication come from Building 333 where the fuel elements are made and assembled. A small amount of emissions is generated in Building 313 by the copper-silicon casting facility. Additional information on the emissions and the monitoring programs for each facility is provided below.

- Uranium Cutoff-Saw Exhaust, Building 333 - Uranium-contaminated fumes and smoke from three cutoff saws and a band saw are drawn through a water spray scrubber before being discharged above Building 333. The exhaust is continuously sampled for uranium particles, and the sample is analyzed daily for alpha and beta activity. The annual emissions rate is approximately 3.3×10^{-5} Ci per year.

- Beryllium Exhaust, Building 333 - This exhaust system removes beryllium and uranium fumes from several shop areas. The air passes through a high-efficiency particulate air (HEPA) filter before being discharged 8 feet above Building 333. The exhaust is sampled daily for uranium as is the cutoff-saw exhaust. Beryllium samples are collected weekly and composited for a monthly analysis by Hanford Environmental Health Foundation (HEHF) (HEHF, 1986a). Typically, both the beryllium and uranium concentrations are below detection limits.

- Chemical Bay Exhaust, Building 333 - Gases and acid fumes from the chemical processing tanks and component preparation areas pass through water spray scrubbers before being discharged through a stack 140 feet above the ground. Although the exhaust is subject to Washington State opacity limits, the nitrogen dioxide concentration and the orange-brown color of the exhaust gas make the measurement of opacity very difficult.

The local air pollution control authority has granted an alternative standard based on an emission rate of 350 kilograms per day and 60 metric tons per year (Cooke, 1986). The effluent from the stack is continuously analyzed by a Beckman Model 951 Chemiluminescent NO/NO_2 Analyzer. Concentrations and stack flow rate are recorded on a strip chart. An integrating totalizer computes the total pounds of nitrogen oxides and the cubic feet of air discharged. For 1985, total emissions were approximately 35,000 pounds with an average concentration of 31 ppm (UNC, 1985). Calibrations are performed weekly on the analyzer in accordance with approved procedures. The HEHF has conducted annual uranium emission tests on the Chemical Bay Stack. Results are typically less than 1 microgram per cubic meter (HEHF, 1985a, 1986b).

- Extrusion Press and Vacublast Exhausts, Building 333 - The press exhauster removes most of the smoke and oil fumes from the burning extrusion lubricant at the extrusion press and tooling preheat furnance. The vacublasters bombard heat treated pieces with very fine alumina grit to remove scale. These exhausts remove smoke, oil fumes, and entrained particulates, and they are subject to the general process source particulate emission limit of 0.1 grains per cubic foot (Washington Department of Ecology). The HEHF tested these exhausts in 1985 for compliance with the emission limit, and all emissions from all points measured well below the emission limit (HEHF, 1985b, c, d). The annual emission rate is about 300 pounds.

- Vacublast Exhaust, Building 313 - Process pieces are bombarded with alumina grit to remove scale. The exhaust contains very fine particles of alumina grit, zirconium oxide, copper oxides, and carbonized extrusion lubricant. This exhaust exceeded the emission limit for particulates during testing in late 1985. After the baghouse was repaired, the tests were repeated in January 1986 by HEHF. The retest results of 0.02 grain/SCF were well below the emission limit of 0.1 grains/SCF (HEHF, 1986c). The annual discharge rate is approximately 400 pounds.

9 2 1 2 4 6 1 1 4 4 0

- Copper-Silicon Casting Facility, Building 313 - This facility produces billet preshapes and backing plates for extrusion of billet assemblies. The facility includes lathes, casting furnaces, ovens, saws, sanders, and shears. A central exhaust system removes gases and fumes from around the furnace, and removes smoke and particles from the band saw and grinder. The HEHF tested the emissions for copper concentration in 1984 and 1985, and concluded that the emission rate is well below the level for potential adverse environmental or health impacts (HEHF, 1985e).

- Uranium Oxidation Facility Exhaust, Building 303M - Uranium chips and fines from fuels fabrication are air-dried and burned in small batches within the 303M Building. The quantity of uranium burned is limited to approximately a 1-liter volume for each ignition. The exhaust system removes heated air and smoke from the uranium incinerator, passes the smoke through a baghouse filter, through a HEPA filter, and discharges vertically about 35 feet above ground level. The discharge is continuously monitored for temperature and alpha radiation levels. The limiting conditions for operation are 6×10^{-2} picocurie per liter and 400°F for the exhaust. If either of these conditions are approached, the dampers on the incinerators will close, and the exhaust fan will shut off automatically. The temperature sensors and alpha monitors are calibrated and tested annually according to approved procedures. The HEPA filters are tested every 6 months by HEHF to ensure a collection efficiency of at least 99.95 percent.

3.1.2.4 PUREX Facility

The initial process at the plutonium uranium extraction (PUREX) Facility (202A Building) removes the cladding from the irradiated N-Reactor fuel elements by dissolution in an ammonium fluoride solution. To suppress the formation of hydrogen gas, ammonium nitrate is added to the solution as well. Ammonia is produced as an offgas of the process. The gas in passed through a water scrubber to remove most of the ammonia, filtered to remove all fine particles, and discharged to the atmosphere through the 200-foot main stack. In July 1986, a Beckman Model 865 infrared analyzer was installed in the 291AH Building for monitoring the concentration of the remaining ammonia entering the main stack.

There are no emission limitations or environmental standards for ammonia, but the concentration is of interest for controlling a reaction between ammonia and nitrogen oxides that forms crystals of ammonium nitrate inside the stack. An additional unknown amount of ammonia is released when the decladding waste stream is treated with sodium hydroxide. All the ammonia generated by this reaction is emitted through a dedicated 80-foot-high stack (A24).

After the fuel elements are declad, they are treated with potassium hydroxide, and then dissolved in nitric acid to produce a feed solution of uranyl and plutonium nitrates. The offgases from the dissolving steps are heated and passed through a silver reactor that removes most of the radioactive iodines, and filtered before being passed through two acid scrubbers (293A Backup Facility) to recover nitric acid. The gases are then discharged to the atmosphere through the main stack. All of the krypton-85, tritium, and carbon-14 contained in the offgases are released to the atmosphere. For scrubber process control, the nitrogen oxides concentration in the offgas is monitored at three locations: at entry to the first scrubber, between the two scrubbers, and at the exit of the second scrubber. The air permit for the PUREX Facility limits the concentration from the second scrubber (also called the XB Absorber Tower) to 2 percent by volume, dry basis, and to a maximum emission rate of 1160 kilograms per day. Additional permit limits restrict emissions from the main stack to 2250 kilograms per day and 424 metric tons per year (EPA, 1980). Aproximately half the nitrogen oxide emissions from the facility come from the sugar denitrification process, in which sugar is added to the waste in order to concentrate it. This offgas passes through a scrubber that removes some of the nitrogen oxides. The remainder passes through a condenser, a steam heater, a silver reactor, and several banks of filters before being released from the main stack. Four DuPont Model 461 analyzers measure the concentration of nitrogen oxides at the three scrubber locations and in the main stack. A fifth analyzer is maintained in standby condition as a backup for the main stack analyzer. These analyzers are maintained and calibrated according to approved procedures (Rockwell, 1985). The scrubber exhaust and main stack analyzers have also been tested for relative accuracy and calibration drift requirements as required by the PUREX air permit.

9 2 1 2 4 6 1 1 4 4 2

Maximum daily emissions and annual emissions of nitrogen oxides are well below the PUREX air permit limits. The 2-percent limit on the concentration of nitrogen oxides leaving the second scrubber has been exceeded, but excursions are infrequent (twice in 1 year) and last for only a few minutes. The exceedances were attributed to excessively rapid dissolution reactions. Since then, administrative controls have been established on the control of dissolution reactions to reduce the chance of exceeding the scrubber emission limit (Bielicki, 1986).

Each of the five smaller stacks at the PUREX Plant has an alpha and a beta constant air monitor (CAM) for detecting gross alpha and beta activity. A "record sampler" whose main components consist of a particulate filter, regulator, rotameter, dry-gas meter, and air-sample pump is used for measuring gross alpha and beta activity on a weekly basis.

The main stack (291-A-1) has a record sampler and a sophisticated one-of-a-kind CAM which was being tested during the Survey. An electronic system controls the sample flow from the stack to obtain isokinetic sampling. The sample is provided to one of two CAMs (the second is a backup). Each CAM has a moving filter, and alpha, beta, and gamma detectors. The gamma detection system can perform on-line gamma isotopic analysis and, if set points are reached, alarms in the plant dispatcher's office.

Discharge measurements for 1985 show that 98 percent of the alpha activity and 99 percent of the beta activity for the entire 200-Area is released from the PUREX Plant main stack. The alpha activity is primarily Pu-239, 240 and the beta activity is primarily Ru-106. The major radioactive releases from the main stack of the PUREX Plant are summarized below. These data (for 1985) are:

Stack #	Alpha (Ci)	Beta (Ci)	H-3 (Ci)	C-14 (Ci)	Kr-85 (Ci)
291-A-1	1.0 E-02	1.0 E+00	2 E+02	4 E+00	7 E+05

A comparison of the PUREX main stack emissions to the Rockwell administrative controls, which are based on the DOE RCG for uncontrolled areas is as follows:

- Krypton-85 emissions were 18 percent of its control value

- Plutonium-239 emissions were 2 percent of its control value

- The sum of releases of all particulate, long-lived beta emitters was 0.8 percent of its control value

- The sum of releases of H-3, C-14 and I-129 was 27 percent of its control value.

Emissions from the PUREX Ammonia Scrubber Discharge stack (296-A-24) exceeded the Rockwell administrative control value (concentration) for ruthenium-106 by 17 percent, but the total amount released was small (less than 1 curie). Emission levels from all stacks were such that personnel and public radiation exposures were well below DOE guidelines (DOE Order 5480.1A).

3.1.2.5 Uranium Oxide Plant

The Uranium Oxide Plant, also referred to as the UO_3 Facility, is located in the 200-West Area of the Hanford Reservation site, and was operated by Rockwell. The main building of the UO_3 Plant is 224U. Other buildings and areas include the 224UA Loadout Facility, the 276U Solvent Handling Area, and the 291U Main Stack.

The Uranium Oxide Plant converts the depleted uranium, recovered by the PUREX Facility as uranyl nitrate hexahydrate (UNH) solution, to solid uranium trioxide (UO_3) powder. The 60-percent UNH solution is received from the PUREX Plant in tank cars. The solution is concentrated to 100-percent UNH, which is converted to uranium oxide by thermal decomposition in electrically heated calciners. The uranium oxide is removed from the calciners by a solids handling system, and is collected in cyclone separators and baghouses. The baghouses are exhausted through a HEPA filter to the atmosphere through the main process stack. The collected uranium oxide is transferred to a loadout facility, which is enclosed and exhausted through a separate HEPA filter to the atmosphere. The recovered uranium oxide is shipped to other facilities.

Nitrogen oxides are evolved as the UNH solution is heated in the calciners. The nitrogen oxides are recovered as nitric acid by acid absorbers which exhaust through a wet scrubber to the atmosphere. The recovered acid is returned to the PUREX Plant for reuse. Liquid condensate from the UNH solution concentrators is recycled within the process for uranium recovery or disposed of in cribs.

The Uranium Oxide Plant has three stacks that account for nearly all of the air emissions from the facility. These are designated as follows: (1) 296-U2 stack - main process (cyclone/baghouse) exhaust; (2) 296-U4 stack - acid absorber exhaust; and (3) 296-U13 stack -uranium oxide loadout area exhaust.

Radionuclide emissions from the main process stack and loadout area exhaust are monitored continuously. Both exhausts are equipped with continuous alpha and beta monitors, and particulate samples are collected on particulate filters and analyzed weekly for total alpha and beta. The sample gas is drawn through the samplers at a constant rate of 2 cubic feet per minute. The acid stack is equipped only with a particulate sampler. The particulate filter used on the acid stack particulate sampler is a nonstandard 5-micron Teflon filter, which is more suitable for acid service than the standard micron particulate filter used in other stack exhaust particulate samplers. The filters are analyzed daily for total alpha and beta concentrations when the plant is operating, and twice per week when the plant is on standby.

All three stacks are sources of radiological emissions, which are almost entirely plutonium-239/240 and uranium (Aldrich and Stanfield, 1986). Emissions are summarized in Table 3-4. The building ventilation system exhaust is a potential source of uranium emissions during calciner upset conditions; however, the actual emissions from this exhaust are not significant based on periodic measurements made by site personnel. The main process exhaust is a potential source of nitrogen oxide emissions during calciner upsets (Millward, 1984a). These emissions can be significant compared to the emissions from the acid absorber exhaust. The acid absorber exhaust is the primary source of regulated/hazardous emissions, primarily nitrogen oxides, from the Uranium Oxide Plant during routine operations (DOE 1982a).

TABLE 3-4

TOTAL URANIUM AND PLUTONIUM - 239/240 EMISSIONS FROM UO_3 PLANT STACKS - 1985

Stack	Title	Total Uranium		Total Pu 239/240	
		Annual Emissions (Ci)	Concentration (μCi/cc)	Annual Emissions (Ci)	Concentration (μCi/cc)
296-U2	Main Process Exhaust	<0.1E-5	<0.9E-13	0.4E-7	0.3E-14
296-U4	Acid Absorber Exhaust	0.7E-4	0.3E-11	0.2E-6	0.9E-14
296-U13	Loadout Area Exhaust	<0.1E-5	<0.2E-13	0.3E-8 (Based on 3 Quarters)	0.5E-14 (Based on 3 Quarters)

Source: Aldrich and Stanfield, 1986

Uranium oxide is removed from the solids handling system exhaust by cyclone separators and fabric filters. The filter bags are cleaned periodically using air jets, and the cleaning cycle time is dependent on the pressure drop across the filter bags. The bags are replaced approximately annually, when the cleaning cycle becomes ineffective. The cyclone separators and fabric filters are not 100 percent efficient in removing uranium trioxide and other particulates from the exhaust stream, and emissions are further controlled by two parallel (redundant) HEPA filter units. These units are monitored for differential pressure and are subjected to annual efficiency testing.

The exhaust rates from the three plant stacks are measured semiannually by Vent and Balance personnel. The acid stack exhaust rate, which may vary by a factor of two, is continuously monitored. The flow rate of sample gas through the acid stack particulate sampler is automatically controlled based on the measured exhaust rate (this is referred to as isokinetic sampling). The main process and loadout exhaust rates are not as variable as those of the acid exhaust, and their sampling rates are not adjusted for flow variations.

The loadout area is completely enclosed, and exhausts to a two-stage HEPA filter unit, which is monitored for differential pressure and tested annually for efficiency. Historically, fugitive emissions of uranium oxide from the loadout area were a cause for concern as the area was not enclosed before 1983. Since the facility has been enclosed and controlled by HEPA filters, fugitive emissions from the area have been essentially eliminated.

The acid absorber exhaust (U4) is not equipped with a HEPA filter unit. Emissions of radionuclides from the acid stack are controlled by the acid absorbers and wet scrubber, which function as particulate scrubbers as well as acid recovery units. Uranium and other radionuclides are removed in the recovered nitric acid. The particulate removal efficiency of the scrubbers is not known; however, they are not expected to function as efficiently as HEPA filter units. Wet scrubber efficiencies for particulates are on the order of 98 to 99 percent.

The concentration of nitrogen oxides in the acid absorber exhaust is continuously monitored and controlled (Harmon, 1983). The NO_x analyzer continuously draws a sample of exhaust gas from the acid absorber exhaust stack. The flow rate of the

gas sample is automatically controlled, based on continuous measurement of the total gas flow through the stack. The analyzer outputs to a recorder in the plant control room, and the recorder is equipped to alarm if the concentration of nitrogen oxides in the exhaust gas exceeds a preset value, the sample flow rate falls below a preset value, or the sampling system loses electric power.

The nitrogen oxide emissions from the Uranium Oxide Plant are subject to EPA permit limitations (EPA, 1980). The preset concentration value that activates the alarm is set lower than the EPA permit limit. The operator is alerted to an increase in emissions before the EPA limit is exceeded, so that the upset condition can be corrected or the plant shut down before permit conditions are violated.

The main process exhaust, which exhausts the uranium oxide solids handling system, baghouses, and cyclone separators, is not monitored for nitrogen oxide concentration, and does not have a nitrogen oxide control system. During process upsets, the normally negative pressure (vacuum) of the calciners increases and the calciners become pressurized. The exhaust gas normally vented to the acid absorbers is instead vented through the solids handling system to the main stack and released uncontrolled to the atmosphere. Plant engineers have reported several of these upset (off-normal) events in the past 2 years, and are required to prepare an estimate of the excess emissions and assess whether these resulted in a violation of permit conditions (Millward, 1984). None of the reported events are believed to have resulted in a permit violation.

Under normal operating conditions, nitrogen oxide emissions from the uranium oxide facility are less than the EPA permit limits of 850 kilograms per day (~ 1875 pounds per day) and 50 metric tons per year (EPA, 1980). The acid absorber exhaust did not exceed the daily emission limit in 1985 (Boothe et al., 1986). Emissions from the main stack are not believed to have exceeded the daily emission limit even under process upset conditions, as such releases are invariably of short duration. However, monitoring data are not available for nitrogen oxide emissions from the main stack, as the stack does not have an NO_x monitoring system. Reported emissions were less than those allowed under the EPA permit in both 1984 and 1985 (Price, 1986).

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Z-Plant

Z-Plant, also referred to as the Plutonium Finishing Plant (PFP), is located in the 200-West Area of the Hanford Site, and was operated by Rockwell. The main building of Z-Plant is 234-5Z, the Plutonium Finishing Facility. Other buildings include the 236Z Plutonium Reclamation Facility and the 291Z Filter Building.

The purpose of Z-Plant is to process liquid plutonium and uranyl nitrate wastes from the PUREX Facility (located in the 200-East Area) and to recover plutonium from the waste in the form of plutonium metal or plutonium oxide. The plutonium in the liquid waste is separated from the uranium and other radionuclides in the waste by a multistage extraction process, which uses carbon tetrachloride and tributyl phosphate as the organic phase, and a concentrated nitric acid solution as the aqueous phase. The plutonium is removed in the organic stream as plutonium oxide, and the uranium and other radionuclides are removed in the aqueous stream. The plutonium oxide is separated from the organic stream, and can be reduced to plutonium metal using hydrogen fluoride and calcium, or left in the oxide form. The recovered plutonium is either shipped to other facilities or stored at Z-Plant.

Nitrogen oxides are evolved from the dissolution of plutonium in nitric acid. The dissolver cells are exhausted by vacuum, and fumes are vented uncontrolled to the main process exhaust. Additional nitrogen oxides will be generated by a second dissolver, for dissolving plutonium-containing waste slag and crucibles in nitric acid. The dissolver was expected to be brought on-line in the fall of 1986. The nitrogen oxide emissions from the dissolver will be controlled by a wet scrubber before being discharged through the main process stack.

The nitric acid, carbon tetrachloride, and tributyl phosphate used in the extraction process are recycled within the process, but some of these chemicals are lost to the main process stack with each cycle. Hydrogen fluoride is not recycled, but is exhausted to a caustic scrubber and then to the main process stack.

Z-Plant has four stacks that account for the major portion of the radiological and regulated/hazardous air emissions from the facility. These are designated as follows: (1) 291Z1 Filter Building - main process exhaust; (2) 296Z3 - 241Z

radioactive liquid waste sump area exhaust; (3) 296Z5 -. 2736ZA plutonium shipping/receiving area exhaust; and (4) 296Z6 - 2736ZB plutonium storage building exhaust.

The radioactive waste incinerator located in the 232Z Building adjacent to the main building is no longer operated and is scheduled to be decommissioned.

The main process exhaust and the sump area exhaust are sources of both radiological and regulated/hazardous emissions. The shipping/receiving and storage building exhausts are primarily a source of radionuclide emissions. All four stack exhaust fans are operated continuously, whether or not the Z-Plant processes are operating.

Each of the four stacks listed above has a CAM, which includes a rotameter and a dry-gas meter, for detecting gross alpha activity. A particulate filter is used for measuring gross alpha and gross beta on a weekly basis. If these activities are greater than 10 percent of the Table 2 values specified in DOE Order 5480.1A, then specific analyses for plutonium, strontium, gamma-emitting nuclides, and other alpha-emitting nuclides are performed. At a minimum, these specific analyses are done quarterly.

Radioactive releases from the four main stacks at Z-Plant are summarized below (1985 data). Plutonium-239/240, plutonium-241 and americium-241 are the major radionuclides emitted.

Stack #	Alpha (Ci)	Beta (Ci)
291-Z1	1.2 E-04	1.4 E-04
296-Z3	3.4 E-07	1.6 E-06
296-Z5	7.4 E-07	1.8 E-5
296-Z6	7.6 E-07	5.7 E-06

The main stack, 291Z1, accounts for approximately 98 percent and 85 percent of the alpha and beta emissions, respectively, from Z-Plant operations.

Regulated/hazardous air emissions from the main stack include carbon tetrachloride, nitrogen oxides, and hydrogen fluoride. The sump area exhaust has the potential to emit carbon tetrachloride. Although regulated/hazardous air

emissions from this source have not been characterized, they are expected to be small compared to the emissions from the main stack.

The concentration of hydrogen fluoride (used to reduce plutonium oxide to plutonium metal) in the exhaust from the plutonium oxide glove box is continuously monitored and controlled. The glove box is exhausted by a vacuum system, which is vented to a caustic scrubber. The vacuum draws approximately 80 cubic feet per minute from the glove box. The scrubber controls the hydrogen fluoride concentration in the exhaust gas to less than 5 parts per million. The scrubber exhausts to the filter building and main process stack which has a total exhaust rate of 240,000 cubic feet per minute. The hydrogen fluoride concentration monitor is located directly after the scrubber, well before the filter building. The concentration of hydrogen fluoride is monitored and controlled primarily in response to safety concerns, as hydrogen fluoride can damage the HEPA filters in the filter building if not adequately controlled.

Emissions of carbon tetrachloride from the Z-Plant are presently uncontrolled. Carbon tetrachloride emissions from the Z-Plant main stack have been estimated by facility safety engineers from purchasing records and process analysis. According to this analysis, annual emissions of carbon tetrachloride were about 21.7 tons in 1984, 11.2 tons in 1985, and 7.4 tons in 1986. Exhaust concentrations were less than 1.0 ppm in 1984, 1985 and 1986.

According to the operators, process analysis indicates that nitrogen oxide emissions from the dissolvers and extraction process, although uncontrolled, are considerably lower than the emissions from either the PUREX or Uranium Oxide facilities. Emissions of hydrogen fluoride under normal operating conditions are less than 0.1 pounds per hour. Facility safety engineers have estimated that, upon failure of the caustic scrubber, up to 3.5 pounds per hour (1600 grams per hour) of hydrogen fluoride could be emitted from the main stack, causing a measurable concentration of hydrogen fluoride in the ambient air in the vicinity of the plant. Failure of the scrubber, however, would activate plant alarms and require shutdown of plant operations because of safety considerations. Thus the emissions would not persist for an extended period.

Nitrogen oxide emissions from the new slag dissolver will be controlled by injection of an acid absorbent (aluminum nitrate) into the exhaust gas, which will then be vented to a wet scrubber and to the main process stack. Nitrogen oxide emissions from the new slag dissolver have been estimated by plant safety engineers and are expected to be less than 1 pound per hour after application of controls.

3.1.2.6 Tank Farms

Radioactive liquid wastes generated at all areas of the Hanford Site are presently stored in underground tanks located in the 200-East and 200-West Areas. These tank farms are designated by the number 241 and a letter (e.g., 241AZ and 241AN, which are located near the 242A Evaporator) or other designations (e.g., 219S, 242TA). Individual tanks are designated by number and letter (e.g., 105A, located in the 241A Tank Farm).

The 200-Area Tank Farms include both single-shell and double-shell tanks of varying ages. No single-shell tanks (SSTs) are now in use for current waste disposal operations. Wastes presently being stored in SSTs are being transferred to double-shell tanks. The double-shell tanks are in active use, and are accepting waste currently generated by the Hanford Site operations. Both single-shell and double-shell tanks in the 200-East Area were investigated during the Survey; tanks in the 200-West Area were not examined because of similarity in design.

The double-shell tanks are being used to store wastes generated by the 242A Evaporator and other Hanford Site operations. Wastes are transferred between tanks and to tanks from process areas by use of underground pipes and jumper (temporary) hose connections. Connections between tanks are made through multidirectional valves (referred to as diversion boxes) by the tank farm operators. Transfer routes are checked manually by the operators and verified before the transfer is begun, according to facility procedures. Installation of diversion box routing indicators in the 242A Evaporator control room is scheduled. This will provide for an additional visual check of the position of the diversion box valve before any waste transfer is begun.

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Double-shell tank systems consist of a double-shell tank, with an inner and outer wall separated by an annular space, pumps, piping and valves, and ventilation and leak detection systems. The main tank ventilation systems (each of which includes an exhaust fan, HEPA filter unit, radiation monitors, and stack) exhaust the inside of the double-shell tanks. A single ventilation system may exhaust multiple tanks, in which case all the tanks are connected to the system by underground ducts. A second ventilation system, also equipped with a radiation monitor and HEPA filter, exhausts air from the annular space between the tank walls. Air is circulated through the annular space for both heat removal and leak detection. Additional elements of the leak detection system include liquid level and radiation detectors in the annular space, as well as ambient air monitors with alarms. Detection of liquid in the annular space, or of high radiation concentrations in either the annular space or in the exhaust gas indicates that the inner wall of the tank has been breached. On the annular ventilation system, the radiation monitor is situated before the HEPA filter unit, so that any release of radiation will be detected before control.

The SST systems consist of an underground tank and associated pumps, piping, and valves, and generally do not have either leak detection or active ventilation systems. Some SSTs (e.g., 105C, 106C) have been equipped with temporary ventilation systems in cases where radiation exposure has been identified as a potential problem. The majority of SSTs, however, are vented to the atmosphere through "breathing vents." These vents are equipped with passive HEPA filter units and emergency pressure-relief valves, but do not have exhaust fans or radiation monitors.

The 200-Area Waste Storage Tanks have four types of potential air emission points, as follows:

- o Double-shell tank main ventilation systems
- o Double-shell tank annulus ventilation systems
- o Single-shell tank breathing vents
- o Diversion boxes and other aboveground liquid transfer points

The double-shell tank main and annulus exhausts and SST breathing vents are continuous sources of both radiological and regulated/hazardous air emissions. All

liquid transfers are potential sources of both radiological and regulated/hazardous air emissions. Under normal operating conditions, the double-shell tank main ventilation systems are the most significant sources of radiological emissions, with the annular ventilation systems and SST breathing vents being somewhat less significant. The liquid transfer points are not significant sources of radiological emissions except under process upset conditions and are not continuous emission sources.

Regulated/hazardous air emissions from the double-shell tank exhausts and SST breathing vents are not monitored and have not been characterized. It is expected that the main ventilation systems are the most significant sources of regulated/hazardous emissions from the tank farms.

Diversion boxes and other liquid transfer points are a major potential source of air emissions in cases where a waste transfer has been misrouted or where tank farm operating procedures have been violated. Such actions have the potential to cause the uncontrolled release of liquid waste to the air or ground. Accidental pressurization of a transfer line during a waste transfer in 1985 (Galbraith, 1985) caused the release of liquid waste to the air and resulted in a measurable increase in ambient strontium-90 levels southeast and northwest of the 200-East Area (Price, 1986). The pressurization of waste tanks also has the potential to cause increased emissions to the air. A series of tank pressurizations occurred in 1985 and 1986, mostly the result of failure of the tank ventilation systems to operate (Bates et al., 1986). None of these events resulted in any significant increase in emissions from the tanks.

The radiological emissions from the breathing vents are not continuously monitored, and emissions are not routinely assessed. In instances where emissions of radionuclides from a breathing vent have been identified as a problem by radiation technologists (e.g., due to condensation of radioactive liquid), temporary ventilation systems similar to those used for tank annulus ventilation have been applied. Radiological emissions from the breathing vents are otherwise controlled by passive HEPA filters. Although these filters are subjected to annual efficiency tests as are other filters, HEPA filter units are not designed for passive ventilation, and it is not known what effect, if any, this has on their efficiency.

The emissions of beta/gamma-emitting radionuclides from the double-shell tank exhausts and annulus exhausts are continuously monitored by drawing a sample of exhaust gas at a constant flow rate through standard beta/gamma detectors. Emissions of alpha-emitting radionuclides are not monitored in all exhausts. Waste analyses indicate that alpha emissions will be proportional to beta emissions for some wastes; in this case, only beta/gamma emissions are monitored. The radiation monitoring system on the double-walled tank ventilation system in the 241AY Area (designated 702A) is equipped with a particulate filter, silver zeolite cartridge, and carbon-14 and tritium bubblers, in addition to the standard beta/gamma detector. This is a unique experimental system designed to assess the emissions of carbon-14, tritium, and volatile radionuclides from the 702A exhaust. Similar systems have not been applied to other tank exhausts, and the results of this monitoring program are not yet available.

Particulate samples are also taken from the tank exhausts and annulus exhausts by drawing exhaust gas through a particulate filter at a constant rate. The filters are analyzed weekly. The samplers are equipped with gas flow totalizers, rotameters (gas flow meters) and hour meters. A rotameter reading is taken each time a filter is replaced, and both readings are used to convert the sample analyses to concentration values. All tank ventilation systems are operated continuously, and particulate samplers and continuous monitors are operated 24 hours per day.

The exhaust rates of the tank exhausts and annulus exhausts are continuously monitored using Pitot tubes. The exhaust rate readings are output to strip-chart recorders located adjacent to the radiation monitoring systems. The flow readings are not output to the tank farm control stations.

The double-shell tank exhausts and annulus exhausts are controlled by redundant HEPA filter units with redundant exhaust fans. The 702A Ventilator has six banks of double filters (one redundant) and two fans (one backup). The fans are switched periodically to reduce wear, which has historically been a problem at the tank farms (Bates et al., 1986). The filter units are equipped with pressure sensors, which are read daily by the operators. The filter units are subjected to standard efficiency tests annually.

In general, tank main and annular exhaust alpha and beta exhaust gas concentrations are less than 10 percent of the DOE Radioactivity Concentration Guides (RCG) for uncontrolled areas. Total beta concentrations in the 241AY, AZ main exhaust (702A) are greater than 10 percent of the RCG, but do not exceed the RCG. Results of the special monitoring program on this exhaust may identify the nature of the emissions. The concentrations of ruthenium-106, a volatile radionuclide, from the 241AW main exhaust are also greater than 10 percent of the RCG, but do not exceed the RCG. Also, the total beta emissions from the 105, 106C SSTs on the temporary exhaust are significantly higher than for several of the double-shell tank main exhausts. Radiological emissions for tank farms and several other facilities for calendar year 1985 are summarized in the 1985 annual emission report (Aldrich and Stanfield, 1986). Regulated/hazardous air emissions from the single- and double-shell tanks have not been characterized.

Continuous radiological emissions from the double-shell tank ventilation systems are in general well controlled and monitored. Several of the exhausts are above 10 percent of the RCG; however, none approach or exceed the RCG. Regulated/hazardous emissions have not been assessed, and the potential environmental impact of any emissions cannot be readily assessed.

3.1.2.7 PUREX Liquid Waste Evaporator

The PUREX Liquid Waste Evaporator, also referred to as the 242A Evaporator, is located in the 200-East Area of the Hanford Site, in the 242A Building. Two other evaporator units, designated 242S and 242T, located in the 200-West Area, are presently on standby status. There are no plans to reactivate 242T; reactivation of 242S may be considered in the future.

The evaporator is used to process radioactive liquid wastes generated by the PUREX Plant (located in the 200-East Area) to reduce the waste volume prior to disposal in the 200-Area Tank Farms. The liquid waste is concentrated by evaporation of water from the waste using a combination of heat and vacuum. The water vapor generated is drawn from the evaporator vessel by vacuum, and recovered by a series of mist de-entrainers and water-cooled condensers. The condenser vacuum exhausts to the main vessel vent and through HEPA filters to the atmosphere. The evaporator building ventilation system is exhausted through a separate HEPA filter unit to a 200-foot stack.

The concentrated waste liquid is pumped from the evaporator to a storage tank, from which it is transferred to the double-shell radioactive waste storage tanks in the 200-East Area. The recovered evaporator condensate, which is contaminated with strontium, cesium, and other radionuclides, is disposed of as low-level radioactive liquid waste in cribs. The low-pressure steam used to supply heat and vacuum to the evaporator is also condensed to liquid. The steam condensate is generally nonradioactive, and is disposed of in an evaporation basin.

The evaporator has two stacks that are sources of both radiological and regulated/hazardous air emissions. These are: 296A22 - 242A vessel vent - main process exhaust for evaporator/condenser vacuum system; and 292A21 - 242A building exhaust - ventilation system exhaust for evaporator process areas.

The vessel vent and building exhaust are sources of beta-emitting radiological emissions. The total beta emissions from the building exhaust were approximately one order of magnitude higher than from the vessel vent in 1985 (Aldrich and Stanfield, 1986). Radiological emissions (beta-emitters) are assumed to be strontium-90 for the purposes of dose calculations, although cesium-137, tin-113, and other radionuclides may also appear in the vessel vent and building exhaust gas. Total alpha emissions from the two exhausts are not significant. The vessel vent is a potential source of regulated/hazardous emissions, as volatile constituents of the PUREX wastes may evaporate and be vented to the vacuum system. The potential for regulated/hazardous emissions from the evaporator has not been assessed.

The vessel vent and building exhaust are continuously monitored for alpha- and beta/gamma-emitting radionuclide concentrations and for total flow rate. Total alpha and beta/gamma radionuclide concentrations are measured by drawing a sample of exhaust gas at a constant flow rate through standard alpha and beta/gamma continuous monitoring devices. In addition, the vessel vent sample line contains a zeolite filter, which is used to collect volatile radionuclides for analysis. A particulate sample is collected from each exhaust with filters that are analyzed weekly. Each particulate sampler is equipped with a gas flow meter and hour meter. The gas flow readings are used to convert the sample analyses to concentration values. The building vent particulate sample is only taken when the building exhaust fan is operating. The alpha and beta/gamma monitor readings and vessel vent record sample are taken continuously. The alpha monitor is calibrated annually, and the beta/gamma monitor is calibrated semiannually.

The exhaust rates of both the evaporator vessel vent and building exhaust are continuously monitored using Pitot tubes. The exhaust rate readings are output to the evaporator control room, where they are monitored by the operators. In addition, Vent and Balance personnel perform a monthly traverse of the exhaust velocity on the building exhaust to measure the exhaust gas flow rate.

The continuous alpha and beta/gamma monitors are alarmed to indicate loss of sample flow, low sample flow, and high radiation readings. The alarms are output to the evaporator control room, where they are monitored by the operators, and to the central control station in the 2750 Building. Alarm set points for emissions of beta-emitting radionuclides are typically 1000 counts per minute. These are determined by ALARA guidelines, and are significantly lower than the Table I DOE guideline concentrations for air emissions. The central control station in Building 2750 also contains alarm outputs for the 200-Area Tank Farms, and the station is staffed 24 hours a day.

Radionuclide emissions from both the vessel vent and the building exhaust are controlled by HEPA filter units. The building exhaust is equipped with two redundant (parallel) filter systems, each consisting of an exhaust fan, prefilter, and primary and secondary HEPA filters. The vessel vent does not have a redundant system, but has a single fan, prefilters, and primary and secondary HEPA filters. The filters are monitored for differential pressure and are subject to standard efficiency tests annually. The HEPA filter exhausts are sampled and the only beta nuclide detected when specific radionuclide analyses were performed on particulate sample filters was strontium-90. The total beta emissions from the inactive 242S and 242T building exhaust and vessel vents and 242A appear below (Aldrich and Stanfield, 1986):

Facility	Status	Stack	Total Beta (Ci)	Beta Conc. (μCi/cc)
242A	Active	Building exhaust	0.73E-4	0.266E-12
		Vessel vent	0.91E-5	0.933E-12
242S	Inactive	Vessel vent	0.51E-6	0.752E-13
		Building exhaust	0.22E-4	0.804E-13
242T	Inactive	Building exhaust	<0.12E-5	<0.374E-13

Regulated/hazardous emissions from the vessel vent and building exhaust have not been characterized. Regulated/hazardous emissions from the inactive 242S and 242T Evaporators are expected to be negligible. Radiological emissions from the 242A Evaporator are well controlled and monitored. Several events in 1985 involving loss of building and vessel ventilation did not result in significant emissions to the environment, but do represent a potential exposure hazard. The causes of these events and corrective actions have been addressed in a trending report (Bates et al., 1986).

Regulated/hazardous emissions from the 242-A Evaporator have not been characterized, and therefore the potential environmental impact of these emissions cannot be reliably assessed.

3.1.2.8 Reactor Facilities

The 100-Area contains the production reactors and was operated by UNC. The N-Reactor located in the 100N-Area is the only operational reactor, and is the major source of radioactive particulate, iodine, and noble gas emissions (73,840 curies for 1985) in the 100-Area. These radioactive air emissions are discharged to the environment via the 116N main stack and via various lesser ventilation exhausts from the buildings.

The other eight reactors in the 100-Area are retired, but several support facilities in the 100K Area are still in operation. The 100K water treatment Systems provide treated process water to the 200-Area, and the 100KE and 100KW Basins are being used to store N-Reactor spent fuel. Because of the radioactive material and the presence of operating personnel, some of the 100K ventilation systems are operated, which resulted in less than 2 microcuries total radioactive release for 1985.

The K-Reactor exhaust (1706KEL) is treated with a HEPA filter and the N-Reactor main stack (116N) is treated with HEPA and charcoal filters. All effluent release points have radiation samplers with particulate filters and charcoal cartridges, which are collected and analyzed routinely per the sampling schedule in UNI-M-76, "Effluent Radioanalytical Program Manual" (UNC, 1984). A new effluent

monitoring system has been installed in a new sample shed at the base of the 116N stack, and is in the final stages of testing. This system has been designed by Eberline to meet the accident monitoring requirements of Nuclear Regulatory Commission (NRC) Regulatory Guide 1.98.

The airborne radioactive releases from the N-Reactor for 1985 totaled 73,840 curies of particulate, iodine, and noble gas activity, with 93.6 percent of the activity due to argon-41. Air emissions of regulated/hazardous substances from N-Reactor are insignificant. The UNC 1985 Effluent Release Report (UNI-3880, UNC, 1985) indicated the total annual release of argon-41 via the 116N stack decreased by 12 percent compared to the same release for calendar year 1984 (65,000 curies versus 74,000 curies) as a result of 23 percent less reactor operating time.

3.1.2.9 Laboratories

Major sources of airborne pollutants in the 300-Area other than the UNC Fuels Fabrication Facilities, and 384 Power House, are the Battelle Pacific Northwest Laboratories (PNL) and the Hanford Engineering Development Laboratory (HEDL) laboratories. The laboratories are minor sources of airborne pollutants.

PNL operates facilities in the Chemical Engineering Laboratory (324 Building) and the Life Sciences Laboratory (331 Building). Emissions from these buildings will be discussed in this section. Inactive 300-Area facilities and facilities with a negligible potential to impact the environment are not discussed.

3.1.2.9.1 Hanford Engineering Development Laboratory

The HEDL includes several buildings in the 300-Area and is operated by Westinghouse. Activities include fuel fabrication and analytical and engineering support for the FFTF program, and engineering development of processes in support of other Hanford Site and off-site activities.

A review of materials used in HEDL facilities by the HEDL environmental and radiological engineering group did not identify a need to monitor for any regulated pollutant emissions other than the 384 Power House emissions. Therefore, no other

monitoring of regulated/hazardous emissions from HEDL facilities is conducted (HEDL, 1984a). Neither radiological nor regulated/hazardous emissions from HEDL Laboratories are significant environmental hazards with respect to other site facilities.

The following 300-Area buildings and facilities are discussed in this section.

1. 306E, Metal Fabrication Development Laboratory
2. 308, Plutonium Laboratory
3. 324, Chemical Engineering Laboratory
4. 325, Radiochemistry Laboratory
5. 326, Materials Technology Laboratory
6. 3718F, Sodium Storage/Disposal Facility

Metal Fabrication Development Laboratory, Building 306E

Uranium-fueled and non-uranium-fueled elements and absorber elements for the FFTF are assembled, inspected, and tested in this facility. Fuel pellets are manufactured from natural uranium in two laboratories in the building. Fuel fabrication operations are similar to those conducted in Building 308 using plutonium, which are described in this section. Other operations include nondestructive materials testing and metallurgy laboratories. Laboratory hoods are equipped with individual exhausters, and the exhausts from the uranium laboratories are equipped with HEPA filters. The building supply air is recirculated through particulate filters. Laboratory equipment exhausts to a duct system leading to two exhaust fans. Chemical and acid tanks are exhausted through two fans to a 40-foot stack separately from the laboratory equipment. Fumes from the tanks are not controlled (Asay, 1983).

Plutonium Laboratory, Building 308

The Plutonium Laboratory is the fabrication facility for plutonium-fueled elements for the FFTF and the experimental breeder reactor (EBR-II) at Idaho National Engineering Laboratory (INEL). Plutonium and uranium oxide powder are formed into pellets, which are stacked into metal tubes referred to as fuel pins. The fuel pins are bundled into fuel assemblies that are shipped to the FFTF. Nondestructive

testing and instrumentation of the fuel assemblies are also conducted in Building 308. Fuel fabrication laboratory functions and some assembly operations are conducted in glove boxes. Other operations are conducted in the high bay area of the building (Asay, 1983).

The laboratory glove boxes are operated under negative pressure (vacuum) such that room air flows into the glove boxes. Both the inlet and outlet glove-box vents are equipped with HEPA filters. The outlet filters are tested for efficiency before installation, but cannot be tested in place. Each glove-box exhausts to a primary HEPA filter unit, which is subject to annual efficiency testing and monitored for differential pressure. These HEPA filters are vented to the glove-box exhaust system, to secondary HEPA filter units equipped with two exhaust fans (one backup), and then to the atmosphere. The secondary filters are tested annually and monitored for differential pressure. Laboratory hoods are also exhausted through in-place and primary HEPA filters before venting to the glove-box exhaust system. The inlets to the primary HEPA filters are sampled for radiation (alpha and beta activity). If trigger radiation levels (usually 10 percent of the DOE RCG) are detected, detailed analyses are performed. The frequency of analysis varies, depending on the specific glove-box operation.

The building supply air is filtered twice through HEPA filters to remove particulates and recirculated into the building through a ventilation system separate from that for the glove-box exhaust, which is not recirculated. The entire Building 308 is operated under negative pressure, and balanced such that air flows from corridors to laboratory rooms to glove boxes to the glove-box exhaust system. All the building air is recirculated, and makeup air is provided to account for that lost through the glove-box exhaust system. The glove-box exhaust and the supply air are continuously monitored for radiation (alpha and beta activity).

There are several small acid/chemical tanks in the 308 Building that are occasionally used to etch assembly components. Dilute nitric acid and caustic solutions are used, and are exhausted to an acid recovery condenser and to the glove-box ventilation system. The fumes have been classified as nonhazardous by HEDL chemical hazard evaluation/industrial safety, and an existing wet scrubber on the exhaust is no longer used. A small amount of room air is also exhausted from a welding area in the 308 Building, which is filtered before being vented to

9 2 1 2 4 6 1 1 4 6 2

the building ventilation system. No monitoring of regulated/hazardous constituents is conducted on any of the exhaust systems in the 308 Building.

Chemical Engineering Laboratory, Building 324

This facility provides areas for laboratory, bench scale, and pilot-plant scale engineering evaluations of various processes. Both HEDL and PNL operated facilities in Building 324. Both short-term and long-term studies are conducted by both groups. Present HEDL activities include a pilot-scale plant (under construction) for dissolution of uranium in nitric acid and nondestructive testing of irradiated fuel. The PNL is presently conducting pilot studies of the high-level-waste vitrification process. The HEDL operates a nuclear materials storage facility, a plutonium glove-box laboratory, and radioactive and nonradioactive materials and wet chemistry laboratories in Building 324. The building has two shielded hot-cell areas for activities involving high-level radioactive materials. These are exhausted to primary and secondary HEPA filters and then to the laboratory exhaust system. No continuous, permanent production facilities are located in Building 324 (Asay, 1983).

The laboratory areas of Building 324 are exhausted by five fans to a filter building and a 100-foot stack. Total alpha and beta concentrations in the building exhaust are continuously monitored, and the analyzers are alarmed to indicate high radiation levels. Particulates are collected on sample filters and are analyzed weekly. Emissions of iodine are monitored by means of charcoal filters that are analyzed weekly. The total stack flow rate is monitored by a Pitot tube/manometer, which is calibrated annually. The five exhaust fans are tested annually for flow rate by HEDL Vent and Balance personnel.

The emission control and monitoring systems for short-term experiments conducted in the 324 Building depend on the nature of the experiment. Laboratory procedures require the experiment design to include provisions for emission control and waste disposal. Activities such as the vitrification pilot plant and nondestructve irradiated fuel testing are conducted in hot cells with permanent HEPA filter units. Other experiments, such as the uranium dissolution experiment, are equipped with temporary control systems for the duration of the study.

The uranium dissolution plant in the 101 Area of the building (presently under construction) will emit nitrogen oxides and particulate uranium when operating. These emissions will be controlled by an acid scrubber and two-stage HEPA filters located outside the building. The facility will also be equipped with an emergency ventilation system and fume scrubber which will be activated in the event of a fire. The facility is expected to operate for 6 months after completion, and emissions are expected to be insignificant.

Irradiated fuel testing is conducted in hot cells in the 139-Area, which are exhausted through primary and secondary HEPA filters and vented to the building exhaust. The primary filters are analyzed for radiation, and both the primary and secondary filters are subjected to annual testing. Carbon filters are used to control iodine emissions when "green" (short-cooled) fuel is tested, and the iodine filters on the exhaust gas sampling system are analyzed when activities having the potential to emit iodine are conducted.

The PNL vitrification process studies are conducted in several areas of the 324 Building. The pilot plant is operated in hot cells, which are equipped with primary and secondary HEPA filters, and vented to the building exhaust. Nonradiological vitrification tests and low-level-waste tests are conducted in the 102-Area and other areas. Emissions of radionuclides and nitrogen oxides from the vitrification calciners are controlled by particulate filters and acid scrubbers. Part of the PNL test program involves testing of alternative control systems. The "cold" test areas exhaust to the building ventilation system and a 150-foot stack. The studies include operation of bench-scale electric furnaces (calciners) and a pilot-scale calciner.

Radiochemistry Laboratory, Building 325

This building houses laboratories devoted to analytical chemistry and chemical research involving radionuclides. Analyses of stack particulate samples and iodine charcoal filters are performed in this facility. Laboratory equipment includes shielded radiochemical cells, electron microscopes, and mass spectrometers. Building ventilation air is supplied to offices and corridors and exhausted from laboratory areas, providing a directed flow for contamination control. Individual laboratories are exhausted to primary HEPA filters. Some of the primary filter

inlets are monitored for alpha and beta activity and alarmed. The primary HEPA filters exhaust to the main building ventilation system, through a secondary HEPA filter unit, and up a 200-foot stack. Both the primary and secondary HEPA filter units are subjected to annual efficiency testing and are monitored for differential pressure (Asay, 1983).

A recent upgrade involved the installation of additional filters and exhaust fans in the Building 325 ventilation system, and also an isokinetic sampling port and constant-flow sampling system on the main stack. The stack exhaust is continuously monitored for alpha and beta activity, and alarmed to indicate high levels. Particulate samples are collected with filters, and iodine emissions are monitored using charcoal filters. There are continuous monitors on the particulate and iodine filters, which are alarmed such that activity above 400 counts per minute and 10,000 counts per minute, respectively, will be indicated. Both filters are analyzed weekly.

Materials Technology Laboratory, Building 326

This building contains laboratories and facilities for the study of the metallurgical, chemical, and physical properties of reactor components and fuel materials. Laboratory equipment includes electron microscopes, metallographic equipment, and x-ray diffraction apparatus. Little work with radioactive materials is conducted in this facility. Building ventilation air is supplied to offices and corridors in the building, and the laboratory areas of the building are exhausted unfiltered to the atmosphere. Laboratory hoods in areas using radioactive materials are exhausted separately through HEPA filters and fans to a 45-foot stack. This provides a pressure barrier to control contamination. A metallographic grinding room is also separately exhausted through a baghouse to control dust emissions (Asay, 1983).

Sodium Storage/Disposal Facility, Building 3718F

This facility is used to dispose of nonradioactive alkali metals (mainly sodium) by incineration. The sodium is removed from equipment (if necessary) using 2-butoxyethanol, and loaded in approximately 20-pound batches into the burn chamber. The sodium is ignited using gasoline and diesel fuel, and takes several

hours to burn to completion. The burn chamber is exhausted by a fan to a venturi water scrubber, which removes particulate sodium oxide and other particulates. The water containing sodium (as hydroxide) is piped to the area process sewer and the scrubbed exhaust gas vented to a 30-foot stack. The burn rate and scrubber water flow rate are set such that the pH of the scrubber effluent is calculated to be less than 12.5. The 2-butoxyethanol is disposed of by the Waste Management Department. Approximately 300-400 pounds of alkali metals are burned each month. The facility is operated only at night when the wind direction is away from the 300-Area buildings, to prevent fumigation of plant areas by the exhaust gas. The emissions and exhaust rate from the facility are not monitored. Recent particulate emission tests show that particulate concentrations from the facility exhaust are less than Washington State standards (Somers, 1986a).

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3.1.2.9.2 Battelle Pacific Northwest Laboratory

Chemical Surety Building Exhaust, Building 331 - Battelle operates the laboratory for the testing of toxic chemical agents. Ventilation exhaust from the fume hoods passes through two charcoal filters in series. The charcoal filters are designed to prevent potentially harmful amounts of toxic materials from being released from the facility. The principal potential challenge to the filters results from the accidental spill of a pure toxic compound within the facility. The PNL has established a collection efficiency requirement of 99.9 percent for the filter system, and has the filters tested annually. The filters were tested in May 1986 by ANCO Engineers. The tests showed the filter system has a collection efficiency of 99.99 percent for Freon (ANCO, 1986; Eberhardt, 1986).

Biological Incinerator, Building 331 - Mixed waste from the PNL laboratories is incinerated on Tuesdays and Fridays. The waste may contain biological samples, plastic containers, and paper. Approximately 14 tons of waste are burned annually in the gas-fired incinerator. The waste burns at a temperature of at least 1600°F, and the exhaust gas is routed through a wet scrubber/cyclone device prior to emission to the atmosphere from a 20-foot-high stack. Tests are conducted annually by HEHF for compliance with the 0.1 grain per standard cubic foot emission limit. Emissions from the incinerator have typically been measured at levels within the standard. Results of the 1986 emissions test were less than 0.015 grain per standard cubic foot (HEHF, 1986d).

3.1.2.10 400-Area Facilities

The 400-Area includes three facilities that release radioactive pollutants to the air; the FFTF, the Maintenance and Storage Facility (MASF), and the Fuel Cycle Plant (FCP). These facilities are the newest major facilities at the Hanford Site.

The FFTF is a sodium-cooled fast flux breeder reactor designed and operated to perform irradiation testing of various materials. Fuel for the reactor is produced in the 300-Area. Once irradiated, the fuel and/or test materials are shipped to the 300-Area or off-site facilities for testing. Small amounts of liquid and solid wastes are transported to the 200-Area for disposal. Air emissions of radionuclides and particulates are controlled, and are discharged from three monitored vents: the lower reactor service building exhaust; the combined exhaust; and HTS south. Small quantities of regulated/hazardous pollutants (primarily oxides of sulfur and nitrogen) are emitted from three emergency electrical generators (two diesel engines and one gas turbine).

The MASF is used for the decontamination, maintenance, and storage of large components from the FFTF. It includes a large bay area and three decontamination cells. Liquid and solid radioactive wastes are handled in the same fashion as those from the FFTF. The ventilation system in the facility includes HEPA filters, and airborne radioactive effluents are monitored. No regulated/hazardous airborne discharges from this facility were identified.

The building housing the FCP was originally constructed as the Fuels and Materials Examination Facility (FMEC). Plans for the FMEC were canceled and most of the facility is not in use. The FCP is located on the top level of the building and includes an automated fuel fabrication facility for the FFTF. The FCP was still under construction at the time of the Survey. Solid, liquid, and airborne wastes from the facility will be monitored and controlled in a fashion similar to the FFTF.

3.1.3 Environmental Monitoring Program

3.1.3.1 Regulated/Hazardous Air Quality Monitoring and Data Summary

Regulated/hazardous gaseous emissions from chemical processes and fossil-fueled steam plants at the Hanford Site consist primarily of oxides of nitrogen (NO_x) and

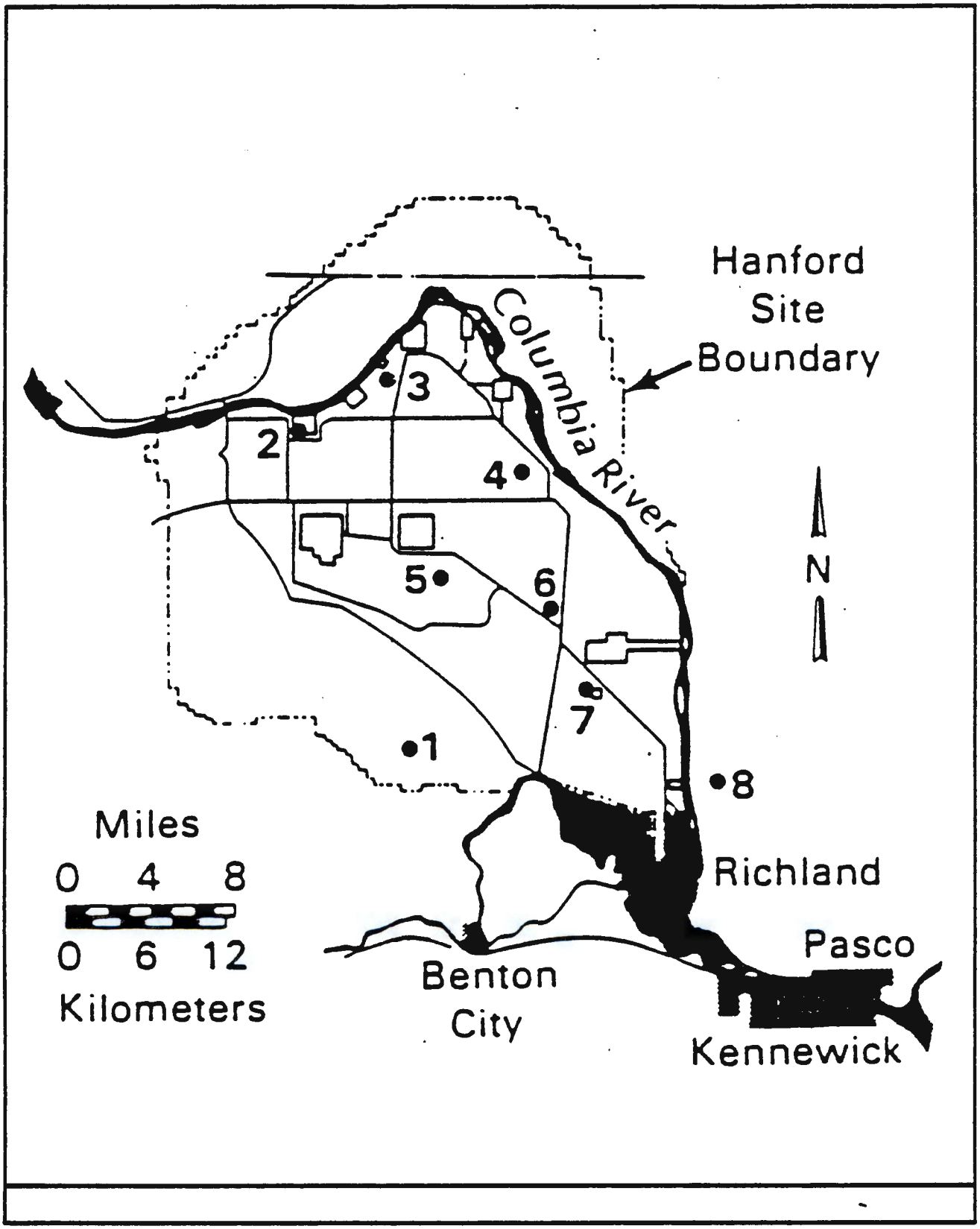
sulfur (primarily SO_2). The HEHF operates an eight-station network for monitoring nitrogen dioxide (NO_2) concentrations around the site. The locations of the monitors are illustrated in Figure 3-1. The sampling procedure follows the EPA Designated Equivalent Method No. EQN-1277-028, TGS-ANSA Method for the Determination of Nitrogen Dioxide in the Atmosphere. The sampling units consist of a series of bubbler assemblies containing absorbing solution. Ambient air is drawn through a bubbler by a sequential pump that cycles every 24 hours. Samples are collected weekly and analyzed as described in the procedure without deviation. The program operated from 1978 through 1980, and was restarted in 1982 in support of the PUREX Plant air quality permit application. The annual averages at all sampling locations have been less than 0.010 part per million and well below the NAAQS for NO_2 of 0.05 part per million as shown in Table 3-5 (Price, 1986). The accuracy of the data is supported by good quality control practices, and the sampling equipment is well maintained and calibrated routinely. To ensure accurate analytical results, the HEHF Laboratory maintains control charts for blanks and standards, and submits blind spiked samples to the analyst.

3.1.3.2 Radiological Monitoring

PNL also monitors the ambient air concentrations of radionuclides for the entire Hanford Site, including the off-site control locations described in Section 3.1.1. In addition to the PNL monitoring, the 100-Area and 200-Area is also monitored by the area custodians. The 300-Area and 400-Area contractors do not conduct any ambient air monitoring but rely on the PNL site-wide monitoring program.

3.1.3.2.1 Pacific Northwest Laboratory

Radioactivity in air is measured by a network of continuously operating air samplers at 25 locations on the Hanford Site, 15 near the site perimeter, 5 in nearby communities, and 5 in relatively distant communities. Air samplers on the Hanford Site are located primarily around the major operating areas to characterize maximum concentrations in the air from site operations. Radionuclides in airborne dust are sampled by continuously drawing air at a flow rate of 2.6 cubic meters per hour through a 5-centimeter-diameter high-efficiency glass fiber filter. The filters are collected biweekly, held for 7 days, and analyzed for gross beta activity. Filters from selected locations are analyzed for gross alpha activity.



NITROGEN DIOXIDE AIR SAMPLING LOCATIONS FIGURE 3 - 1

TABLE 3-5

AMBIENT NITROGEN DIOXIDE (NO_2) CONCENTRATIONS IN THE HANFORD ENVIRONS FOR 1985

Location	Map Location[a]	Number of 24-hour Samples	Annual Average[b] (ppm NO_2)	% Samples Less Than Detection Limit (0.003 ppm NO_2)	Maximum Sample (ppm NO_2)
ALE	1	268	0.006 ± 0.0003	4.5	0.018
100B	2	282	0.006 ± 0.0003	2.8	0.016
100D	3	286	0.006 ± 0.0004	5.2	0.017
Hanford Townsite	4	289	0.007 ± 0.0003	1.0	0.015
200 ESE	5	265	0.007 ± 0.0004	2.6	0.021
Wye Barricade	6	193	0.009 ± 0.0006	0.5	0.039
400-Area [c]	7	62	0.007 ± 0.0008	0.0	0.016
Sullivan Barn	8	278	0.008 ± 0.0004	0.0	0.020

(a) Locations are identified in Figure 3-1
(b) Annual averages ± two standard error of the mean. Samples less than detectable daily concentrations were assumed equal to the 24-hour detection limit (0.003 ppm).
(c) Based on data for March, April, and May only because of electrical maintenance work.

Source: Price, 1986

Monthly composites are made of the biweekly samples and analyzed for gamma-emitting radionuclides. Quarterly composites are made of the monthly composites and analyzed for strontium and plutonium. Most quarterly composites are also analyzed for uranium.

Gaseous iodine-131 is sampled by drawing a 2.6 cubic-meter-per-hour air flow through a 6.3-centimeter-diameter by 2.5-centimeter-deep cartridge containing activated charcoal. These cartridges are placed downstream of the particulate filter at each air sampling station. Charcoal cartridges from prescribed sampling locations are exchanged biweekly and analyzed for iodine-131. The remaining cartridges are exchanged monthly to maintain fresh adsorption media, but are analyzed only if iodine-131 is identified in one of the routinely analyzed samples, or if there is any other indication of an airborne release that could result in a detectable ambient concentration. Iodine-129 is sampled using the same technique; however, a petroleum-based charcoal is used because of its lower background concentration, and samples are obtained once per quarter at four locations.

Atmospheric water vapor is collected for tritium analysis by continuously passing air through cartridges of silica gel at a flow rate of 0.014 cubic meter per hour. The collected moisture is removed from the silica gel and analyzed. The silica gel cartridges are exchanged every 4 weeks.

Atmospheric carbon dioxide is collected by continuously passing air through a soda-lime collection medium for 8 weeks at a flow rate of 0.28 cubic meter per hour. The trapped CO_2 is then analyzed for carbon-14 content and the atmospheric concentration calculated. Soda-lime cartridges are changed every 8 weeks.

Samples of air for krypton-85 analysis are collected using a small pump that continuously fills a collection bag with air at a low flow rate. About 0.3 cubic meter of air is collected over 4-week sampling periods throughout the year. The entire sample of air is analyzed for krypton-85.

On August 25, 1986, observations were made during the Survey of the exchange of PNL air particulate filters and charcoal cartridges at seven stations. Silica gel cartridges were also exchanged at two of these seven stations. One of the sampling units was not operating, so the sample collector removed the defective unit and replaced it with one that was operable.

Average concentrations of radionuclides in air for 1985 from the PNL site-wide monitoring program are presented in Table 3-6. Table 3-7 presents the PNL area-specific measurements of radionuclides in air.

3.1.3.2.2 100-Area Monitoring

Environmental air samples were collected in the 100-Area by UNC with continuously operating low-volume sample pumps. Ambient air is drawn through a 1-cubic-foot-per-minute orifice into a stainless-steel sample cartridge containing a particulate filter and a bed of activated charcoal. The sample cartridges are changed monthly and analyzed for gamma-emitting radionuclides at the 100-Area Radioanalytical laboratory located in Room 50 of the 105N Building. There are three air monitoring stations for the 100N-Area. One of the ambient air monitoring stations is at the 1301N Liquid Waste Disposal Facility (LWDF). Average radionuclide concentrations in air reported by UNC are presented in Table 3-8.

3.1.3.2.3 200-Area Monitoring

Ambient air sampling is conducted to determine baseline concentrations of radionuclides in the 200-Area and to assess the impacts of site operations. In 1985, 8 new air sampling stations were established, bringing the total number to 44. Two were placed inside the 241TY Tank Farm, three were added to monitor the proposed grout disposal site east of 200-East, and three were added inside the 200-East Area.

Air samplers are operated at a flow rate of 2 cubic feet per minute, drawing the sample through a 47-millimeter, open-face filter at ~ 3 feet above the ground. All filters are exchanged weekly, held 1 week, and then sent to the 222S Laboratory for initial analysis of gross alpha and gross beta activity. Quarterly composites are sent to U.S. Testing for analysis of gamma-emitting nuclides, strontium-90, plutonium, and uranium. Average annual radionuclide concentrations in air for locations within the 200-Area are presented in Table 3-9.

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TABLE 3-6

ON-SITE AND PERIMETER MEASUREMENTS OF RADIONUCLIDES IN AIR, CONDUCTED BY PNL (1985 DATA ONLY)

Parameter	Average Activity, $pCi/m^3 \pm 2s$(1)	
	On-site	Perimeter
Gross Alpha	0.0011 ± 0.0001	0.0011 ± 0.0001
Gross Beta	0.035 ± 0.002	0.033 ± 0.003
H-3	3.1 ± 0.6	1.7 ± 0.4
C-14	1.4 ± 0.1	1.3 ± 0.1
Kr-85	710 ± 300	150 ± 47
Sr-90	$7.5 \times 10^{-4} \pm 7.0 \times 10^{-4}$	$2.9 \times 10^{-4} \pm 2.0 \times 10^{-4}$
Ru-106	$1 \times 10^{-3} \pm 1 \times 10^{-3}$	$0 \pm 2 \times 10^{-3}$
I-129	$1.1 \times 10^{-4} \pm 1.7 \times 10^{-4}$	$1.7 \times 10^{-5} \pm 7.9 \times 10^{-6}$
I-131	$2 \times 10^{-4} \pm 7 \times 10^{-4}$	$1 \times 10^{-4} \pm 9 \times 10^{-4}$
Cs-137	$3 \times 10^{-4} \pm 2 \times 10^{-4}$	$1 \times 10^{-4} \pm 2 \times 10^{-4}$
Total U	$1.72 \times 10^{-4} \pm 1.12 \times 10^{-4}$	$1.2 \times 10^{-4} \pm 2.7 \times 10^{-5}$
Pu-238	$2.0 \times 10^{-6} \pm 1.1 \times 10^{-6}$	$1.4 \times 10^{-6} \pm 9.0 \times 10^{-7}$
Pu-239, 240	$6.4 \times 10^{-6} \pm 3.0 \times 10^{-6}$	$3.2 \times 10^{-6} \pm 1.0 \times 10^{-6}$

(1) 2 times the Standard Error of the Calculated Mean

TABLE 3-7

AVERAGE CONCENTRATIONS OF RADIONUCLIDES FOR THE 100-, 200-, 300- AND 400-AREAS, PNL DATA FOR 1985

Parameter	Average Activity, pCi/m^3 ± 2s(1)				
	100-Area	200-East Area	200-West Area	300-Area	400-Area
Gross Alpha	0.0011 ± 0.0002	0.0011 ± 0.0001	0.0011 ± 0.0001	0.0015 ± 0.0002	0.0011 ± 0.0001
Gross Beta	0.033 ± 0.004	0.037 ± 0.005	0.039 ± 0.009	0.035 ± 0.004	0.037 ± 0.005
H-3	2.1 ± 0.7	5.7 ± 1.8	2.0 ± 0.9		3.2 ± 3.3
C-14	1.4 ± 0.3	1.5 ± 0.2			
Kr-85	-(2)	970 ± 420		180 ± 130	
Sr-90	$1.8 \times 10^{-4} \pm 2.3 \times 10^{-4}$	$2.6 \times 10^{-3} \pm 4.7 \times 10^{-3}$	$1.5 \times 10^{-3} \pm 2.7 \times 10^{-3}$	$1.6 \times 10^{-4} \pm 1.8 \times 10^{-4}$	$3.2 \times 10^{-4} \pm 3.6 \times 10^{-4}$
Ru-106		$0 \pm 4 \times 10^{-3}$	$3.0 \times 10^{-3} \pm 3.0 \times 10^{-3}$		
I-129	$3.2 \times 10^{-5} \pm 1.0 \times 10^{-5}$	$2.1 \times 10^{-4} \pm 4.2 \times 10^{-4}$			
I-131	$2.0 \times 10^{-3} \pm 3.0 \times 10^{-3}$	$1.0 \times 10^{-3} \pm 3.0 \times 10^{-3}$	0	$-2.0 \times 10^{-3} \pm 2.0 \times 10^{-3}$	$0 \pm 3.0 \times 10^{-3}$
Cs-137	$2.0 \times 10^{-4} \pm 2.0 \times 10^{-4}$	$2.0 \times 10^{-4} \pm 4.0 \times 10^{-4}$	$2.0 \times 10^{-4} \pm 6.0 \times 10^{-4}$	$2.0 \times 10^{-4} \pm 3.0 \times 10^{-4}$	$1.0 \times 10^{-4} \pm 5.0 \times 10^{-4}$
Total U	$6.0 \times 10^{-5} \pm 3.0 \times 10^{-5}$	$6.0 \times 10^{-5} \pm 4.0 \times 10^{-5}$	$8.0 \times 10^{-5} \pm 3.0 \times 10^{-5}$	$2.1 \times 10^{-4} \pm 2.0 \times 10^{-4}$	$7.5 \times 10^{-5} \pm 7.0 \times 10^{-5}$
Pu-238	$6.0 \times 10^{-7} \pm 7.0 \times 10^{-7}$	$1.7 \times 10^{-6} \pm 1.9 \times 10^{-6}$	$2.6 \times 10^{-6} \pm 4.9 \times 10^{-6}$	$8.0 \times 10^{-7} \pm 6.0 \times 10^{-7}$	$1.0 \times 10^{-6} \pm 1.0 \times 10^{-6}$
Pu-239,240	$2.7 \times 10^{-6} \pm 2.1 \times 10^{-6}$	$1.8 \times 10^{-5} \pm 2.2 \times 10^{-5}$	$4.7 \times 10^{-6} \pm 5.0 \times 10^{-6}$	$2.6 \times 10^{-6} \pm 2.9 \times 10^{-6}$	$7.0 \times 10^{-6} \pm 1.8 \times 10^{-5}$

(1) 2 times the Standard Error of the Calculated Mean
(2) Not measured

TABLE 3-8

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN AIR IN THE 100-AREA, UNC DATA FOR 1985

Parameter	Average Activity, pCi/m3	
	100-N Area	1301-N Area
Mn-54	0.039	0.048
Fe-59	--(1)	0.095
Co-60	0.15	0.17
As-76	--	3.8
Zr, Nb-95	0.043	0.040
Ru-103	0.011	0.023
I-131	0.058	0.35
Ce-144	0.027	0.12

(1) Not detected

TABLE 3-9

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN AIR, ROCKWELL DATA FOR 1985

Location	Average Activity, pCi/m^3 ± 2s(1)			
	Sr-90	Cs-137	Pu-239	Total U
241-TX Tank Farm	2.6E-03 ± 8.7E-03	3.8E-03 ± 5.1E-03	4.5E-05 ± 8.9E-05	6.8E-05 ± 1.1E-04
241-U Tank Farm	2.6-03 ± 1.0E-02	3.5E-04 ± 6.9E-04	3.7E-05 ± 6.5E-05	1.2E-04 ± 1.3E-04
241-BY Tank Farm	7.0E-04 ± 7.9E-04	8.2E-03 ± 5.8E-03	1.2E-05 ± 1.2E-05	7.8E-05 ± 7.0E-05
241-AX Tank Farm	1.6E-03 ± 2.4E-03	2.4E-03 ± 2.7E-03	4.6E-05 ± 3.0E-05	1.0E-04 ± 1.3E-04
241-C Tank Farm	1.3E-03 ± 2.2E-03	2.3E-03 ± 3.5E-03	2.3E-05 ± 1.7E-05	7.9E-05 ± 1.1E-04
241-TY Tank Farm	2.0E-04 ± 9.4E-05	1.5E-03 ± 8.8E-04	1.9E-05 ± 3.2E-05	6.7E-05 ± 2.8E-05
B Plant	3.9E-04 ± 3.7E-04	1.9E-03 ± 2.4E-03	2.9E-05 ± 3.0E-05	7.4E-05 ± 7.6E-05
T Plant	2.9E-03 ± 1.1E-02	2.0E-04 ± 1.1E-03	3.0E-05 ± 3.0E-05	6.0E-05 ± 8.6E-05
U Plant	2.7E-03 ± 9.6E-03	8.3E-04 ± 1.1E-03	2.3E-05 ± 1.4E-05	5.6E-04 ± 7.0E-04
Z Plant (East)	4.1E-04 ± 9.1E-04	5.3E-05 ± 9.1E-04	3.1E-05 ± 2.4E-05	8.9E-05 ± 1.4E-04
PUREX	1.8E-03 ± 4.1E-03	1.1E-04 ± 3.5E-04	9.9E-05 ± 3.6E-05	1.4E-04 ± 2.1E-04

(1) 2 times the Standard Error of the Calculated Mean

3.1.3.3 Meteorology System and Data Summary

PNL operates a 24-hour meteorological monitoring system on and around the Hanford Site. The system consists of 20 towers that are 33 feet high, 3 towers that are 200 feet high, and 1 tower of 410 feet. The 33-foot towers are located at nearby communities and at several locations on the Hanford Site. The 200-foot towers are located at the 100-, 300-, and 400-Areas, and these towers are instrumented at the 32-foot and 200-foot levels. The main tower (410 feet) is located near the 200-West Area. The tower is instrumented at the 7-foot level and at each 50-foot increment in height. Additionally, a Doppler acoustic radar is operated at the main tower and at each of the 200-foot towers for determining mixing-layer height. Sensors on each tower measure wind speed, direction, and temperature, and hourly averages of these parameters are telemetered to the Hanford Meteorology Station. Atmospheric stability classes are determined by temperature differences between the upper and lower levels at each of the four multilevel towers. In case of an incident involving an airborne release, the current meteorological data are available for immediate use in plume transport and dispersion codes. The collection of accurate data is ensured by an active maintenance and calibration program for the sensors based on specific procedures for each sensor and system.

Annual summaries of the wind data are compiled as joint frequency distributions of wind speed, direction, and stability class for use in atmospheric dispersion models and for dose calculations from airborne radioactive releases. The dispersion models produce average dilution factors (X/Q), in units of seconds per cubic meter that, when combined with annual average source emission rates, will predict annual average radionuclide concentrations in the air for each sector around the Hanford Reservation.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

None

3.1.4.3 Category III

1. Carbon Tetrachloride Emissions from Z-Plant. Emissions of carbon tetrachloride from Z-Plant may represent a significant source of environmental contamination and a potential human health hazard.

   Although it is not presently regulated under the Clean Air Act, carbon tetrachloride is a toxic substance and a known carcinogen, and EPA has published a notice of intent to list the substance as a hazardous air pollutant under National Emission Standards for Hazardous Air Pollutants (NESHAP). Presently, these emissions from Z-Plant are neither controlled nor monitored. Carbon tetrachloride inventory data provided by the site indicate the annual use of the substnace has decreased by a factor of three, from 21 tons to 7 tons between 1984 and 1986. NESHAP regulations are source-specific rather than being applicable to all sources that emit the particular substance. Although EPA has not indicated what source types would be regulated under any proposed regulations, or what the emission limits might be, it is unlikely that the unique Z-Plant would be included among the applicable sources. However, the NESHAP limits (when proposed) will establish emission limits (and possibly alternative ambient concentrations limits as well) that can be considered as significant. These limits would be relevant to the Z-Plant emissions of carbon tetrachloride as a means of assessing any environmental impact even though the plant is unlikely to be covered by a new NESHAP.

2. Insufficient Characterization of Regulated/Hazardous Air Emissions. In general, emissions of regulated/hazardous substances to the air from Hanford Reservation operations, with the exception of nitrogen and sulfur oxides, have not been characterized, and therefore the potential impact of these emissions on human health and the environment cannot be reliably assessed.

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Aside from the routine testing of the 300-Area fuel fabrication exhausts and Z-Plant hydrogen fluoride scrubber and continuous monitor, no routine characterizations of regulated/hazardous air emissions are performed at Hanford facilities either by periodic stack testing or by continuous monitoring. In some instances, process analysis has been used to estimate emissions of a specific constituent from a facility (e.g., carbon tetrachloride emissions from Z-Plant). However, this has only been performed on a case-by-case basis and not facility-wide. Lack of a well-defined facility emission inventory for regulated/hazardous pollutants other than nitrogen and sulfur oxides makes it difficult to assess the potential impact of regulated/hazardous emissions from Hanford operations on human health and the environment.

While the emissions of regulated/hazardous constituents such as volatile organics, fluorine, and heavy metals from individual process areas laboratories and waste treatment/storage facilities may be small, the aggregation of numerous small sources may result in the total emissions of a particular constituent to be significant from an environmental impact or regulatory standpoint. Preparation of a detailed site emission inventory of regulated/hazardous substances, considering both known and potential emission sources, will enable the potential and actual environmental impacts of facility operations to be assessed.

3. Potential Accidental Releases from Waste Storage Tank Farms. The potential exists for airborne releases of radionuclides from the high-level waste (HLW) storage tanks due to accidental pressurization or transfer equipment failure.

Accidental pressurization of waste storage tank transfer lines has in the past caused the uncontrolled emissions of radioactive waste to the air, and has resulted in measurable increases in ambient concentrations of strontium-90 downwind of the tank farm and a significant increase in environmental contamination. Although one such occurrence in 1985 did not result in a significant increase in off-site ambient concentrations, there is the potential for off-site contamination in the event of a large accidental release during waste transfer operations at tank farms.

The unusual occurrence report for the 1985 release indicates that remedial action was taken promptly and that an investigation report was issued addressing both the cause of the incident and steps that should be taken to reduce the probability of recurrence. Steps taken included verification of active nonroutine and inactive waste routes, verification of lock and tag procedures, and the location of inactive and nonroutine routes. In addition, the installation of the diversion box routing indicators in the 242A Evaporator control room, which is in progress, should also significantly reduce the recurrence probability. As the probability of occurrence of accidental releases is in large part a function of waste tank farm operating procedures, continued management and operations attention to procedural requirements should minimize potential environmental hazards from waste transfer operations.

Pressurization of the single-shell and double-shell tanks has the potential to cause the uncontrolled release of radioactive waste to the air. These events have resulted from failure of tank ventilation systems to operate, and also from procedural deficiencies. Response to tank pressurization events has been prompt, and event reports indicate that none of the recent tank pressurizations caused any contamination of the local environment. Although none of the reported events of tank pressurization resulted in measurable releases of radioactive waste to the environment, there is the potential for such a release to occur if, for example, a tank ventilation system were to remain in a failed state for an extended period.

Pumping and ventilation equipment failure has historically been a problem at the tank farms, and steps have recently been taken to increase system reliability. These include changes in procedures for operating backup equipment and scheduled improvements in preventive maintenance. Waste transfer procedures have also been modified to minimize tank temperature and pressure increase during transfer operation. Installation of remote tank pressure meters, which can reduce operator response time in the event of a tank pressurization, has been scheduled according to the facility operators. Continued attention to operating procedures and equipment reliability and continued upgrade of the single-shell and double-shell tank pressure monitoring systems will further reduce the likelihood of tank pressurization events and decrease the response time for initiation of corrective action.

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3.1.4.4 Category IV

1. Documentation of the Quality of Emissions Data. The air quality data collected at the Hanford Site lack documentation that would indicate the quality of the data collection efforts.

Continuous emissions data are compiled without a determination of data quality. This observation applies to all facility operators. Each Hanford contractor has several departments (or crafts) that contribute to or influence the process for collecting opacity and pollutant emissions data: Purchasing orders gas standards, Maintenance Engineering performs calibrations, and Operations personnel collect and process the data. Although each group performs its required tasks, there appears to be no transfer of information between the groups upon which an evaluation of the accuracy of the data can be made. Determining the amount of pollutants emitted requires accurate measurements of the stack flow rate and the pollutant concentration with time. The accuracies of these parameters are determined by calibrations, and the accuracy of the calibrations depends upon the accuracy of the gas standards employed. The quality of the gas standards and their useful life are not adequately documented.

Since safety and limiting conditions on plant emissions are set well below the emission rates that would cause an adverse environmental or health impact, inaccurate emissions data are not expected to lead to adverse environmental impacts. However, inaccurate emissions data may indicate an "false exceedance" of a limiting condition or safety level which could cause plant operations to be curtailed or suspended while actual emission rates are still below those levels requiring action.

2. Nitrogen Oxide Emissions from Uranium Oxide Plant During Upsets. The concentration of nitrogen oxides emitted during upset conditions from the Uranium Oxide Plant main stack is not monitored or controlled.

Normal emissions of nitrogen oxides from the Uranium Oxide Plant acid absorber exhaust are well monitored and controlled. There is the potential, however, for the facility to emit nitrogen oxides through the main process

stack, which is neither monitored nor controlled, during process upset conditions. Although these upsets are infrequent and generally do not persist for extended periods, exhaust concentrations during these periods can far exceed those experienced during normal operations and may exceed the EPA permit limitations. The lack of a continuous monitoring device on the main stack causes dependence on engineering calculations to estimate the emissions during upset conditions. Also, no permanent record of the extent and duration of any increases in emissions can be obtained, because of the absence of a continuous monitor. Such records would enable the potential impact of any future excursions to be more easily assessed, and also serve to document that these events do not represent a serious environmental problem or permit violation.

Response time for corrective action in the event of an increase in radiological emissions from the UO_3 Plant stacks could be affected by the condition of the alarm on the continuous monitor, as several of these were not operational at the time of the Survey.

3. Stack Monitoring, Sampling Equipment, and Procedures. Deficiencies in monitoring equipment and procedures used at various facilities on the Hanford Site may lead to inaccurate air quality measurements. These measurements could adversely affect regulatory data or dose estimates.

At several Hanford facilities, the sample gas rate is preset at an assumed constant value for each sample period, and only a single gas flow reading is recorded at the beginning of each sampling period. If the gas rate deviates from the preset value during the sampling period, this change will not be reflected in the exhaust gas concentration calculations. This can cause inaccuracies to enter into calculations of ambient concentrations from the stack radiation emissions.

At some Hanford facilities, gas flow readings are taken at the beginning and end of the sampling period. Both of these values are incorporated into the concentration calculations, which can account for any changes in the flow rate and increase the accuracy of the calculations. In other areas,

concentrations are calculated from total gas flow measurements taken using a dry-gas meter. Use of total sample gas flow readings increases the accuracy of the calculated concentrations, and is the preferred method.

A second concern related to the measurement and recording of exhaust gas rates is the potential for deviations from isokinetic sampling conditions if the exhaust gas velocity is inaccurately measured or the proper sample flow rate not accurately determined. Some facilities routinely verify the accuracy of the Pitot tubes used to continuously measure exhaust gas velocities by conducting periodic vent and balance tests to measure the stack flow, and comparing the test results with continuous measurements. This is not, however, routinely done for all Hanford stacks. Comparison of the preset sample gas flow rates with measured exhaust gas rates is also not routinely done facility-wide. Such comparisons performed on a routine basis would ensure that isokinetic conditions are approached as closely as possible, and would increase the accuracy of emission measurements. Also, accurate measurements of total exhaust rates would result in more accurate dose assessments, as the total exhaust rate from each facility stack is an important component of dose calculations.

4. N-Reactor Argon-41 Releases. Releases of argon-41 from N-Reactor have been increasing, and although not a concern in regard to dose estimates at this time, are not consistent with DOE's ALARA policy.

The short-lived (1.83-hour half-life) argon-41 noble gas release rate from the N-Reactor, caused mainly from air inleakage into the "carbon stack" surrounding the reactor core, is increasing. Despite the magnitude of the releases (65,000 curies in 1985), there is little off-site dose (<.01 millirem whole-body to the maximally exposed individual and < 3 manrem whole-body dose integrated over the entire population in an 80-kilometer radius). The low dose is due to the fact that argon-41 is a noble gas that does not interact with the body and has a short half-life. In addition, this gas is released from a high stack located at a distance from any densely populated area, which results in the argon-41 being dispersed and diluted because of the distance traveled prior to reaching a receptor.

Despite the present low off-site doses, good ALARA practices would indicate that continued attempts should be made to reduce air inleakage to the reactor gas system, thus reducing radioactive releases to the environment.

5. Opacity Monitoring of Coal-Fired Steam Boilers. Opacity meters on the coal-fired boilers in the 100- and 200-Areas are not adequate to monitor air emissions.

200-Area

There is the potential for uncontrolled and unmonitored releases of particulates from the 200-Area steam plants during process upset conditions, such as baghouse fires. The exhaust gas ductwork is configured in such a way that the plant operators can bypass the exhaust gas around the fabric filters in the event of an emergency situation such as a bag fire. No opacity meters are installed on the bypass ducts, and in the event of a bypass, the particulate emissions are neither controlled nor monitored. The plant operators record the nature and duration of these events and report them to the facility management, but no permanent record of the actual emissions (e.g., opacity) is provided. Permanent records would serve to document that emission excursions due to bypasses are not an environmental concern.

The 200-Area steam plants are prone to bag fires because of boiler control problems that allow hot ash to enter the fabric filters. The boilers do not have exhaust-gas oxygen meters, which would decrease the difficulty in controlling coal combustion. Also, the computerized boiler control system is prone to malfunction, further increasing boiler control difficulty. Once hot ash enters the fabric filters, it is sometimes not removed quickly because plant administrative procedures allow only certain workers, who may not always be available, to perform this work. These factors combine to increase the frequency of bag fires and emergency bypasses. Bag fires affect the availability/reliability of the fabric filters.

The opacity meters at the 284E Plant are properly calibrated and maintained, and were functional at the time of the Survey. However, particulate emissions from the 284W coal boilers are not presently being monitored, as the opacity meters at the plant are not functional. The maintenance and

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calibration procedures for the opacity meters are not being implemented at 284W, and the meters have not been calibrated since being installed in 1981. One of the two 284W Plant opacity meters was not functional at all, and the other one was not properly calibrated. Lack of adequate emission monitoring makes it difficult to assess the impact of facility emissions. Also, the resulting lack of adequate permanent documentation makes it difficult to demonstrate that facility emissions are in compliance with local standards.

100-Area

The opacity meters on the 184 plant oil boilers are adequately maintained and calibrated; however, the location of the opacity meters in the boiler outlet ducts, rather than in the stack, subjects them to high exhaust-gas temperatures and heavy soot concentrations, and may increase maintenance requirements. Also, the exhaust-gas oxygen meters on the boiler exhausts, which are used to monitor and control boiler operating conditions, are difficult to maintain, as the availability of replacement parts is poor. Neither the location of the opacity meters nor the operability of the oxygen meters directly affects the boiler emissions, but may cause the boiler to be more difficult to operate and bias the results of opacity monitoring.

6. FFTF Noble Gas Releases. The reported releases of noble gases from the FFTF are biased because of inadequate procedures.

The calculation and reporting of noble gas releases from the FFTF are inadequate for two reasons:

a. The discharge rates are based on a single instantaneous reading from the noble gas monitor, which is taken daily during the third shift.

b. Releases are reported as krypton-85 in order to be "conservative," when in fact most of the release is actually argon-41.

The reported releases of noble gases from the facility are probably overestimates of the true releases due to a number of "corrections" made by operating personnel. Also, assuming that all noble gas releases are krypton-85 will result in overestimates of the resulting doses. Many of the activities

that could result in this type of release occur during the first shift and would not be accounted for with single readings on the third shift.

The resulting noble gas releases should be reported as accurately as possible with respect to quantity and radionuclide. Corrections in either direction should be made only if substantiated by operational data.

7. Building 325 HEPA Filters. There is the potential for loss of radionuclide emission control efficiency at the 325 Building due to HEPA filter failure, which could result in radionuclide concentrations in the exhaust exceeding DOE standards.

Many of the primary laboratory HEPA filter units in Building 325 are original plant equipment and are 34 years old. They are subject to more frequent failure than new units of similar design. The old units are being replaced as required upon failure of efficiency or pressure differential testing, but there are presently about 160 of these original units still in service. Replacement of these filters would minimize potential releases of activity to the environment by minimizing the occurrence of a filter failure.

8. Environmental Radiation Monitoring. Calculated results of ambient particulate sampling for radionuclides may not be representative of ambient concentrations at some locations. Some ambient samplers are located too close to the ground and near buildings or vegetation that obstruct the air flow from at least one direction.

Ideally, intake sample filters are situated a few feet above the ground with unobstructed exposure to any wind direction. When the sampler is located close to a building, the measured concentration is affected by the building's interference on the wind. Depending upon wind direction and speed, the sampled radionuclide concentration may be less than, or greater than, the actual concentration. Samplers on the downwind side of a building may collect only entrained dust lifted from the ground near the building, and they may not collect particles emitted by a source and carried by the wind. High vegetation near a sampler will have a similar effect. Also, the closer the sample filters are to the ground, the more likely for the collected particles to have come from the nearby ground due to wind turbulence rather than from a

distant source. One sampler, observed at the 200-ESE location (old army camp), was so encrusted with dirt that sample air could be heard leaking around the quick-disconnect fittings.

Specific concerns are as follows:

PNL

Some RADeCo sampling equipment operated by PNL appeared to need maintenance and better labeling for calibrations. One sampler at 200-ESE was depositing carbon particles (from the carbon vane pump) on the other equipment inside the sampling shelter. One pump was observed to be very noisy (615C Building), and another had a wildly fluctuating flow meter (Wye Barricade). Flow meters have been removed or bypassed on some samplers, (although flows are checked with a portable flow meter). Samplers contained old calibration-due-date stickers in addition to the current "sticker," which was a piece of masking tape.

Currently, an assumed sample flow rate ($\sim$ 1.5 cubic feet per minute) is used to calculate ambient concentrations from filter analyses for all air stations for each sampling period, although two measurements of the flow rate are made in the field. With the double-headed air sampling units, the measured flow should be around 3 cubic feet per minute. However, the air flow calibrator only goes up to 3 cubic feet per minute. It is possible that when the meter pegs at 3 cubic feet per minute, the flow rate is actually greater than 3. The actual sample flow rate may differ from the assumed value and result in an incorrect calculated concentration.

UNC

The UNC air samplers are in a general state of disrepair. The rubber tubing on one unit disintegrated when it was touched due to excessive weathering. Also, an assumed flow rate is used for these samplers, similar to the PNL procedure. With no actual measurements of flow rate being made in the field, the results may lead to incorrect concentrations.

Carbon vanes in the sample pumps are replaced every 1 or 2 years, not every 6 months as recommended by the manufacturer. Many of the sample pumps were not in proper working condition at the time of the Survey. In addition, there was no evidence of calibration of the samplers, which causes the data to have limited utility for assessing actual concentrations.

Air samples are not changed on the recommended weekly schedule, but are changed monthly.

Rockwell

Rockwell air samplers were generally in good shape. However, as with PNL and UNC, an assumed flow rate was used. No actual measurements of flow rate are made in the field. Also, the hour meter data are not used to calculate total sample flow, although they are available. If there is a power failure during the week, no adjustment is made for the reduced sample volume. This can lead to underestimates of radionuclide concentrations.

9. Resuspension of Particulate Matter from Ash Storage/Handling Areas. Some of the particulate collected by the coal boiler fabric filters is being resuspended and released to the atmosphere as fugitive dust.

Fugitive emissions from ash handling and storage areas were visible during the Survey. These fugitive emissions partially negate the high efficiency of the fabric filters and may cause contamination of surface soil and surface water with heavy metals, which are constituents of the fly-ash. Both the 284E and 284W steam plants have several areas where fugitive-dust emissions arise. The areas directly below the fabric filter ash hopper are open space, and ash from the hoppers falls into these areas when the hoppers are opened. Ash may accumulate up to a depth of several inches in these areas, but is difficult to control and remove because these areas are not paved and cannot be swept. High winds can resuspend this ash, and during the Survey there was visible airborne dust in these areas. Also, the ash being transported from the ash pond to disposal pile was fairly dry. Additional fugitive dust was generated both by the loading of ash onto the transport trucks and by movement of the trucks over dry, unpaved areas.

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3.2 Soil

3.2.1 Background Environmental Information

Data provided by Myrick et al. in 1983 indicate average background surface soil concentrations of radionuclides in Oregon and Idaho to be as follows:

	Oregon	Idaho
Ra-226	0.82 pCi/g	1.1 pCi/g
Th-232	0.72 pCi/g	1.2 pC/g
U-238	0.84 pCi/g	1.1 pCi/g

The study by Myrick et al. did not include the State of Washington. Soil samples are analyzed for gamma emitters by WPPSS for the WNP-2 power reactor. In 1985, only cesium-137, with an average activity of 4.9 picocuries per kilogram, was detected in the samples from control locations (WPPSS, 1986).

The most extensive work done on soil for the off-site Hanford Site environs is conducted by PNL. The data from 1980 through 1985 are presented in Table 3-10 (Price, 1986).

Milk samples from Seattle, Washington, are analyzed quarterly by the EPA for strontium-90, cesium-137, and iodine-131 (EPA, 1985). During the third quarter of 1985, only strontium-90 was detected in the samples at 1.9 picocuries per liter. Milk samples are also collected as part of the WNP-2 radiological environmental monitoring program and analyzed for gamma emitters and iodine-131. Detectable activity, cesium-134 at 1.8 picocuries per liter, was found in only one sample from a control location in 1985. Milk samples are also collected and analyzed by PNL for the Hanford Site. Data from control locations (Sunnyside Area and Moses Lake) are provided in Table 3-11 (Price, 1986).

The vegetation data for control locations are from the WNP-2 monitoring program and the Hanford Site monitoring program. There was no detectable activity in the vegetation samples for 1985 from the WNP-2 monitoring program. For the Hanford Site monitoring program, samples of leafy vegetables, wheat, and alfalfa were analyzed for cesium-137 and strontium-90. Fruit samples were also analyzed for tritium-3. Data for the control locations are provided in Table 3-12.

TABLE 3-10

OFF-SITE MEASUREMENTS OF RADIONUCLIDES IN SOIL, CONDUCTED BY PNL

AVERAGE OFF-SITE ACTIVITY, pCi/g (dry wt) + 2s(1)

Year	Sr-90	Cs-137	Pu-239, 240	Total U
1980	0.11 ± 0.07	0.75 ± 0.20	0.015 ± 0.004	0.38 ± 0.09
1981	0.14 ± 0.04	0.46 ± 0.13	0.011 ± 0.005	0.53 ± 0.11
1982	0.15 ± 0.05	0.63 ± 0.15	0.013 ± 0.005	0.35 ± 0.08
1983	1.0 ± 0.29	0.85 ± 0.28	0.019 ± 0.004	0.32 ± 0.05
1984	0.20 ± 0.06	0.44 ± 0.21	0.0084 ± 0.0037	0.54 ± 0.15
1985	0.26 ± 0.08	0.56 ± 0.19	0.012 ± 0.0046	0.54 ± 0.14
Average	0.31 ± 0.68	0.62 ± 0.32	0.013 ± 0.007	0.44 ± 0.21

(1) 2 times the standard error of the calculated mean

(2) Data from Price, 1986, Tables A.27 through A.30.

TABLE 3-11

OFF-SITE MEASUREMENTS OF RADIONUCLIDES IN MILK, CONDUCTED BY PNL

Average Off-site Activity, pCi/l ± 2s(1)

Year	Location	I-131	Cs-137	Sr-89	Sr-90	H-3	I-129
1985	Sunnyside	-0.01 ± 0.06	0.66 ± 1.5	0.28 ± 0.36	0.88 ± 0.31	120 ± 73	0.009 ± 0.011
	Moses Lake	0.02 ± 0.09	1.2 ± 2.5	No Data	1.4 ± 0.3	250 ± 160	0.001 ± 0.001
1984	Sunnyside	-0.07 ± 0.08	< 1.7 ± 1.8	0.83 ± 0.76	0.69 ± 0.59	150 ± 81	0.0015 ± 0.002
	Moses Lake	-0.5 ± 0.31	3.0 ± 1.8	No Data	No Data	230 ± 92	0.0006 ± 0.0002
1983	Sunnyside	-0.30 ± 0.12	0.38 ± 1.6	0.19 ± 0.41	0.85 ± 0.45	150 ± 110	0.0019 ± 0.0035
	Moses Lake	-0.29 ± 0.15	2.6 ± 3.1	0.21 ± 1.0	1.1 ± 0.61	280 ± 110	0.00060 ± 0.00096

(1) 2 times the Standard Error of the Calculated Mean

(2) Data from: Price, 1986, Table A.16
Price, 1985, Table A.14
Price, 1984, Table 10

TABLE 3-12

OFF-SITE MEASUREMENTS OF RADIONUCLIDES IN VEGETATION (FOOD PRODUCTS), CONDUCTED BY PNL (1985 DATA ONLY)

AVERAGE OFF-SITE ACTIVITY, pCi/g (wet weight) + 2s(1)

Location	Sample Type	Sr-90	Cs-137	H-3(2)
Sunnyside Area	Leafy Vegetables	0.004 ± 0.004	0.002 ± 0.004	Not Analyzed
Moses Lake	Leafy Vegetables	0.007 ± 0.004	- 0.003 ± 0.014	Not Analyzed
Sunnyside Area	Apples	0.004 ± 0.003	0.001 ± 0.004	180 ± 290
Sunnyside Area	Cherries	0.002 ± 0.002	0.005 ± 0.011	180 ± 340
Sunnyside Area	Grapes	0.004 ± 0.003	0.003 ± 0.005	380 ± 170
Sunnyside Area	Wheat (3)	0.012 ± 0.004	- 0.002 ± 0.004	Not Analyzed
Moses Lake	Wheat (3)	0.009 ± 0.004	0.003 ± 0.008	Not Analyzed
Sunnyside Area	Alfalfa(3)	0.095 ± 0.027	0.022 ± 0.024	Not Analyzed
Moses Lake	Alfalfa(3)	0.019 ± 0.008	0.000 ± 0.022	Not Analyzed

(1) 2 times the Standard Error of the Calculated Mean

(2) Units for H-3 are pCi/l of water

(3) Dry weight

(4) Data from: Price, 1986, Tables A-17, A-18 and A-19

3.2.2 General Description of Pollution Sources and Controls

The three sources of radioactive soil contamination are liquid discharges to the ground, burial of solid waste, and deposition on the surface from airborne particulate releases, with the first two sources being the primary means of soil contamination on the Hanford Site. Soil contamination off-site is minimal, as discussed in Section 3.2.3.

The two principal areas where there are either existing or potential problems with soil contamination are the 100- and 200-Areas. In the 100-Area, the liquid wastes are discharged into the new 1325 LWDF (they were previously discharged into the 1301 LWDF until 1985). The waste management facilities in the 200-Areas that eventually receive the liquid waste include the tank farms, cribs, ponds, and ditches, French drains, and reverse wells. Burial sites receive the solid waste. Currently there is no liquid or solid radioactive waste disposal in the 300-Area and there has not been any in the 400-Area. All liquid and solid radioactive waste is transported from the 300- and 400-Areas to the 200-Area for disposal. The 100-Area also ships its solid waste to the 200-Area for disposal.

All of these liquid waste disposal facilities have the potential to contaminate the soil. Many have already contributed to elevated levels of radioactive contaminants in the vicinity of the facility. Details on these sources of soil contamination can be found in Surface Water Sections 3.3.2.1 (for the 100-Area) and 3.3.2.2 (for the 200-Area). Soil contamination levels are discussed in Section 3.2.3.

All the reactors in the 100-Area had cribs that were used to receive radioactive constituents from the liquid discharges; these discharges resulted in contaminated sediments in the cribs and contaminated soil in the vicinity of the cribs. All the reactors, except N-Reactor, have been shut down for a number of years, thus allowing many of the short-lived radionuclides to decay.

At the 100N-Reactor, liquid wastes were discharged to the 1301 LWDF (prior to September 19, 1985) and are currently discharged to the new 1325 LWDF. The newer facility consists of a crib and trench, with the trench being covered by cement slabs to reduce direct radiation and prevent intrusion by plants and animals. The results of sediment samples taken from the 1301 LWDF are discussed in Section 3.2.3.2.

Groundwater seepage enters the Columbia River at a number of sites (approximately 115) that have been termed "springs" (McCormack and Carlile, 1984). In the vicinity of N-Reactor, this seepage area has been named the N-Springs and results from liquid waste disposal in the 1301 and 1325 LWDF. Contamination of the bank and shoreline has occurred as a result of previous disposal in the 1301 LWDF because of reduction in holdup capacity of the soil column. Riprap was placed along the shoreline to prevent personnel from coming in contact with the contamination. Vegetation has been sampled in the vicinity of N-Springs. The breakthrough of strontium-90 appears in the vegetation, and the strontium-90 concentrations for 1985 are a thousand times greater than the on-site average and 100,000 times greater than off-site background vegetation concentrations. These data are shown in Table 3-13.

In the 200-Area, there are 25 liquid discharge streams that were classified as normally or potentially contaminated with radioactive material in 1985. The waste from these discharge streams, as well as the liquid shipped from the 300- and 400-Areas, ultimately is discharged to the ground in the 200-Area.

Highly radioactive solutions are evaporated in the 200-Area, with the condensate being discharged to liquid waste disposal facilities, and the concentrated solution is stored in underground tanks in tank farms scattered throughout the 200-Area. A total of 149 Single-Shell tanks (SSTs) were built between 1943 and 1964 to store radioactive waste solutions. There are 133 SSTs with 75-foot diameters and nominal capacities of 530,000 to 1,000,000 gallons (100 series) and 16 SSTs of a similar design with a 20-foot diameter and a capacity of 55,000 gallons (200 series). All of the tanks have at least 6 feet of earth cover. The SSTs are now inactive (the last tank was taken out of service in 1980) and double-shell tanks are now used to store the high-level-waste solution. Of the 149 SSTs at Hanford, 29 have developed confirmed leaks of various sizes (from negligible to 115,000 gallons), thus contaminating the subsurface soil in the various tank farms with <0.5 to 51 curies of cesium-137 (Smith, 1986a).

There is an ongoing program to isolate and stabilize the single-shell tanks. Most of the activity in the tanks is in the form of a crystalized salt cake or a sludge on top of the salt cake. The major radionuclides in the single-shell tanks are strontium-90

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TABLE 3-13

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/g, dry weight) DETECTED IN N-SPRINGS VEGETATION FROM 1980 TO 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	.16	5.6	NR(1)	.44	NR
1981	NR	3.3	200	NR	.0037
1982	.15	2.8	480	NR	.0083
1983	.070	3.0	330	.040	.0080
1984	NR	NR	NR	NR	NR
1985	.076	1.2	420	.17	.00044

(1) NR - Not Reported

(2) Data from Jacques, 1986, Table 2.4.6

(~2E7 Ci) and plutonium-239, 240 (~2E4 Ci) in the sludge and cesium-137 (~8E6 Ci) and samarium-151 (~3E5 Ci) in the salt cake (DOE, 1986). All the SSTs in three of the tank farms (B, TX, and TY) have been interim-stabilized (the pumpable liquids have been transferred to double-shell tanks) and interim-isolated (all inlet lines have been disconnected so that no new waste can be inadvertently added). A total of 56 SSTs, which contain an average of 119,000 gallons of drainable liquid per tank, remain to be interim-stabilized. The only confirmed leaker in this group is BY-103, and the level in this tank is not decreasing. The remainder of the above tanks are expected to be interim-stabilized over a period of 5 years (Smith, 1986b).

Radioactive solid waste has been buried in numerous trenches in the 200-Area and a few trenches in the 300-Area. In some cases, material has been packaged in wooden or cardboard boxes. Some of these packages are likely to have deteriorated over the years, since the surrounding soil is contaminated as evidenced by contamination in deep rooted plants (Elder et al., 1986; Phillips and Raymond, 1975).

The contamination of soil due to liquid discharges and burial of solid radioactive waste is primarily a subsurface problem where the contamination is not readily accessible to personnel. However, plants and animals have intruded into the contaminated sediments at LWDFs, packages of solid waste at burial sites, and the surrounding contaminated subsurface soil at these facilities (Elder et al., 1986).

This intrusion has caused contamination of the surface soils. Some plant intrusion has occurred in the 100-Area at the N-Springs by vegetation as shown in Table 3-13. However, the primary problem is in the 200-Areas, principally because of the magnitude of subsurface contamination due to liquid disposal through many LWDFs, solid disposal in numerous shallow-land burial trenches, and leakage from high-level-waste tanks.

The major intrusion by vegetation is caused by tumbleweeds, which have a taproot that can extend 15 to 25 feet deep. This root absorbs the radioactive material, transmitting it to the bush on the surface. In the fall the bush dies, dries up, and breaks off when the wind blows. The high winds in the area cause the dried bush to tumble around, breaking into pieces as it goes, thus contaminating the areas where it travels. Contamination levels on the order of 10,000 counts per minute (as

measured with a Geiger Meuller dectector) are typical. Direct radiation levels of 1 to 5 mrad/hr due primarily to tumbleweed growth are observed, although levels as high as 500 mrad/hr were measured on the 216-S site in 1985 (Elder et al., 1986).

In the fall the site collects, monitors, and disposes of quantities of tumbleweed bushes that collect along the fencelines. There is a question whether prior to this action some of the tumbleweed may blow into other areas and possibly off-site.

To mitigate part of the problem, a surface stabilization program was initiated in 1979 to decrease the amount of contaminated vegetation (principally tumbleweeds) as a means of controlling and reducing surface contamination from this source. This program involves the following (Elder et al., 1986):

- Placing additional soil cover over waste sites
- Revegetating existing waste sites; tumbleweed growth is inhibited when forced to compete for moisture with other vegetation
- Applying herbicides
- Providing clean surfaces that can be easily monitored for changes in radiological conditions.

As a result of this program, there has been a significant decrease in contaminated vegetation growth (estimated to be 20 percent of the 1977 level) as discussed in Elder et al., 1986.

Surface soil contamination has also occurred as a result of animal intrusion into buried radioactive solid waste, LWDFs, contaminated subsurface soil and retired facilities, and as a result of eating contaminated vegetation. This intrusion into waste and contaminated facilities in the 200-Area has been by various small animals and birds (such as mice, pigeons and swallows). They ingest the radioactive material and contaminate the area with urine and fecal matter and/or become prey for larger predators who do the same.

In 1959 it was discovered that small animals had burrowed into retired LWDF (BC cribs and trenches) and transported radioactivity over an area estimated to exceed 2,500 acres. The cribs and trenches were surface stabilized in 1982 (Elder et al., 1986).

A summary of significant 1985 animal intrusions follows (Elder et al., 1986):

- Pigeons - Though several past sources of pigeon intrusion have been eliminated, an additional source, Building 242B in the 200-East Area (retired) was identified in 1985. Several contaminated pigeons that had intruded into radioactive material inside this facility were found. Cleanup and isolation was completed in 1985.

- Snakes - Contaminated bull snakes are occasionally found adjacent to tank farms where they consume other contaminated animals that have intruded into radioactivity in the tank farms. Only two were found in 1985. The sources of their contamination were not identified.

- Swallows - Often the mud used by swallows to construct nests originates from radioactive liquid waste disposal sites. Two contaminated nests were found at 221B in 1985. Potential sources for the contamination were the nearby 207B Retention Basin and a waste disposal ditch. Another nest was found at the PUREX Plant, where several nearby waste sites were potential sources.

- Rabbits - Rabbits have caused the greatest spread of contamination in the Separations Area through ingestion of contaminated material and subsequent elimination of contaminated feces. In 1985, rabbit feces, contaminated to 50,000 counts per minute, were found near the retired 216Z-10 Crib. The source of contamination was believed to be the retired crib.

- Mice - Contaminated mouse feces were found in two areas in 1985. One finding was at the stabilized 218E-12A Burial Ground, where a cave-in provided easy access to the buried waste. The cave-in was promptly covered. The other area was near the 244A Lift Station, where mouse feces were found contaminated at levels ranging up to 7 rads per hour. The exact source has yet to be identified. The area has since been decontaminated.

Although these incidents of animal intrusion occurred in 1985, the total number has been reduced over the past years.

3.2.3 Environmental Monitoring Program

3.2.3.1 Pacific Northwest Laboratory

The PNL monitors soil, milk, and vegetation for the entire Hanford Site, including the off-site control locations described in Section 3.2.1. In addition to the PNL monitoring, the 100-Area and 200-Area are also monitored by UNC and Rockwell, respectively. The 300-Area and 400-Area contractors do not conduct any monitoring, but rely on the PNL site-wide monitoring program.

Soil samples are collected annually from 15 on-site and 16 off-site locations. The off-site data are discussed in Section 3.2.1. Single composited samples of surface soil are collected at each of the locations. Each sample is made up of five plugs of soil, approximately 2.5 centimeters deep and 10 centimeters in diameter, obtained within a 100-square meter area at the sampling site. The samples are dried, sieved through a 2-millimeter screen, and thoroughly mixed. Aliquots of this mixed composite are analyzed for gamma-emitting radionuclides, strontium-90, plutonium, and uranium. Average results from on-site locations for the years 1980 through 1985 are presented in Table 3-14.

Samples of perennial vegetation are collected by PNL in the immediate vicinity of the soil sample locations when soil samples are collected. Vegetation samples include a mixture of rabbitbrush, sagebrush, and bitterbrush in roughly the same proportions as naturally occur at the specific sample site. The vegetation samples are collected by cutting a small amount of recent growth from a sufficient number of plants in the area to make up a sample weighing approximately 1 kilogram. The

TABLE 3-14

AVERAGE ON-SITE CONCENTRATIONS OF RADIONUCLIDES IN SOIL, SITE-WIDE PNL DATA, 1980-1985

Year	Average Activity in pCi/g (dry) ± 2s(1)			
	Sr-90	Cs-137	Pu-239, 240	Total U
1980	0.34 ± 0.22	5.3 ± 7.7	0.12 ± 0.20	0.31 ± 0.12
1981	0.30 ± 0.15	4.6 ± 4.5	0.069 ± 0.10	0.49 ± 0.11
1982	0.25 ± 0.12	2.4 ± 2.9	0.062 ± 0.10	0.39 ± 0.11
1983	1.1 ± 0.40	2.8 ± 3.7	0.068 ± 0.11	0.28 ± 0.061
1984	0.32 ± 0.10	1.9 ± 2.8	0.016 ± 0.009	0.46 ± 0.11
1985	0.42 ± 0.15	2.3 ± 3.0	0.035 ± 0.042	0.82 ± 0.66
Average(1)	0.46 ± 0.64	3.2 ± 2.8	0.062 ± 0.071	0.46 ± 0.39

(1) 2 times the Standard Error of the Calculated Mean

(2) Data from Price, 1986, Tables A.26 through A.29.

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sample is then dried and ground, and aliquots are taken for analysis, which includes gamma-emitting radionuclides, strontium-90, plutonium, and uranium. Concentrations of these radionuclides in on-site samples from 1980 through 1985 are provided in Table 3-15.

Samples of raw whole milk are collected from several dairy farms near the site perimeter to evaluate possible Hanford Site impacts. Samples are collected every other week or monthly during the year and analyzed for iodine-131, cesium-137, strontium-89, and strontium-90. Selected milk samples are also analyzed for tritium and iodine-129. In addition to milk samples, food products are also obtained from areas surrounding the Hanford Site. Milk and food product data for 1985 are presented in Tables 3-16 and 3-17, respectively.

3.2.3.2 UNC Monitoring

Surface soil and vegetation samples are collected by UNC at a variety of locations in the 100-Area. Duplicate samples of approximately 100 grams each were collected from the top 2.5 centimeters of the soil surface. One of each duplicate sample was sent to the U.S. Testing (UST) laboratory for strontium and plutonium analysis. Each remaining duplicate sample was analyzed for gamma-emitting radionuclides at the UNC radioanalytical lab. Average concentrations of radionuclides in 100N-Area soil from 1980 through 1985 are provided in Table 3-18.

Duplicate 500-gram samples of green vegetation are collected from available perennial shrubs at the same general locations where surface soil samples are obtained. The vegetation consists mostly of gray rabbitbrush. Strontium and plutonium analyses are conducted by U.S. Testing; gamma analyses are conducted at the UNC radioanalytical lab. Average radionuclide concentrations detected in 100N-Area vegetation from 1980 through 1985 are provided in Table 3-19.

Shoreline vegetation growing near N-Springs is also sampled. The plants are growing through the cover of boulders along the shoreline. Average radionuclide concentrations detected in N-Springs vegetation have been previously presented in Table 3-13.

Sampling of soil and vegetation is also conducted by UNC near the 1301N LWDF in the 100N-Area. Five locations are sampled and, in general, the locations sampled

TABLE 3-15

AVERAGE ON-SITE CONCENTRATIONS OF RADIONUCLIDES IN VEGETATION, SITE-WIDE PNL DATA, 1980-1985

Year	Average Activity in pCi/g (dry) ± 2s(1)			
	Sr-90	Cs-137	Pu-239, 240	Total U
1980	0.078 ± 0.045	0.16 ± 0.17	0.033 ± 0.077	0.016 ± 0.031
1981	0.069 ± 0.028	0.054 ± 0.024	0.0022 ± 0.0010	0.010 ± 0.0037
1982	0.058 ± 0.024	0.072 ± 0.055	0.00087 ± 0.00065	0.0099 ± 0.0025
1983	0.61 + 0.22	0.035 ± 0.023	0.0028 ± 0.0042	0.0083 ± 0.0018
1984	0.19 ± 0.14	0.034 ± 0.033	0.0010 ± 0.00085	0.0093 ± 0.0026
1985	0.36 ± 0.16	0.062 ± 0.045	0.0016 ± 0.0012	0.021 ± 0.0099
Average (1)	0.23 ± 0.44	0.070 ± 0.094	0.0069 ± 0.0256	0.012 ± 0.010

(1) 2 times the Standard Error of the Calculated Mean

(2) Data from Price, 1986, Tables A.32 through A.35.

TABLE 3-16

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN MILK FROM PERIMETER LOCATIONS, 1985 PNL DATA

Location	Average Activity, pCi/l ± 2s(1)					
	I-131	Cs-137	Sr-89	Sr-90	H-3	I-129
Wahluke East	-0.044 ± 0.15	1.2 ± 2.5	-0.91 ± 3.0	0.85 ± 0.36	230 ± 89	0.026 ± 0.045
Sagemoor	-0.026 ± 0.07	0.8 ± 1.4	--	0.94 ± 0.23	310 ± 89	0.027 ± 0.032
Riverview	0.006 ± 0.078	0.7 ± 2.2	-0.019 ± 0.65	1.2 ± 0.5	160 ± 92	0.018 ± 0.009
Benton	-0.004 ± 0.061	2.5 ± 2.1	--	1.5 ± 0.35	240 ± 140	0.098 ± 0.23

(1) 2 times the Standard Error of the Calculated Mean

(2) Dashed lines indicate no analysis

(3) Data from Price 1986, Table A.16

TABLE 3-17

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN FOOD PRODUCTS FROM PERIMETER LOCATIONS, 1985 PNL DATA

Average Off-Site Activity, pCi/g (wet) + 2s(1)

Location	Sample Type	SR-90	CS-137	H-3
Wahluke East	Leafy Vegetables	0.006 ± 0.003	-0.005 ± 0.005	--
Sagemoor	Leafy Vegetables	0.005 ± 0.002	0.004 ± 0.011	--
Riverview	Leafy Vegetables	0.028 ± 0.008	0.008 ± 0.01	--
Benton City	Leafy Vegetables	0.005 ± 0.002	-0.001 ± 0.017	--
Sagemoor	Apples	0.002 ± 0.001	0.008 ± 0.10	160 ± 250
Sagemoor	Cherries	0.002 ± 0.001	0.007 ± 0.017	66 ± 140
Sagemoor	Grapes	0.005 ± 0.002	0.001 ± 0.005	250 ± 200
Wahluke East	Wheat	0.015 ± 0.004	0.004 ± 0.006	--
Sagemoor	Wheat	0.012 ± 0.004	0.004 ± 0.004	--
Riverview	Wheat	0.013 ± 0.004	0.001 ± 0.007	--
Benton City	Wheat	0.027 ± 0.015	0.002 ± 0.002	--
Wahluke East	Alfalfa	0.110 ± 0.017	0.011 ± 0.013	--
Sagemoor	Alfalfa	0.085 ± 0.012	0.003 ± 0.020	--
Riverview	Alfalfa	0.110 ± 0.050	-0.003 ± 0.018	--
Benton City	Alfalfa	0.076 ± 0.009	0.005 ± 0.011	--

(1) 2 times the Standard Error of the Calculated Mean

(2) Dashed lines indicate no analysis

(3) Data Price 1986, Tables A-17, A-18 and A-19

TABLE 3-18

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/g, dry weight) DETECTED IN 100N SURFACE SOIL FROM 1980 TO 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	.24	.85	.18	.50	.018
1981	.16	1.3	.21	1.0	.011
1982	.13	1.6	.099	.34	.0050
1983	.21	2.7	.29	.44	.0085
1984	NR(1)	.88	.28	.62	.014
1985	.12	1.2	.13	.52	.013

(1) NR - Not Reported

(2) Data from Jacques, 1986, Table 2.4.2

TABLE 3-19

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/g, dry weight) DETECTED IN 100N VEGETATION FROM 1980 TO 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	.48	1.0	NR(1)	.28	NR(1)
1981	1.8	25	.58	.71	.021
1982	.49	1.5	.20	.13	.0078
1983	.36	1.0	.39	.090	.0086
1984	.13	.46	.081	.090	.0013
1985	.36	1.4	.051	.16	.00087

(1) NR - Not Reported

(2) Data from Jacques, 1986, Table 2.4.4

nearer the 1301N Crib contain higher concentrations of the contaminants. Average radionuclide concentrations detected in 1301N soil and vegetation samples are presented in Tables 3-20 and 3-21, respectively. These concentrations are only about a factor of 2 higher than the average on-site soil concentration and a maximum of a factor of 7 (for cesium-137) higher than off-site background concentrations.

The new 1325N LWDF receives liquid effluent from N-Reactor, but prior to September 19, 1985 most effluents went to the old 1301N LWDF. The liquid effluent is discharged to the soil column of the LWDF that partially retains the radionuclides as the effluent percolates through the subsoil. Samples of surface sediment were obtained from the bottoms of both LWDFs on August 1, 1985. The samples, approximately 10 grams each, were collected by means of several sampling ports located on each of the disposal facilities. At the time of sampling, the 1301N LWDF was receiving liquid effluent from N-Reactor. The samples were analyzed for gamma-emitting radionuclides at the UNC radioanalytical laboratory. The samples were then shipped to U.S. Testing for analyses of strontium and plutonium. The radionuclide concentrations detected in the 1301N sediments, together with previous results from 1975 to 1985, are presented in Table 3-22. If the results are compared with off-site radionuclides in soil (Table 3-10), the concentrations are approximately a factor of a million higher for cesium-137, strontium-90 and Pu 239/240. Cobalt-60 was not analyzed in the off-site samples.

3.2.3.3 Rockwell Monitoring

Rockwell measures the radioactive content of soil, vegetation, and animal feces in the 200-East and 200-West Areas to evaluate long-term trends in environmental accumulation of radioactivity. Soil samples are collected annually or every 2 years from a network of 78 grid sampling sites and 29 fenceline sampling plots. Each soil sample represents a composite of five plugs of soil 2.5 centimeters in depth by 10 centimeters in diameter. Analyses include gamma-emitting radionuclides, strontium-90, uranium, and plutonium. Results from 1985 are presented in Table 3-23.

TABLE 3-20

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/g, dry weight) DETECTED IN SURFACE SOIL NEAR THE 1301N LWDF FROM 1980 TO 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	2.5	13	.35	4.1	.025
1981	6.6	4.0	.70	6.1	.044
1982	.66	6.3	.27	2.7	.018
1983	.41	5.4	1.3	3.8	.043
1984	.18	2.8	.21	1.1	.017
1985	1.5	13	.65	3.9	.032

(1) Data from Jacques, 1986, Table 3.3.2

TABLE 3-21

AVERAGE RADIONUCLIDE CONCENTRATIONS (pCi/g, dry weight) DETECTED IN VEGETATION NEAR THE 1301N LWDF FROM 1980 TO 1985

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-239/240
1980	1.4	4.0	NR(1)	1.1	NR
1981	2.5	12	1.8	1.8	.0071
1982	.46	1.6	.12	.26	.0026
1983	.45	1.9	.60	.39	.0032
1984	.29	1.0	.12	.083	.00085
1985	.59	1.7	1.9	.10	.0015

(1) NR - Not Reported

(2) Data from Jacques, 1986, Table 3.3.4

TABLE 3-22

AVERAGE RADIONUCLIDE CONCENTRATIONS (µCi/g, dry weight) DETECTED IN 1301N LWDF SEDIMENT FROM 1975 TO 1985

Year	Co-60	Cs-137	Sr-90	Pu-239/240
1975	5.2	1.1	.0024	.00098
1976	2.0	.18	.027	.0037
1977	.71	.079	.021	.0046
1978	5.2	.22	.025	.0052
1979	26	.81	.042	.0062
1980	6.4	.28	.11	.040
1981	9.1	.45	.15	.018
1982	15	.66	.16	.42
1983	12	.62	.028	.0078
1984	22	1.2	.12	.021
1985	1.1	.038	.12	.020

(1) Data from Jacques, 1986, Table 3.4.3

9 2 1 2 4 6 1 1 5 1 0

TABLE 3-23

AVERAGE CONCENTRATIONS FOR RADIONUCLIDES IN SOIL FOR THE 200-EAST AND 200-WEST AREAS - 1985

Radionuclide	Average Activity, pCi/g (dry)			
	200-East	200-East Fenceline	200-West	200-West Fenceline
Sr-90	1.02	2.7	1.113	7.2
Ru-106	-(1)	-	0.173	-
Cs-134	0.043	-	0.036	-
Cs-137	5.67	14.0	8.823	36.4
Pu-238	0.001	-	0.019	-
Pu-239	0.042	13.5	0.248	0.86
Total U	0.306	0.24	0.461	0.26

(1) Mean was less than detection limit

(2) Data from Elder et al, 1986, Tables E-1, E-2, and E-3

Vegetation samples are collected annually from each of the 78 grid sites to determine accumulation of radioactivity in plants and soil. Cuttings from growing plants are collected during the early summer of each year. Analyses are performed for gamma-emitting radionuclides and at selected sites for strontium-90 and plutonium isotopes. Average radionuclide concentrations detected in 200-Area vegetation samples are presented in Table 3-24.

When soil and vegetation samples are collected from the 78 grid sampling sites, animal feces (if present) are also collected within the sampling area. The feces are analyzed as an indicator of the impact of radioactive waste management operations on the animal populations in the 200-Area. These measurements provide an indication of the potential transport of radioactive waste as a result of animal intrusion. Feces are analyzed for gamma-emitting radionuclides. Average concentrations of radionuclides in feces for 1985 are presented in Table 3-25.

Special animal samples were also collected at sites of known or suspected intrusion, or where contaminated animals were found and the source needed to be identified in an attempt to prevent future intrusion. These results are provided in Table 3-26.

3.2.4 Findings and Observations

3.2.4.1 Category I

None

3.2.4.2 Category II

None

3.2.4.3 Category III

1. Surface Contamination Due to Intrusion into Buried Wastes by Animals and Plants. There is surface contamination in certain sites in the 200-Area due to intrusion into buried liquid and solid wastes by animals and plants

TABLE 3-24
AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN VEGETATION FOR THE 200-EAST AND 200-WEST AREAS - 1985

Radionuclide	Average Activity, pCi/g (dry)	
	200-East	200-West
Co-58	-(1)	<0.1
Sr-90	8.346	1.092
Zn-65	-	<0.2
Ru-103	<0.1	-
Ru-106	<0.7	-
Cs-134	-	<0.09
Cs-137	0.211	0.293
Eu-155	<0.2	-
Pu-238	0.0009	0.0007
Pu-239	0.0049	0.007

(1) Mean value was less than the detection limit

(2) Data from Elder et al., 1986, Tables E-4 and E-5

TABLE 3-25

AVERAGE CONCENTRATIONS OF DETECTABLE RADIONUCLIDES IN RABBIT FECES FOR THE 200-AREA - 1985

Radionuclide	Average Activity, pCi/g (dry)	
	200-East	200-West
Mn-54	0.146	-(1)
Co-58	0.417	0.254
Co-60	0.317	-
Zn-65	-	0.336
Ru-106	2.15	1.59
Cs-134	-	0.323
Cs-137	0.314	0.392
Eu-152	0.988	1.72
Eu-155	0.508	-

(1) Mean value was less than the detection limit

(2) Data from Elder et al, 1986, Table E-6

TABLE 3-26

ANIMAL BIOTRANSPORT SAMPLING RESULTS - 1985
pCi/g dry weight

Sample Type	Location	Sr-90	Ru-103	Ru Rh-106	Cs-134	Cs-137	Pu-239
Pigeon and eggs	242-BL	91	- (1)	-	-	315	-
Snake Skin(2)	244-UR	22,000	-	-	-	350,000	70
Bird nest	PUREX	18	5.4	2,400	-	25	1
Mice feces(3)	244-A	9,500	-	-	-	1,600,000	3,500
Swallow's nest	221-B	4,200	-	-	-	14,000	-
Swallow's nest	221-B	614	-	-	5.2	5,400	4.9
Snake	241-AY	440	-	-	-	4,400	2.2
Rabbit feces	216-Z-6	160,000	-	-	-	-	2,100
Mice feces(3)	218-E-12A	400,000,000	-	-	-	86,000	8,400

(1) A dash (-) indicates that the radionuclide concentration is less than detectable
(2) Concentrations reported are for whole sample
(3) Though reported on per gram basis, feces weighted significantly less than 1 g
(4) Data from Elder et al, 1986 (Table E-7)

(principally tumbleweed). Contaminated animals and tumbleweeds have the potential of moving off-site or recontaminating previously stabilized waste sites.

Surface contamination levels from 1 mrad/hr to 500 mrad/hr due to tumbleweed contamination have been measured.

There has been a significant decrease in contaminated vegetation growth (~20% of the 1977 level) since a surface stabilization program was initiated in 1979. However, the tumbleweed problem is always present and probably will never be completely eradicated. There is the potential for contaminated tumbleweeds to roll off-site. This potential problem will be better defined when the results of tumbleweed sampling along certain areas of the Columbia River shoreline is completed. The purpose of the sampling is to determine if contaminated tumbleweeds have migrated from the 200 Area to areas near the river where they would leave the site.

Small animals and birds have intruded into areas where liquid and solid radioactive waste have been disposed of and into retired contaminated facilities. In 1959 they contaminated 2,500 acres. They currently contaminate portions of the 200-Area with radioactive urine and fecal matter.

Biological transport involving animals continues to be of concern, principally near the 204S Waste Unloading Station in the 200-West Area, the Strontium Semiworks in the 200-East Area, and the 216B-3-1 Ditch. Although a number of incidents of animal intrusion did occur in 1985, the total number has been reduced over the past several years. As with tumbleweeds, the animal intrusion problem is always present and probably can never be completely eradicated.

2. Leaks From Single-Shell Tanks. Because of the large volumes of the SSTs (up to 1,000,000 gallons) and high concentrations of radioactive material, leaks from these tanks pose a potential threat to the environment.

Of the 149 tanks at Hanford Reservation, 29 have developed confirmed leaks of various sizes, contaminating the soil around the tanks. All of these tanks have been taken out of service and have been interim-isolated, and 93 have been interim-stabilized. All the known leaking tanks have been interim-stabilized except for BY103. Interim stabilization (i.e., pumping of liquid) from this tank is scheduled for fiscal year 1987.

Large leaks have occurred in the past, the most significant one being the T 106 Tank leak (which released 40 curies of cesium-137 in 115,000 gallons of liquid). The contaminants resulting from this leak were studied over a 5-year period. Results indicated that essentially all the activity was immobilized in the soil very close to the tank; although the soil was contaminated, no indication of groundwater contamination was ever observed. The most mobile radionuclide, ruthenium-106, was found to have migrated downward only about 70 feet from the point of release, which was well above the water table, reported to be 200 to 250 feet below that specific tank at the time.

The T 106 Tank data would tend to indicate that there are no off-site environmental problems currently and there will not be any in the future as a result of tank leaks. However, with the startup of the PUREX Plant, large quantities of water have been disposed of in the 200-Area liquid waste disposal facilities, which may be providing hydraulic force to move these radionuclides toward the water table. If the BY 103 Tank starts losing liquids it will contaminate the soil and potentially could have an impact on the off-site environment through the groundwater. Since this tank is scheduled for interim stabilization in fiscal year 1987, this action should reduce the potential for adverse impact to the off-site environment from this tank.

3.2.4.4 Category IV

None

3.3 Surface Water

3.3.1 Background Environmental Information

There is no planned stormwater collection and diversion at the Hanford Site. Topographic features of the site dictate the final destination of any surface water from precipitation. In most areas, stormwater will simply percolate into the soil and end up mixed with groundwater. Some stormwater will also be diverted to surface ponds (B-Pond, Gable Mountain Pond, or West Lake, Figure 3-2), while some is collected in various ditches and trenches located throughout the site. The only stormwater that could directly enter the Columbia River would be from the land areas directly adjacent to the river. However, there were no signs of large quantities of stormwater entering the river (i.e., eroded areas were not noted on the riverbanks, which would indicate stormwater flow).

Average surface water radionuclide activities in the Columbia River upstream of the Hanford Site provided by PNL in the 1985 Environmental Monitoring Report (Price, 1986) are shown in Table 3-27 These values occurring upstream of any Hanford influences, represent the background or baseline conditions in the Columbia River near the Hanford Site.

Tritium concentrations in surface water and drinking water are available from selected locations monitored by the U.S. Environmental Protection Agency (EPA). In the third quarter of 1985, the tritium concentrations were as follows:

Surface Water - Northport, WA = 100 pCi/l
Richland, WA = 400 pCi/l

Drinking Water - Seattle, WA = 200 pCi/l
Richland = 400 pCi/l

Cothern and Lappenbusch (1983) report nationwide concentrations of uranium in drinking water. The location closest to the Hanford Site included in the report was Portland, Oregon. The average uranium concentrations were as follows:

U-234 = 0.015 pCi/l
U-235 = 0.002 pCi/l
U-238 = 0.011 pCi/l

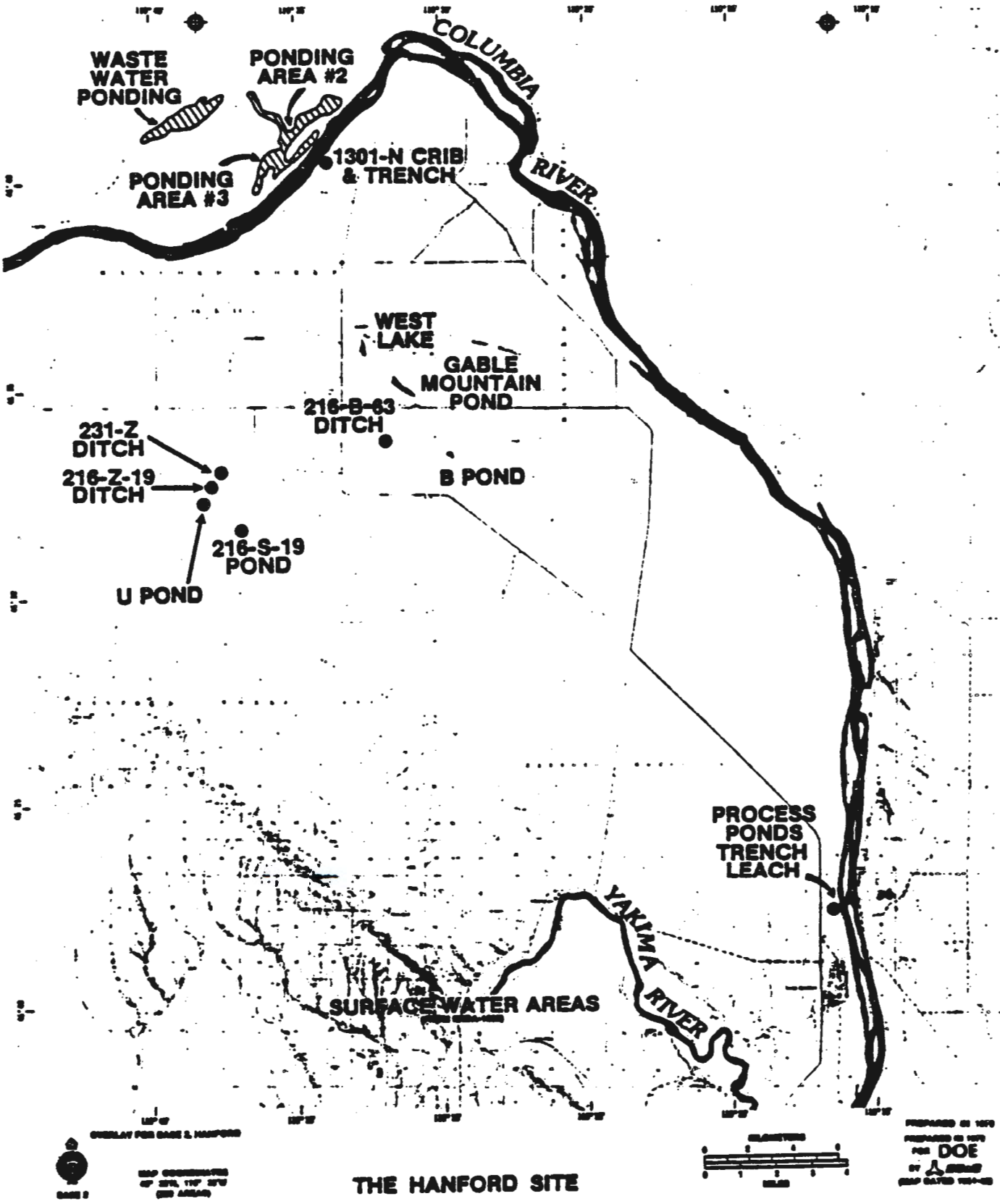


FIGURE 3 - 2

Source: EG&G 1979.

TABLE 3-27

UPSTREAM MEASUREMENTS OF RADIONUCLIDES IN THE COLUMBIA RIVER, CONDUCTED BY PNL

Parameter	Average Upstream Activity, pCi/l $\pm$ 2S[1]
H-3	110 $\pm$ 18
Co-60 (Particulate)	0.0017 $\pm$ 0.0017
Sr-89	0.089 $\pm$ 0.052
Sr-90	0.15 $\pm$ 0.025
I-129 (Dissolved)	$8.9 \times 10^{-6} \pm 8.5 \times 10^{-6}$
Cs-137 (Particulates)	0.091 $\pm$ 0.0032
Cs-137 (Dissolved)	0.018 $\pm$ 0.0058
U (Natural)	0.38 $\pm$ 0.10
Pu-239, 240 (Particulate)	$2.14 \times 10^{-5} \pm 1.0 \times 10^{-5}$

(1) 2 times the Standard Error of the Calculated Mean

Source: Price, 1986

Environmental data from control locations for the WPPSS Unit No. 2 (WPPSS-2) monitoring program include gamma spectrometry, gross beta, and tritium in surface water. In 1985, only gross beta was detected in the samples from control locations with an average activity of 1.33 picocuries per liter (WPPSS, 1986). The WPPSS (1986) also analyzes sediment from the Columbia River. From the upstream control location, only cesium-137 was detected in 1985, at 99.7 picocuries per kilogram.

3.3.2 General Description of Pollution Sources and Controls

Section 3.3.2 presents a description of plant processes and potential pollution sources for the water media. These potential sources are grouped by area.

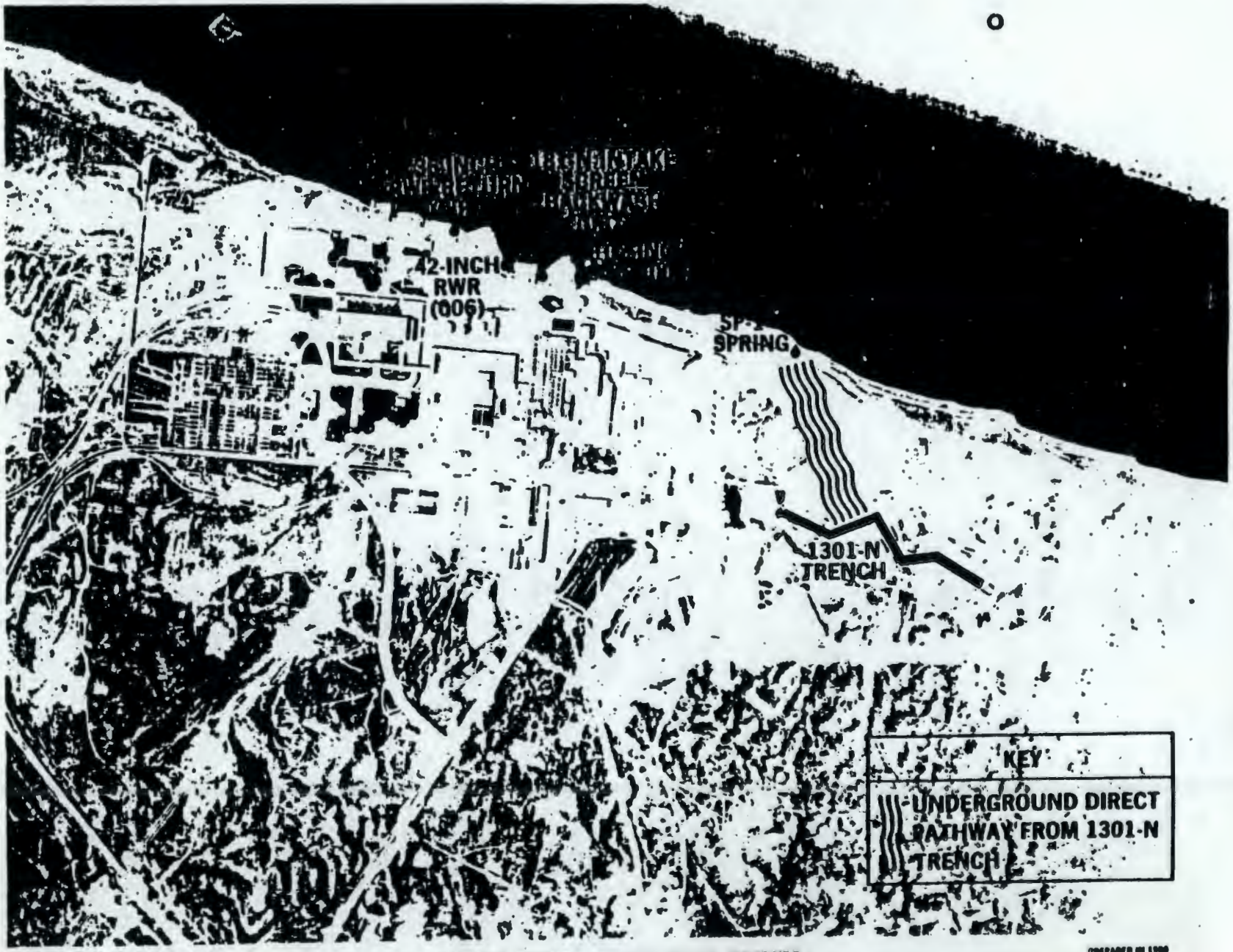
3.3.2.1 100-Area

The only radioactive discharges in the 100-Area to surface water are from the 100N Reactor and the 100K-Area (See Figures 3-3 and 3-4).

In the 100K-Area, there is a cooling water discharge of approximately 700 gallons per minute to the Columbia River via the 1908K Outfall. This water is used mainly to provide cooling to and blowdown from the 100KE and 100KW Spent Fuel Basins where old N-Reactor fuel is still stored.

In the 100N-Area, there is a cooling water discharge of approximately 285,000 gallons per minute to the Columbia River through the 102-inch discharge line. This water is used mainly to provide cooling to the plant condensers and heat exchangers.

Both the above cooling water discharges contain relatively low levels of radioactivity. The main radioactive liquid discharge from the N-Reactor is currently into the 1325N Liquid Waste Disposal Facilities (LWDF) and prior to September of 1985 into the 1301N LWDF. Both of the LWDFs consist of cribs with covered trenches to handle the excess liquid. Cribs are subsurface low-level liquid waste disposal sites that allow liquid waste to percolate into the surrounding soils.



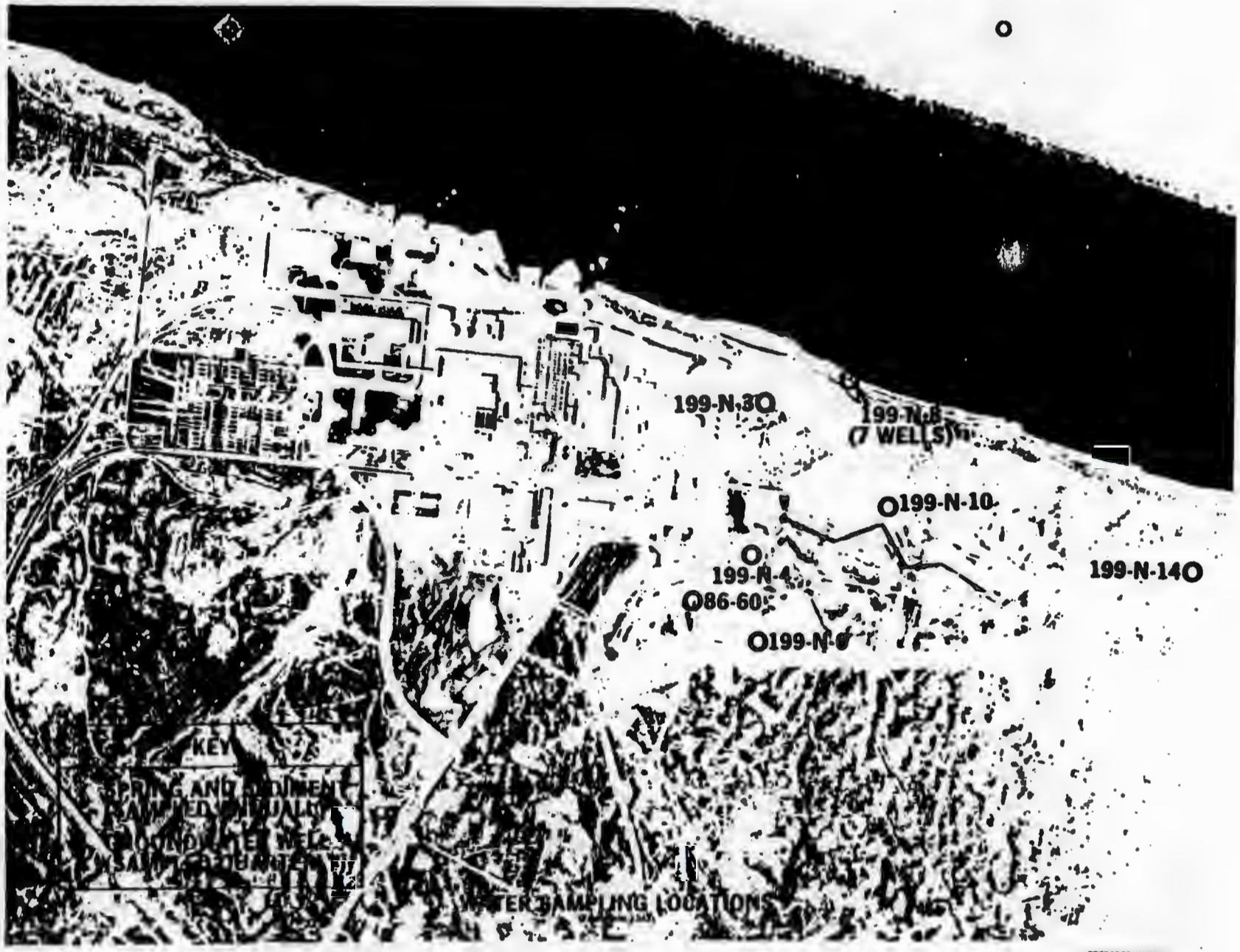
LIQUID EFFLI RELEASE POINTS

REACT... AREA 100-N

HANFORD SITE

OVERLAY FOR BASE 100-N, HANFORD

PREPARED IN 1980 FOR DOE



OVERLAY FOR BASE 100-N, HANFORD

REACTOR AREA 100-N
HANFORD SITE

PREPARED IN 1990
FOR DOE
BY EG&G

The ion exchange and filtering capabilities of the soil surrounding the cribs and trenches are used to remove radioactive materials from the water. The "treated" water can infiltrate to the water table, travel horizontally, or evaporate at the surface. Groundwater seepage from the N-Crib effluent has formed springs (N-Springs) along a 1500-foot stretch of the Columbia River shoreline. In the case of the N-Reactor site, approximately 50 percent of the 1900 gallons per minute discharged to the LWDF is transported horizontally and appears at the N-Springs.

The 1301N LWDF has been in use approximately 20 years and toward the end of its service life started losing its ion exchange and filtering capability. Starting in 1982, the effectiveness of 1301N LWDF relative to iodine-131 and strontium-90 holdup was reduced significantly. As an example, the annual discharges from 1982 through 1985 were 2.7, 4.0, 7.0, and 8.4 curies of strontium-90, respectively. A new facility, the 1325N LWDF, was installed and was fully operational in September 1985. Riprap and boulders have been used to cover the contamination from the N-Springs along the shoreline.

The use of the 1325N LWDF increases the path length to the river, which was a problem with the 1301N facility, and provides a new soil column. Because of the strontium-90 that is assumed to be in the soil near the river as a result of 1301N operation, it is expected that releases will not drop significantly until the strontium-90 has been flushed out of the riverbank.

Demineralizer Operations (100N)

Acid and caustic from bulk storage tanks are used to fill day tanks in the demineralizer building. A neutralization pit is located at the low point of this transfer piping. The old pit has deteriorated and a new neutralization pit is currently under construction. The exposed piping between the neutralization pit and the demineralizer building is contained by a concrete trench. The trench has deteriorated because of a history of chronic small leaks. The integrity of the system to contain a major spill at the present time is doubtful.

The vent/overflow pipe from the 10,000-gallon acid day tank penetrates the wall of the demineralizer building and is directed to a French drain located near the building. A three-way valve provides the capability to pump the demineralizer

regeneration wastes to the neutralization pond or the river. Administrative controls are used to prevent the discharge of regeneration waste to the river. The flow is directed to the river only when clean water from the demineralization facility is discharged.

The regenerant wastes from the demineralizers discharge to the 1324N Surface Impoundment. This impoundment has a double liner with a leachate collection system. The acid and caustic regenerant wastes are pumped to the impoundment and allowed to self-neutralize. A grab sample is checked for pH and if the pH is between 3 and 11, then the neutralized waste is pumped to Percolation Pond 1324NA. If the pH is high or low, acid or caustic is added to bring the pH into the proper range (i.e., 3 to 11) before pumping the waste to the percolation pond.

Oil Storage Tanks (100N)

The oil storage tanks are surrounded by a concrete containment wall approximately 5 feet high. However, the bottom is sand and gravel and therefore provides no barrier to the groundwater. Discolored sand provided evidence of past spills.

Battery Room (100N)

The drains from the battery room are directed to the process sewer, which discharges to the crib. A battery rupture will result in sulfuric acid being dumped to the process sewer. During normal operation, administrative controls are used to prevent waste acid from being washed down the sewer.

1310N Decon Waste Storage (100N)

The N-Reactor cooling system is periodically cleaned with diethyl thiourea phosphoric acid cleaning solution. This cleaning solution is pumped to the 1310N Decon Waste Storage Tank and neutralized. The storage tank has a capacity of 800,000 to 900,000 gallons and is partially surrounded by an earthern berm for shielding purposes. There is no spill containment for this storage tank. After neutralization, the spent solution is sent to Rockwell in the 200-Area for disposal.

Filtration facility (100K)

Water from the 100K-Area intake is used to supply the water requirements for the 100K-Area. It is also a source of fire protection water. The water is pumped through a filtration plant and the filters are backwashed to holding basins. The solids are allowed to settle for a minimum of 2 hours before the supernatant water is discharged to the river. The basin outlet is surrounded by a floating boom to prevent floating objects from being discharged to the river. However, at the time of observation there was floating material (presumably algae) inside the boom area.

100D/DR-Area

The pumping station in this area is used as a backup to the 100K Pump House. A small sand filter is used and the filter backwash is discharged into a percolation pond excavated in the old ash pit.

100H-Area

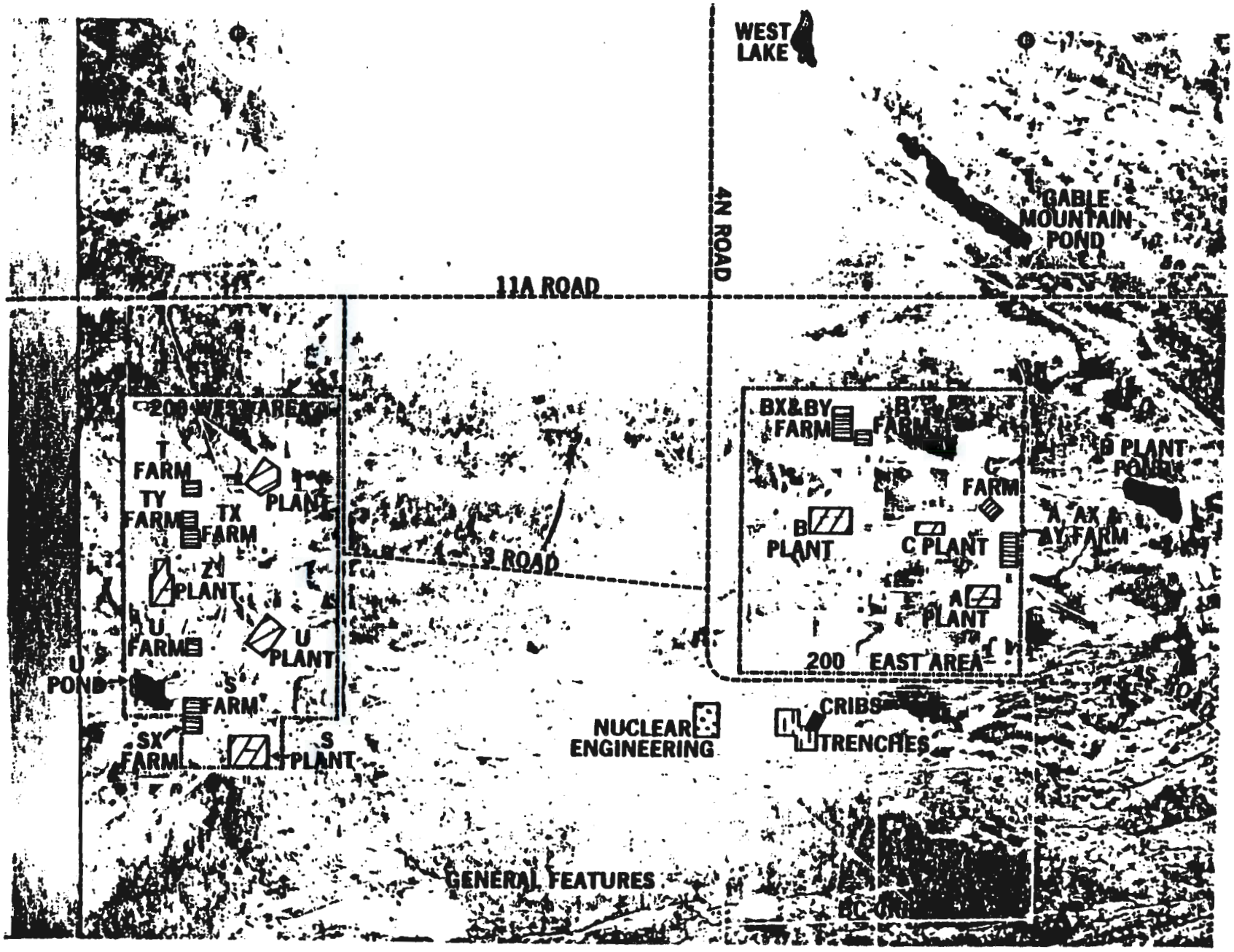
The solar evaporation ponds in this area are no longer in use and are currently being decontaminated/decommissioned.

100F-Area

The 100F-Area contains several abandoned retention basins. This area is unused except for an engineering group using the uncontaminated side of Building 108.

3.3.2.2 200-Area - General

There are 27 liquid discharge streams in the 200-Area (excluding sanitary sewers). Twenty-five streams were classified as normally or potentially contaminated with radioactive material in 1985. Two streams had no potential for radioactive contamination (Aldrich, 1986). The waste from these discharge streams, as well as the liquid waste shipped in from the 300- and 400-Areas, ultimately is discharged to the ground. The discharge of radioactive liquids to the ground is subject to DOE Order 5820.2 requirements. This order requires that the use of the soil column for disposal be eliminated as soon as possible with a goal of not exceeding EPA drinking water standards at the point of discharge (Figure 3-5).



OVERLAY FOR BASE 200 AREA DYCOMED

200 METERS 1000

200 AREA

PHOTO COORDINATES 46 33 N 119 35 W (SITE CENTER)

PREPARED IN 1980 FOR DOE BY EG&G

In the 200-Area in 1985, the principal sources of alpha-emitting radionuclides were the PUREX Plant process condensate and the Z-Plant wastewater, at 56 percent and 21 percent of the total liquid emissions, respectively. The main sources of beta-emitting radionuclides were the PUREX Plant ammonia scrubber and the B-Plant process condensate, at 73 percent and 9 percent of the total liquid emission, respectively. The largest source of tritium was the PUREX Plant process condensate at 92 percent of the total emission. The waste management facilities in the 200-Area that eventually receive the liquid waste are as follows:

- Tank Farms—Liquid waste from chemical processing operations containing high concentrations of radionuclides is stored on an interim basis in underground tanks. The Hanford Site tank farms contain 169 tanks (149 SSTs and 20 double-shell tanks) with capacities ranging from 50,000 to 1,000,000 gal. Since 1967, new liquid waste has been stored in double-shell tanks. The SSTs are no longer receiving waste and the contents are scheduled for complete stabilization. Eight additional double-shell tanks are under construction in the new AP Tank Farm.

  Associated with the tank farms are the three evaporators. These facilities are used to remove water from the liquid waste, thereby reducing the total volume of waste stored by the tank farms. During 1985, the 242A Evaporator was operational while the 242S Evaporator was used in remedial cleanup of groundwater beneath an inactive waste site. The 242T Evaporator continued to be used as a tank farm surveillance substation.

- Cribs—Low-level liquid waste is discharged to the ground via structures called cribs. These subsurface systems allow the liquid component of the waste to percolate into the soil. Of the 95 cribs in the 200-Area, 16 were active in 1985.

- Ponds—Ponds are used to manage the large quantities of water (i.e., cooling water and steam condensate) associated with chemical processing operations. These liquid effluents are normally not radioactively contaminated. The ponds function to promote percolation of the liquid effluent. Of the 16 ponds in the 200-Area, only 2 remained active by the end of 1985.

- o Ditches—A ditch is an open, unlined excavation used for disposal of liquid effluents or for transporting liquid effluents to ponds for disposal. Of the 18 ditches in the Separations Area (200-Area), 7 were active in 1985.

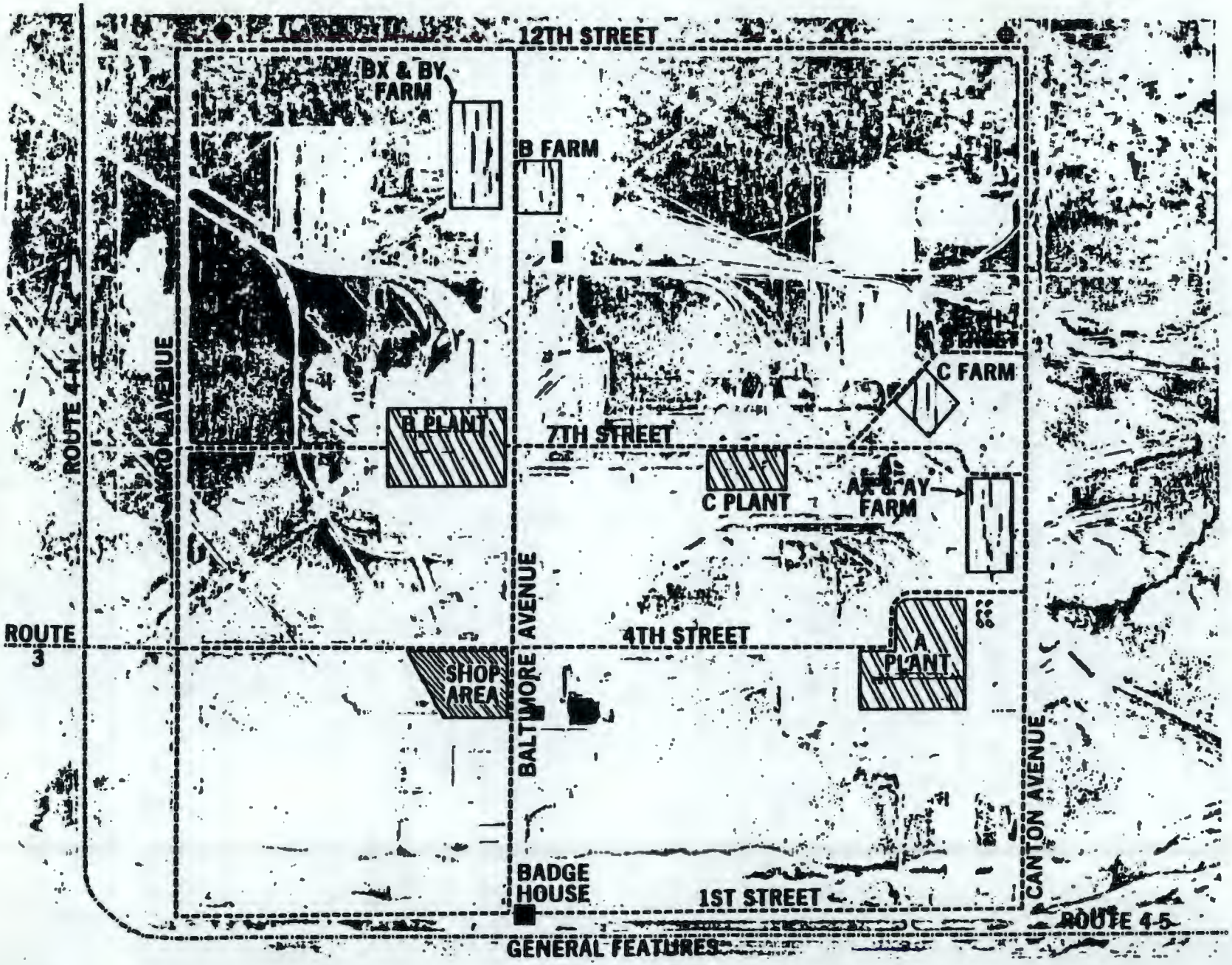
- o French Drains and Reverse Wells—These are pipes or rock-filled encasements inserted into the ground. These subsurface systems are used for managing potentially contaminated liquid waste by promoting percolation into the soil. Of these 37 process facilities in the 200-Area, 6 French drains (one of which is a pipe extending 50 feet underground) were active in 1985. These facilities terminate 200 or more feet above the groundwater.

Eventually, the liquid from many of the above waste facilities reaches the groundwater and then discharges into the Columbia River. Tritium and strontium-90 are two of the more mobile radionuclides. The environmental implications of these high-mobility radionuclides are discussed in Section 3.3.4.

3.3.2.2.1 200-East Area

The PUREX Plant and B-Plant, along with their associated facilities, are located in the 200-East Area. The PUREX Plant processes irradiated fuels from N-Reactor to recover special materials. This process includes metal dissolution, solvent extraction, and ion exchange. The B-Plant formerly separated strontium-90 and cesium-137 and prepared them for customer use. Currently, these B-Plant processes are in standby. Upgrades are planned at the B-Plant to prepare the facility as a support for the vitrification and grout projects (Figure 3-6).

The various waste liquids from both these facilities are disposed of in a number of ways. Process solutions containing high concentrations of radionuclides are stored (on an interim basis) in a series of underground storage tanks. The solution sent to these tanks is first sent to an evaporator for removal of water from the waste, reducing the volume to be stored. Lower level liquid radioactive waste is discharged to the ground via a series of cribs. These cribs allow the liquids to percolate into the soils. Waters that are not contaminated with radionuclides (cooling water and steam condensate) are sent to ponds for evaporation or eventual percolation into the ground.



OVERLAY FOR BASE 200 E. HANFORD

200 HANF

PHOTO COORDINATES (SITE CENTER) BASE 200 E

PREPARED IN 1980 FOR DOE BY EG&G

Source: EG&G 1979.

FIGURE 3

In the 200-East Area, the nonradioactively contaminated liquids from the PUREX and B-Plants are conveyed to the ponds via a ditch system (216B-3-3, 216B-63, and 216A-29). The two ponds are B-Pond and Gable Mountain Pond (See Figure 3-1). At present, approximately 85 percent of the flow is discharged to B-Pond, with the remainder being sent to Gable Mountain Pond. (Gable Mountain Pond is presently undergoing decontamination and decommissioning. The flow currently being diverted there is only to keep the site wet. This pond will be decommissioned by 1988.)

In the PUREX area, three low-level liquid waste streams are discharged to cribs. These streams are the ammonia scrubber discharge (ASD), process condensate discharge (PCD), and steam condensate discharge (SCD). Two other streams are discharged, eventually entering the B-Pond system. These are the chemical sewer line (CSL) and the cooling water line (CWL). All of these streams are sampled and analyzed. The samples are weekly composites that are analyzed for gross gamma, alpha, and beta; radionuclides; and nonradiological indicators such as pH, nitrate, and total organics.

The water used in the 200-East and 200-West Areas is pumped from the Columbia River through the 100B Pump House (also the 100D Pump House can be used to obtain water). This water is held in a 2.5-million-gallon reservoir at the 200-East Area. From there, raw water can be distributed, as needed, to those areas using water without treatment. The water needing treatment is coagulated with alum and filtered. The filter backwash, as well as wastes from the 284E Power House (soot blowing, ash removal, and fly-ash liquids), is sent to the ponding area behind the power house where the water percolates into the ground.

The sanitary waste from the various areas in the 200-East Area is sent to a number of septic tank drainage fields. Thus, any liquid from these systems eventually discharges to the ground.

3.3.2.2.2 200-West Area

<u>Z-Plant</u>

Z-Plant processes plutonium from the PUREX operation and reclaims plutonium from waste materials. Many of the process streams that have potential for

discharge of contamination have been retrofitted with secondary heat exchangers to provide additional protection against accidental releases to the environment. Some potential for contamination still exists through process streams that cannot be retrofitted in this manner.

There are reportedly no sanitary drains in any areas where there is potential for contamination. The chemical sewer/floor drains are directed to a crib. The flow to the crib is primarily secondary cooling water. Most of the potential for contamination comes from accidental spills to the floor drains and from heat exchange leaks that contaminate the secondary cooling water. The chemical preparation rooms probably represent the single largest potential for contaminating this crib. There are two of these rooms, both using different techniques for preventing contamination. The Plutonium Reclamation Facility (PRF) chemical makeup room has installed a conductivity probe in the drain line to alert operators when a spill occurs. The RMC chemical makeup room uses curbs to contain the spill and standpipes over each drain to ensure that no chemicals accidentally discharge to the floor drains. Any spilled material is then cleaned up and disposed of. Good housekeeping practices in the RMC chemical makeup room aid in the prevention of spills.

Uranium Trioxide Plant

Process condensate is discharged to 216U-12 Crib. The process condensate has potential for low pH and radioactive contamination. Currently there are no provisions for pH adjustment prior to discharging wastes into the crib. A new facility to keep the pH above 2.5 is being planned for installation.

Steam condensate, cooling water, and the chemical sewer are all discharged to the 207U Retention Basin. The concrete retention basin is divided into two sections that can be isolated. At the time of this Survey, the north basin was full of water and valved out of service, both influent and effluent, because of an accidental discharge of uranium to it. There is currently no continuous monitoring of pH or other parameters for this retention basin.

3.3.2.3 300-Area

The 300-Area contains a number of fabrication facilities, laboratories, storage areas, and maintenance buildings. Fuel rods for the 100N reactor and the Fast Flux Test Facility (FFTF) reactor are fabricated in various buildings on this site (Figures 3-7 and 3-8).

There are three contractors in the 300-Area—UNC, PNL, and Westinghouse Hanford Company (WHC). Each occupies a number of buildings in this area; however, WHC is the "landlord" with primary responsibility in regard to the facilities' maintenance.

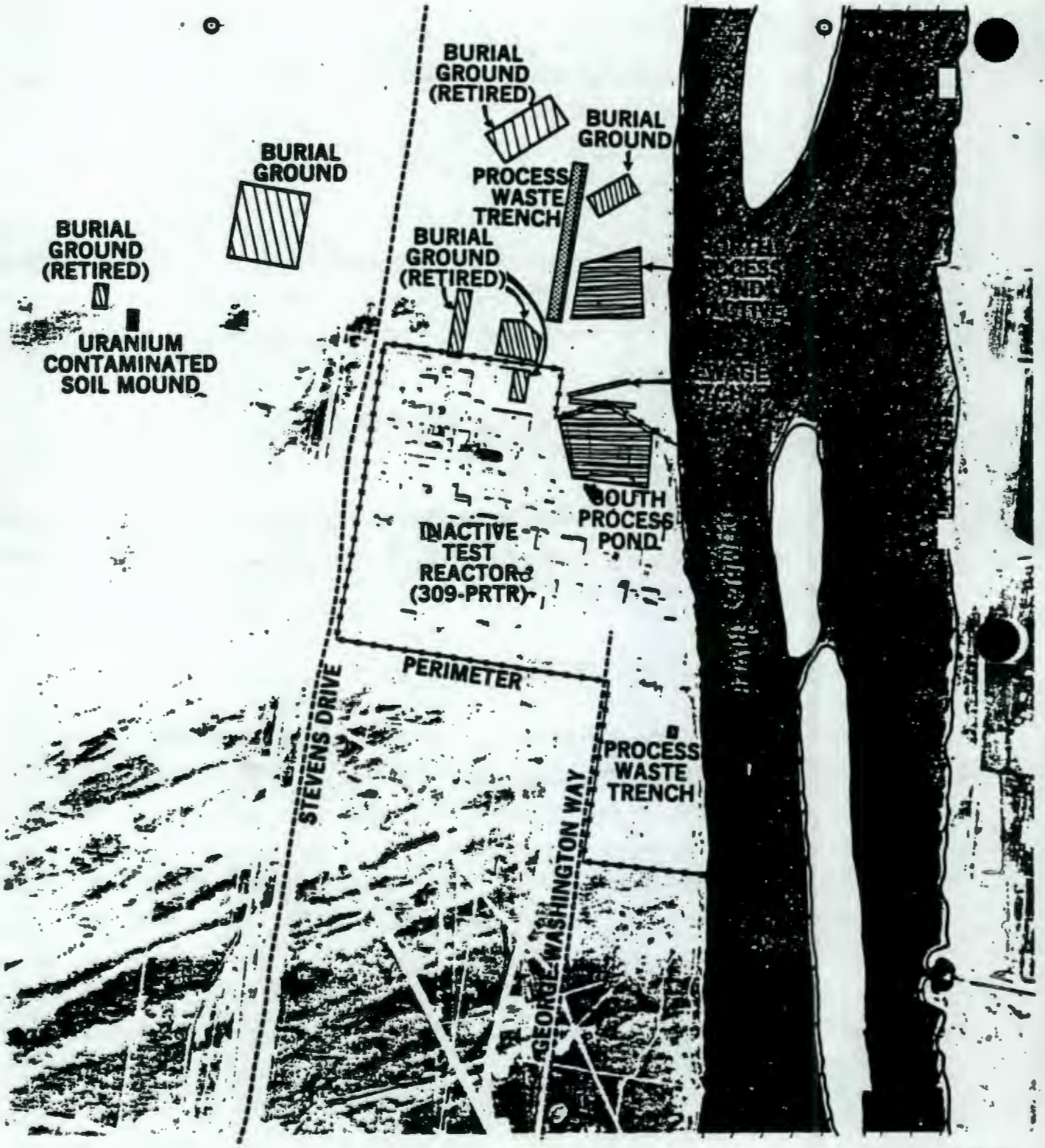
Pump House

Water is pumped from the Columbia River at the 312 Pump House. The water is then treated by coagulation and filtration prior to being used. The filter backwash is discharged to the Process Trench.

Process/Sanitary Sewer System

Liquid process wastes from the various buildings are discharged to the process sewer system which then discharges to the Process Trench. Any of these wastes that are likely to be contaminated with radiological materials are continuously monitored prior to leaving the building. If radiological materials are detected, the liquids are automatically diverted to the holding tanks at Building 340 for further sampling. If these wastes are found to be within limits, they can then be discharged to the Process Trench. Otherwise, these wastes are held and transported to the 200-Area for disposal. If the process liquid from each building is within limits (from the radiological monitoring), then the liquids are discharged to the Process Trench.

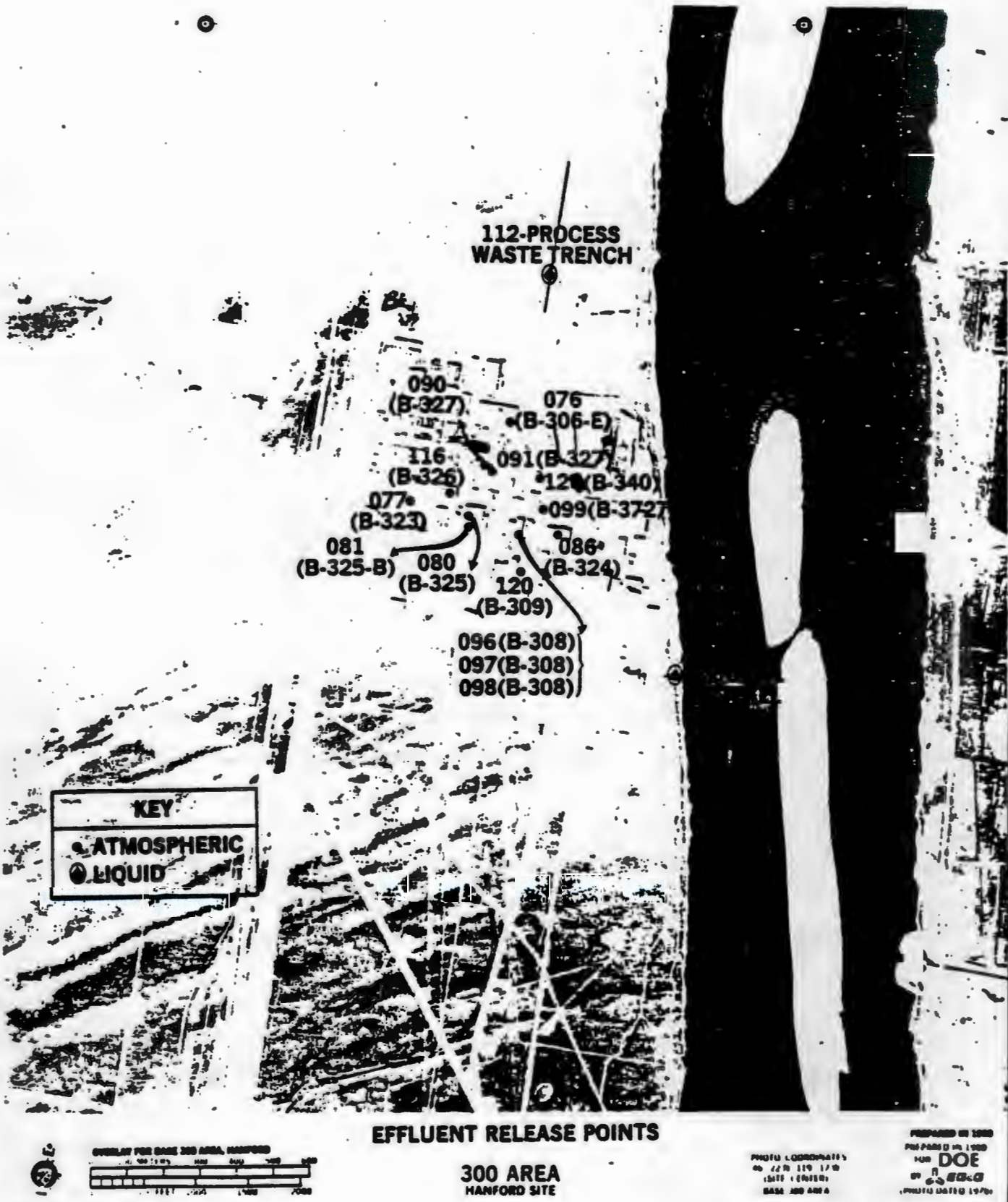
All the sanitary waste from the 300-Area is collected in the sanitary sewer system and directed to a septic tank/leaching trench system. In addition to the sanitary waste, it is reported that a significant quantity of uncontaminated cooling water is discharged to the septic tank.



GENERAL FEATURES
300 AREA
HANFORD SITE

Source: EG&G 1979.

FIGURE



EFFLUENT RELEASE POINTS

300 AREA
HANFORD SITE

Source: EG&G 1979.

FIGURE 3 - 8

The liquids that are sent to the Process Trench and septic tank/leach trench are discharged to the ground and, thus percolate into the groundwater.

Life Sciences Laboratory

Building 331, Life Sciences Laboratory, is operated by PNL. The aquaculture facility utilizes both well water and Columbia River water. Since the water continuously flows through the aquaculture systems, there is a direct discharge to the Columbia River. This discharge is included in the NPDES permit and is sampled/analyzed.

Power House

The Power House (Building 384, operated by WHC) receives treated water from the 300-Area filter plant. Waste liquids from the power house are discharged to the pond in the 300 Area from which the liquid percolates into the ground.

Fuel Fabrication Facility

The Fuel Fabrication Facility is operated by UNC and fabricates the fuel elements for N-Reactor. There are several areas in this facility with potential for discharge to the environment. The component cleaning line and the chemical cleaning bay have rinse tanks that overflow to the process sewer. There is potential for spills of nitric acid, nitric/hydrofluoric acid, perchloroethylene, and 1,1,1-trichloroethane to occur. The degreasing areas currently have catch basins under the tanks for drip and leak collection. There is a project in the design stage to isolate these trenches from the process sewer and to provide an effluent treatment facility. Construction is scheduled for 1988.

The cutoff saws and counterbore operations contribute to the potential for uranium and beryllium contamination in the process sewer. Uranium particulates are sent to the process sewer from the cutoff saws. Weirs in the trenches hold up most of the uranium fines, but the collection efficiency is not 100 percent and some of the fines are washed down the sewer. The chips and fines from the counterbore area are collected and stored under water due to their pyrophoric nature. These chips are sent to the uranium oxide facility and converted to uranium trioxide prior to

shipping. The water covering the chips is poured off and discharged to the process sewer. A strainer in the drain prevents chips from entering the sewer. There is an oil residue from the water-soluble cutting oil used in the lathe operations that goes to the process sewer with the discharged water. The uranium oxide facility is periodically hosed down and the washwater is discharged to the chemical sewer.

There is an nitrogen oxide scrubber in the chemical bay. The overflow from this scrubber is discharged to the process sewer.

The mixed bed demineralizers are regenerated with acid and caustic. The caustic is stored near the demineralizer in a 55-gallon drum. This area is surrounded by a curb for spill containment, but a floor drain which is connected to the process sewer is located in the curbed area near the caustic drum.

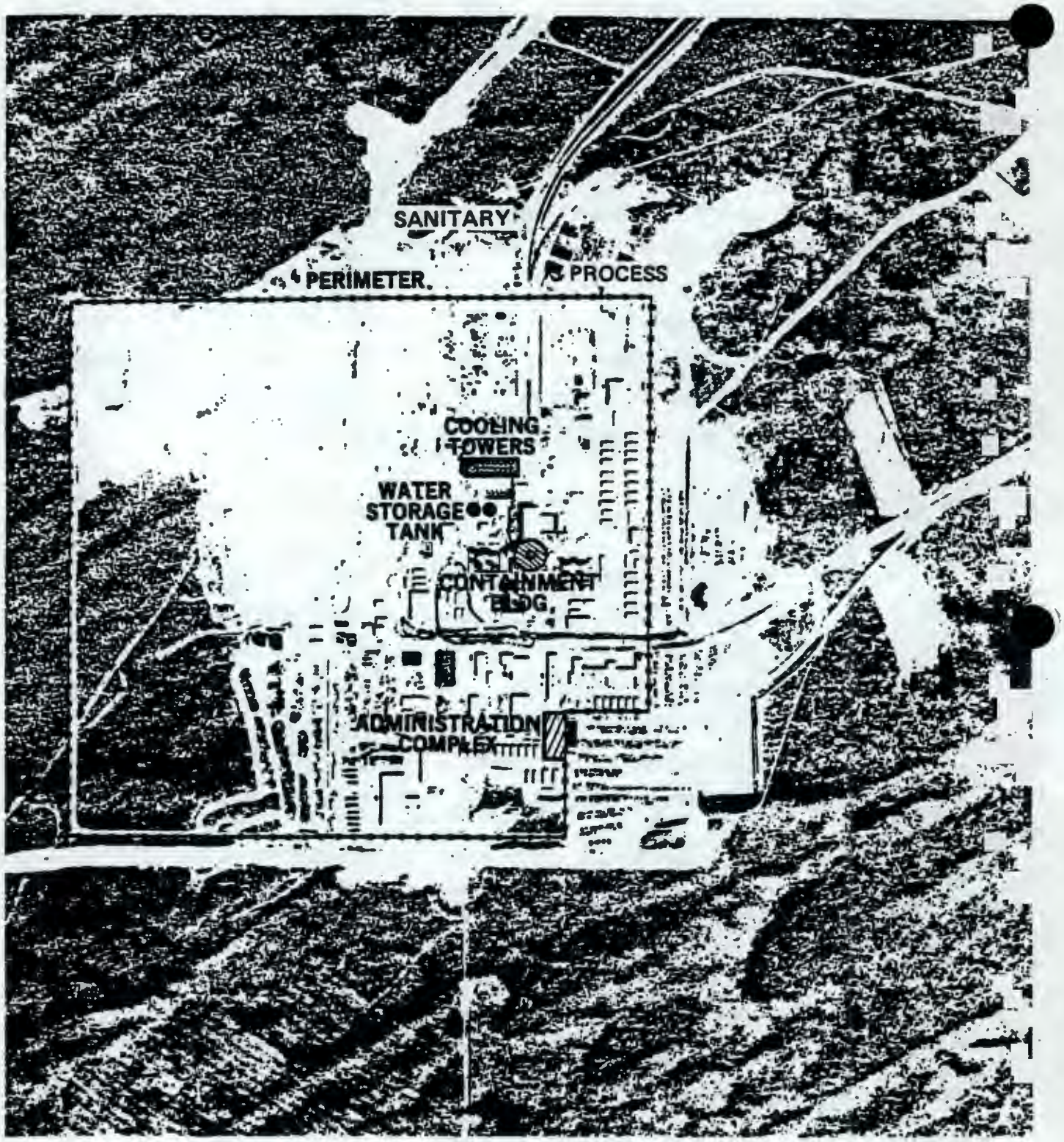
3.3.2.4 400-Area

The 400-Area is also known as the FFTF. The FFTF is a sodium-cooled fast flux test reactor designed for irradiation testing of fuels and materials. It provides long-term testing and evaluation of plant components and systems for the Liquid Metal Reactor Program (Figure 3-9).

The water supply for the FFTF is from a series of wells. There are three storage tanks on-site, which are used to supply drinking water, process water, and fire water.

The main process water usage is either once-through cooling water or makeup for a cooling tower water system. The process water is collected and sent to a leaching pond. The water simply flows into the pond and percolates into the ground. The sanitary wastewaters are collected, sent to a septic tank, and then discharged to a sanitary leaching pond. Again, the water discharged from both the process sewer and septic tank simply percolates into the ground.

There are a number of drywells situated around the site. A number of these receive stormwater runoff from pads, etc. Several receive water that is collected in sumps and pumped to the drywells. These sumps could pick up oil or other materials spilled in the area of the sump.



GENERAL FEATURES
400 AREA
HANFORD SITE

Source: EG&G 1979.

FIGURE 3

3.3.2.5 1100-Area

Building 1166 is a receiving and storage warehouse. The floor drains are reportedly plugged with dirt accumulated over the years. The drains are not isolated from the stored chemicals by curbs or other means.

Building 1164 is used to store paints and solvents. There is a curb around the inside of the building that prevents release of any spills to the environment.

Building 1169 is used for storage of acids, bases, and other laboratory-type chemicals. There is a trench-type floor drain around the inside of the building that drains to drywells outside the building. These drains and drywells are primarily used to discharge water used in hosing down the floor. Most of the spills that occur in this building are small and are contained inside the building.

The vehicle wash and maintenance shop has relatively small potential for discharge to the environment. The vehicle wash uses standard car-wash detergents and discharges to the City of Richland sewer system. Oil and antifreeze from vehicle maintenance are drummed for disposal or reclamation. Two 4000-gallon underground storage tanks collect condensate from steam cleaning and other wash operations with the collected water trucked to the 200-Area for disposal.

3.3.3 Environmental Monitoring Program

3.3.3.1 Radionuclide Monitoring

PNL is the only contractor that conducts surface water and fish sampling for the Hanford Reservation site. Although the contractors for the 100-Area and the 200-Area conduct area-specific environmental sampling, they do not monitor surface water or fish. The following information is from Price (1986) and only covers indicator-type locations.

The PNL reports upstream data for the Columbia River for surface water and fish. The PNL does not collect sediment from the Columbia River. Table 3-27 (Section 3.3.1) lists the surface water concentrations of radionuclides detected from the upstream location. The only data on concentrations of radionuclides in fish are

available from PNL. The PNL reports upstream concentrations of cobalt-60, strontium-90, and cesium-137 in whitefish. Only strontium-90 and cobalt-60 were detected with average activities of 0.027 ± 0.028 picocurie per gram (wet) and 0.004 ± 0.001 picocurie per gram (wet), respectively (Price, 1986).

The Hanford Site annual monitoring reports use these effluent data to calculate the 50-year cumulative dose equivalent to the population residing in an 80-kilometer radius and the dose to a hypothetical, maximally exposed individual at an off-site location (Price, 1986). For 1985 the organ receiving the largest fractions of the annual dose standard was the bone (10 millirem). The calculated whole-body dose in 1985 was 3 millirem, as compared to 2 millirem in 1984 and 1 millirem in 1983. These levels are well below the DOE standard of 500 millirem per year. However, the bone and whole-body doses for the entire Hanford Reservation site were due almost entirely to the strontium-90 effluent released to the Columbia River in the 100N-Area.

PNL monitors the concentrations of radionuclides of Columbia River water and fish. In addition, B Ponds, Gable Mountain Pond, West Lake, and Power House Pond are sampled periodically to determine radionuclide concentrations. The Columbia River is used as a source of drinking water on-site as well as at communities downstream of the Hanford Site. As a result, the Environmental Protection Agency (EPA) and the State of Washington drinking water regulations are applicable. In addition, the river is also used extensively for crop irrigation and recreational activities such as fishing, hunting, boating, water skiing, and swimming. For these reasons, the riverwater and fish continue to be monitored for radionuclides of potential Hanford Site origin. Radionuclides of primary significance in the river are tritium, cobalt-60, strontium-89 and 90, iodine-131 and 129, celsium-137, plutonium-239 and 240, and uranium. Fish samples are analyzed for cobalt-60, strontium-90, and cesium-137.

Samples of Columbia River water are collected at two downstream locations, one at the 300-Area intake and one at the City of Richland water supply intake. Two types of samplers are used. The first type is a cumulative system that collects a fixed volume of water at set intervals during each sample period. The second type is a specially designed system that continuously collects waterborne radionuclides from the riverwater on a series of filters and ion-exchange resins. During the

9 2 1 2 4 6 1 1 5 4 0

Survey, observations were made of the collection of water samples from both types of samplers at the river stations.

Results of the 1985 analyses of Columbia River water downstream of the site are summarized in Table 3-28. The upstream analytical results are tabulated in Table 3-27 in Section 3.3.1. Concentrations of tritium and iodine-129 were significantly higher downstream, whereas strontium-90, uranium, and cobalt-60 were only slightly higher downstream.

The 1985 radionuclide analytical results are included as Table 3-29 for the major on-site ponds. These ponds are all manmade features that were constructed to support process operations.

Fish are collected at various locations along the Columbia River and boneless fillets are analyzed for cobalt-60, strontium-90, and cesium-137. In 1985, cesium-137 was identified more frequently in whitefish samples collected along the Hanford Reservation reach of the river near the 100D-Area than in samples collected upstream. The maximum and average concentrations of strontium-90 in whitefish fillets from samples collected near the 100D-Area were slightly higher than those collected upstream (Price, 1986). Data on concentrations of radionuclides in fish are summarized in Tables 3-30 and 3-31, upstream and downstream, respectively.

According to Price (1986), the presence of strontium-90 in whitefish at both sample collection areas is accounted for by the migratory pattern of whitefish along the Hanford Reservation reach of the Columbia River. The whitefish population in the Columbia River near the Hanford Site migrates upstream in the fall and winter to spawn. Therefore, the whitefish population upstream probably includes fish that have resided near or below reactor areas. The presence of cobalt-60 in the fish collected upstream may thus be associated with residual radioactivity in sediments of the Columbia River from past operations or effluent releases from the N-Reactor. The lack of data on sediment is a noted weakness in the PNL monitoring program.

TABLE 3-28

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN DOWNSTREAM COLUMBIA RIVER WATER, 1985 PNL DATA

Radionuclide	Activity, pCi/l $\pm$ 2S(1)
H-3	150 $\pm$ 21
Co-60 (Particulates)	0.0044 $\pm$ 0.0020
Co-60 (Dissolved)	0.0076 $\pm$ 0.0036
Sr-89	0.10 $\pm$ 0.065
Sr-90	0.16 $\pm$ 0.029
Nb-95 (Particulate)	0.0017 $\pm$ 0.0012
Nb-95 (Dissolved)	0.0027 $\pm$ 0.0021
I-129 (Dissolved)	$8.8 \times 10^{-5} \pm 4.9 \times 10^{-5}$
I-131 (Particulate)	0.0017 $\pm$ 0.0016
I-131 (Dissolved)	0.019 $\pm$ 0.0062
Cs-137 (Particulate)	0.0072 $\pm$ 0.0025
Cs-137 (Dissolved)	0.016 $\pm$ 0.0049
U (Natural)	0.48 $\pm$ 0.19
Pu-239,240 (Dissolved)	$2.79 \times 10^{-4} \pm 1.9 \times 10^{-4}$

(1) 2 times the Standard Error of the Calculated Mean

Source: Price, 1986

9 2 1 2 4 5 1 1 5 4 2

TABLE 3-29

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN ON-SITE PONDS, 1985 PNL DATA

Location	Average Activity, pCi/l ± 2s(1)				
	Gross Alpha	Gross Beta	H-3	Sr-90	Cs-137
West Lake	160 ± 62	220 ± 110	780 ± 140	1.8 ± 0.73	0.045 ± 2.8
Gable Pond	1.0 ± 0.54	19 ± 7.9	190 ± 180	2.1 ± 2.0	9.1 ± 5.8
B Pond	0.47 ± 0.62	11 ± 10	570 ± 450	1.5 ± 1.8	1.1 ± 1.9
FFTF Pond	3 ± 6	32 ± 7	25,000 ± 3900	0.73 ± 0.87	1.3 ± 1.7

(1) 2 times the Standard Error of the Calculated Mean

Source: Price, 1986

TABLE 3-30
AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN UPSTREAM FISH, 1985 PNL DATA

Location	Average Activity, pCi/g (wet weight)[a]		
	Co-60	Sr-90	Cs-137
Upstream of Site Boundary	0.027 ± 0.028	0.004 ± 0.001	0.009 ± 0.023

a Averages ± 2 time the Standard Error of the Calculated Mean

Source: Price, 1986

9 2 1 2 1 5 1 1 5 4 4

TABLE 3-31

AVERAGE CONCENTRATIONS OF RADIONUCLIDES IN DOWNSTREAM FISH, 1985 PNL DATA

Location	Average Activity, pCi/g (wet weight) I 2s(1)		
	Co-60	Sr-90	Cs-137
100D Area	0.002 ± 0.02	0.005 ± 0.002	0.016 ± 0.018
100F Sloughs	-0.004 ± 0.015	0.002 ± 0.002	0.035 ± 0.03

(1) 2 times the Standard Error of the Calculated Mean

Source: Price, 1986

3.3.3.2 NPDES Monitoring

There are presently eight NPDES monitoring locations on-site. These are included in permit number WA-000374-3, which expired on December 31, 1985. Re-application has been made and is in the process of being discussed between EPA - Region X and DOE. However, until such time as a new permit is issued, the old permit remains in force. The discharges covered by the permit are 003, 004, 005, 006, 007, 009, and N-Springs, which are all located in the 100-Area, and Outfall 013, which is located in the 300-Area. Table 3-32 lists the sampling and monitoring requirements.

3.3.3.3 100-Area Sampling

Sampling efforts in the 100-Area include monitoring wells for detection of oil spills and pH monitoring at the 1324N Neutralization Facility. Sampling of three monitoring wells was observed.

3.3.3.4 200-East Area Sampling

Both the B-Plant and the PUREX Plant collect weekly composites of the liquid waste streams that are discharged from the various processes. These streams are:

- o PUREX Plant
  - -Ammonia scrubber discharge
  - -Chemical sewer
  - -Cooling water
  - -Process condensate
  - -Steam condensate

- o B-Plant
  - -Chemical sewer
  - -Process condensate
  - -Steam condensate
  - -Cooling water

TABLE 3-32
HANFORD NPDES SAMPLING REQUIREMENTS

Discharge No.	Effluent Characteristics	Measurement Frequency	Sample Type
003 (181-KE Inlet Screen Backwash)			
	Flow	Maintain log - date, times & duration of all inlet screen backwashes	---
	Suspended Solids	Monthly	Composite
004 (1908K Outfall Structures)			
	Flow	Continuous	
	Temperature	Weekly	Grab
005 (Overflow from 182-N Water Tank Farm)			
	Flow	Continuous	
	Temperature	Continuous	
	Suspended Solids	Weekly	Grab
	Total Oil & Grease	Monthly	Grab
	Visible Oil Sheen	Monthly	Visual Observation
	Chlorine	Monthly	Grab
006 (182-N High Lift Pumphouse Drain)			
	Flow	Maintain logs of dates, time, duration of usage of two fog-spray pumps	
	Suspended Solids	Monthly	Grab
	Total Oil & Grease	Monthly	Grab
	Visible Oil	Monthly	Visual Observation
007 (181-N Inlet Screen Backwash)			
	Flow	Maintain log of dates, times, and duration of 181-N inlet screen backwashes	

9 2 1 2 4 1 1 5 4 7

TABLE 3-32 (continued)

Discharge No.	Effluent Characteristics	Measurement Frequency	Sample Type
009 (102" Line)			
	Flow	Maintain log for 181-N CRW pumps	
	Temperature	Continuous	
	WT, Discharge Temperature - Ambient River Temperature	Continuous	
	Chlorine	Monthly	Grab
1301-N Riverbank Screens			
	Oil & Grease	Monthly	Grab
	Iron	Quarterly	Grab
	Ammonia	Quarterly	Grab
	Chromium	Quarterly	Grab
	Temperature	Quarterly	Grab
013 Aquaculture Facility)			
	Flow	Continuous	
	pH	Weekly	Grab
	Settleable Solids	Weekly	Grab
	Suspended Solids	Monthly	Grab

Source: DOE Survey Team

9 2 1 2 4 6 1 1 5 4 8

These samples are either flow proportional, time proportional or, in some cases, grab samples, depending upon the type of operation from which they are being discharged. They are basically given a gamma, beta, and/or alpha analysis. Many are then composited into a monthly sample that is given a more intense radionuclide analysis, as well as a check for pH, nitrate, and total organics.

Likewise, a series of samples are taken from various sampling locations by the Rockwell Environmental Control group in order to provide an ongoing monitoring program. In 1985, there was also a program established to provide analytical data to support the Resource Conservation and Recovery Act (RCRA) program. These samples were taken once in 1985 and were analyzed, for the metals, organics, etc. contained in the RCRA listing. Continuing sampling will be performed in 1986 on a quarterly basis.

Soil samples are also collected at the 15 on-site and 18 off-site locations and are analyzed for Sr-90, Cs-137, Pu-239, 240, and U.

3.3.3.5 200-West Area Sampling

Effluent samples are taken in two locations at the UO_3 Plant. A weekly grab sample is collected at the 207U Retention Basin and these weekly grab samples are combined into a monthly composite sample.

The 216U-12 Crib has a time collection sampling system that is activated when the pump is operating. Weekly samples are combined into a monthly composite. The parameters monitored at the UO_3 Plant are uranium, pH, alpha, and beta.

The plant has two sampling stations that monitor process sewer flow to the crib. The first station is located in the 2904ZA Building and takes a proportional sample downstream of Manhole 7. A sample is analyzed every 8 hours. An alpha monitor is also installed at this point and records the count rate every 10 minutes.

The second sampling station is at Manhole 9. This consists of a Leeds & Northrup continuous pH monitoring system, and a Marsh McBirney totalizing flow meter.

3.3.3.6 300-Area Sampling

As mentioned in the previous section, WHC is the "landlord" for this area. Thus, WHC is responsible for waste management, including treatment and disposal. The tenant operators are responsible for their process and its effluent. The non-radiological contaminated waste streams are collected and discharged to the Process Trench at the north side of the 300-Area. A weekly composite of the process waste liquid is collected from the influent to this trench. This sample is analyzed for alpha, beta, total organic carbon, pH, chloride, copper, sodium, fluoride, nitrate, nitrite, bromine, phosphate, sulfate, arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, methylene chloride, perchloroethylene, and 1,1,1-trichloroethane.

The sanitary waste stream is sampled weekly (composited) for radiological aspects and every 6 months for all other parameters listed for the Process Trench. In addition to these analyses, the noncontaminated (radiological) streams are monitored as they leave the various buildings for gamma, beta, and/or alpha. If any of these parameters are found, the streams, in most cases, automatically divert to Building 340 for further checking and final disposition.

PNL is responsible for sampling/analyzing the discharge from the aquaculture facility, which enters the river as Outfall 013. This discharge is sampled (composited) weekly and checked for pH and settleable solids. A monthly sample is checked for suspended solids.

UNC does monitoring of the liquid discharges from the buildings it occupies in the 300-Area. This monitoring takes place at Building 333 and Building 313. Both sampling points record flow and take a weekly time-composited sample which is analyzed for pH, fluorides, nitrates, copper, and uranium. The sample points have a continuous pH monitoring system. A quarterly grab sample is analyzed for organics. This sample is analyzed within 24 hours but is not refrigerated.

3.3.3.7 400-Area

This area is also operated by WHC. The process liquid waste is collected and discharged to the process pond at the north end of the 400 Area. This stream is sampled quarterly (grab sample) and analyzed for the same suite of parameters as the 300-Area process sample. Additionally, the sanitary waste is sampled quarterly and analyzed for the same parameters that are mentioned in Section 3.3.3.6.

There are 13 drywells in and around the FFTF. These drywells receive runoff from transformer pads, drippage and/or leakage from equipment, and discharges from sumps in the buildings. Any material collected in these drywells simply percolates into the ground. These drywells are sampled annually and are analyzed for the same parameters as the process and sanitary waste streams.

3.3.3.8 1100-Area

With the exception of the vehicle wash station, the 1100-Area does not discharge water to the environment. The only sampling performed is on the 4000-gallon sumps in the steam cleaning area. The water in these sumps is checked for oil and grease before it is sent to the 200-Area for disposal.

3.3.4 Findings and Observations

3.3.4.1 Category I

None

3.3.4.2 Category II

1. Discharge of Contaminated Wastewaters to the Ground. Untreated wastewaters containing radiological and hazardous constituents are being disposed to the environment causing widespread contamination of soils and groundwater.

Wastewater streams are released to the environment in the 100-, 200-, 300- and 400-Areas at the Hanford Site. These discharges may contain hazardous constituents (both radionuclides and non-radiological constituents). Many discharges receive little, if any, treatment prior to being released. The existing wstewater monitoring program is inadequate to determine if hazardous pollutants are contained in these waste effluents.

The cribs, trenches, and septic tanks where these wastes are discharged are elementary treatment units that would accomplish little or no removal of hazardous constituents. These releases may cause environmental degradation of the soil, groundwater, or surface water at the Hanford Reservation site, or could migrate off-site. Wastewater at Hanford has been discharged to the environment since the facility's inception. Consequently, the sediments in the ditches, ponds, trenches, and river that received these wastewaters may be contaminated with hazardous constituents. The wastewaters currently discharged and the potential accumulation of pollutants in sediments may lead to problems of human exposure via direct contact, ingestion through resuspension of contaminants in drinking water supplies, or uptake through the local food chain.

The significant fact with this finding is that hazardous constituents can be making their way to the groundwater and then, in time, be discharged to the Columbia River. The liquid discharges from all areas of the Hanford Site are disposed of into the ground with virtually no treatment. More data are needed to identify potential problem areas (i.e., heavy metals, organics). The sampling and analysis of the waste streams will attempt to identify areas that need more identification or remediation. At that point, longer term characterization studies or pilot studies will be identified and, from these, treatment processes can be developed.

2. Discharge of Potentially Undertreated Sanitary Wastewater. Large quantities of sanitary wastewaters, potentially containing process or hazardous waste streams, are being released to elementary septic system that may not be providing adequate treatment. Contaminants are potentially being released to soils, groundwaters, and surface waters.

Sanitary wastewaters are sent to septic tank/drainage fields in trenches in the 100-, 200-, 300- and 400-Areas of the Hanford Site. Whether the systems are overloaded or receiving types of wastes that should be diverted elsewhere is unknown at this time. A new sanitary treatment system is being constructed in the 100-N Area that will handle most of the sanitary waste from that area (there are a few isolated areas within 100-N that will not be tied in due to unaccessibility). Both the 300- and 400-Areas collect and discharge their sanitary waste to septic tanks, which in turn discharge to an open trench and pond, respectively. In the case of the 300-Area system, it was reported that cooling water is discharged to the septic system thus possibly hydraulically overloading the system. A project has been proposed to redesign and reconstruct the sanitary system in the 300-Area and at the same time remove the uncontaminated cooling water streams from the sanitary system.)

3. Improper Sampling of Oil Detection Wells. The sampling protocols used to monitor certain groundwater wells in the 100N-Area are inadequate for the detection of oils, causing lower levels to be reported than actually occur and cross-contaminating samples.

Groundwater monitoring wells in the 100N are being sampled to determine if, and when, oil contaminated water reaches the Columbia River. The procedures for sampling these wells appear to be improper and could lead to the development of inaccurate data. The sampling method employed does not measure floating oil and potential cross-contamination of samples may result from inadequate decontamination of sampling equipment.

Changes in technique will improve the reliability and credibility of the analytical results obtained from these wells. There were problems observed with the current sampling procedure used for these wells. The same bailer was used to sample all three wells with no cleaning or decontamination between wells. This causes inaccurate analytical results because of cross-contamination.

In the sampling observed, the bailer was dropped to the bottom of the well and two to three bailer volumes were removed before collecting the sample. This procedure does not allow the determination of whether a floating layer of oil is present. The sample to be analyzed is again taken from the bottom of the well, potentially missing substantial quantities of oil floating at the water surface.

3.3.4.3 Category III

1. N-Spring Water Releases to the Columbia River. Wastewaters from the N-Reactor are discharged to the 1301-N Crib at such a large volume that seeps occur along the Columbia River which contain radiological and potentially hazardous constituents. The 1301-N Crib is an ineffective treatment system that contributes to the degradation of surface water and groundwater.

   Untreated water seeps from the N-Springs and is discharged to the Columbia River. These seeps constitute a major portion of the radiation dose at the Hanford Site. Although the dose level is low, the significance of confirmed discharge of N-Reactor wastewaters to the crib is very high.

   The bone and whole-body doses for the entire Hanford Site were due almost entirely to the strontium-90 effluent from the N-Springs released to the Columbia River in the 100-N Area. The Hanford annual monitoring report use the data presented in report to calculate the 50 year cumulative dose equivalent to the population residing in a 80 km radius and the dose to a hypothetical, maximally exposed individual at a off-site location (Price, 1986). For 1985 the organ receiving the largest fractions of the annual dose standard was the bone (10 mrem). The calculated whole body dose in 1985 was 3 mrem as compared to 2 mrem in 1984 and 1 mrem in 1983. However, the bone and whole body doses for the entire Hanford Site was due almost entirely to the Sr-90 effluent released to the Columbia River in the 100-N Area.

9 2 1 2 4 6 1 1 5 5 4

3.3.4.4 Category IV

1. Columbia River Water Sampling. Improper sampling equipment and procedures employed to obtain composite samples of Columbia River water lead to potentially inaccurate data.

Observations were made on August 26, 1986, of the collection of surface water samples from the Richland Pump House, the 300-Area intake, and the upstream station at Priest Rapids Dam. All three of the stations had a cumulative water sampler that consisted of a timer-activated solenoid valve that periodically diverted a continuously flowing substream of Columbia River water into a 10-liter container. Two of the stations, the 300-Area intake and Priest Rapids Dam, also have a special water sampling system that is used to separate the radionuclides from river water prior to analysis, using filters and ion-exchange resins.

Several problems were observed with the sampling equipment and procedures:

- Two of the three stations (Richland Pump House and 300-Area Intake) were found to have overflowing 10-liter collection containers. This overflowing condition means that the sample was not collected over the full sampling period and was unrepresentative of the compositing period. The sampling technician was unable to make the necessary adjustment to the timer to properly adjust the flow rates.

- The sample container for the composite sample cannot be completely emptied, which results in some cross-contamination of the sample from one compositing period to another.

2. Diversity of Water Sampling Programs. Because surface water sampling is conducted by a number of contractors using various procedures, it is difficult to ensure consistency among the programs and comparability of resulting data.

Environmental (water and sampling) programs are performed by the various contractors. While all programs are designed to obtain the necessary monitoring data, there does not appear to be a common procedure to be followed. This could lead to confusion, particularly when it comes to establishing representatives, definable data.

9 2 1 2 4 5 1 1 5 3 6

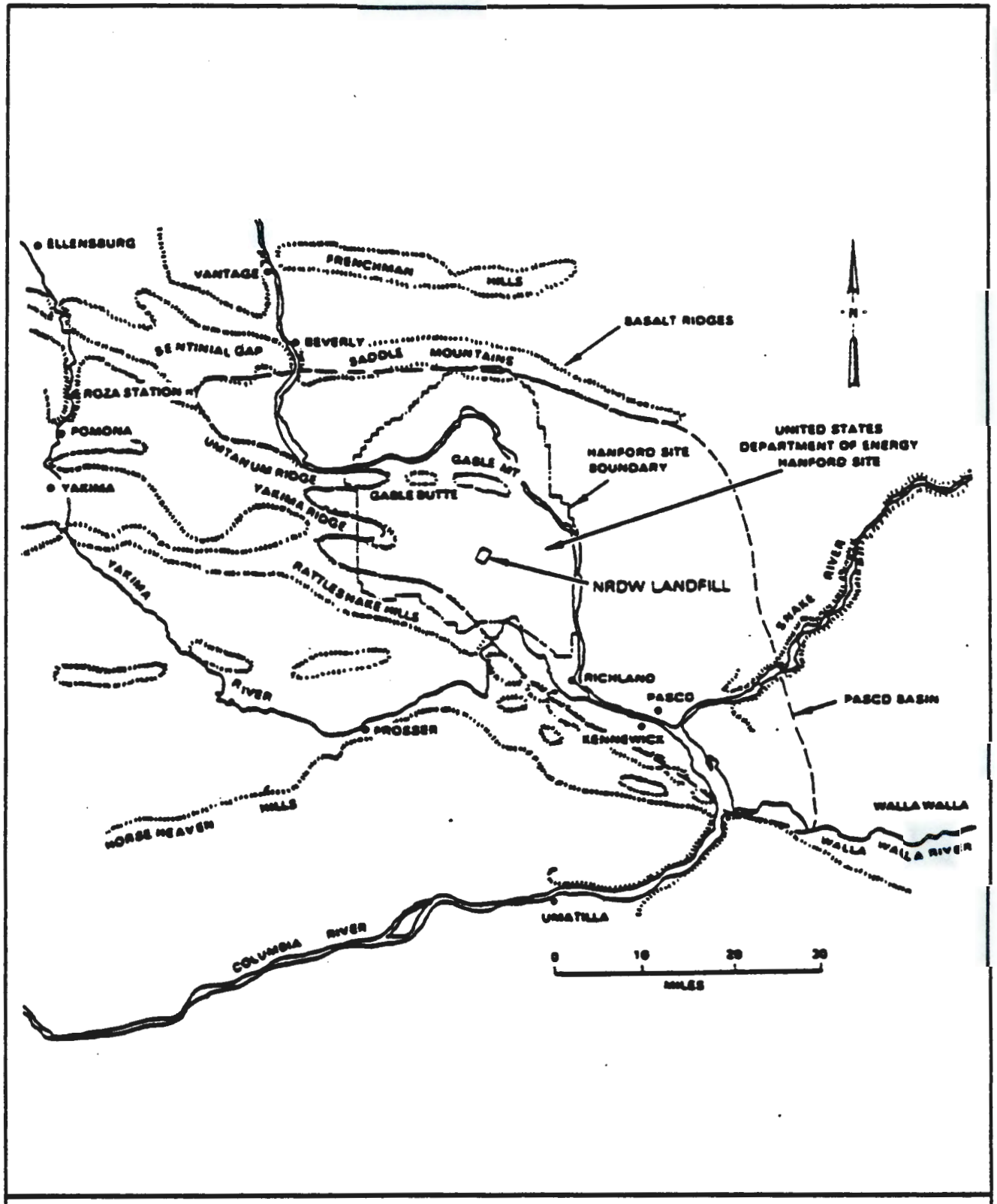
3.4 Hydrogeology (Groundwater)

3.4.1 Background Environmental Information

The Hanford Reservation site is located in southeastern Washington State and occupies 570 square miles of the semiarid Pasco Basin. The desert plains on which the site is located rise gradually from an altitude of about 400 feet above mean sea level (MSL) in the southeastern part of the site to about 700 feet above MSL in the northwestern part (see Figure 3-10). Along the western boundary and in the center, basalt ridges rise above the plains (see Figure 3-11). The Columbia River flows through the northern part of the site and forms part of its eastern boundary, and the Yakima River flows along a portion of the site's southern boundary. The generalized structure of the Pasco Basin is shown on Figure 3-12.

Geology

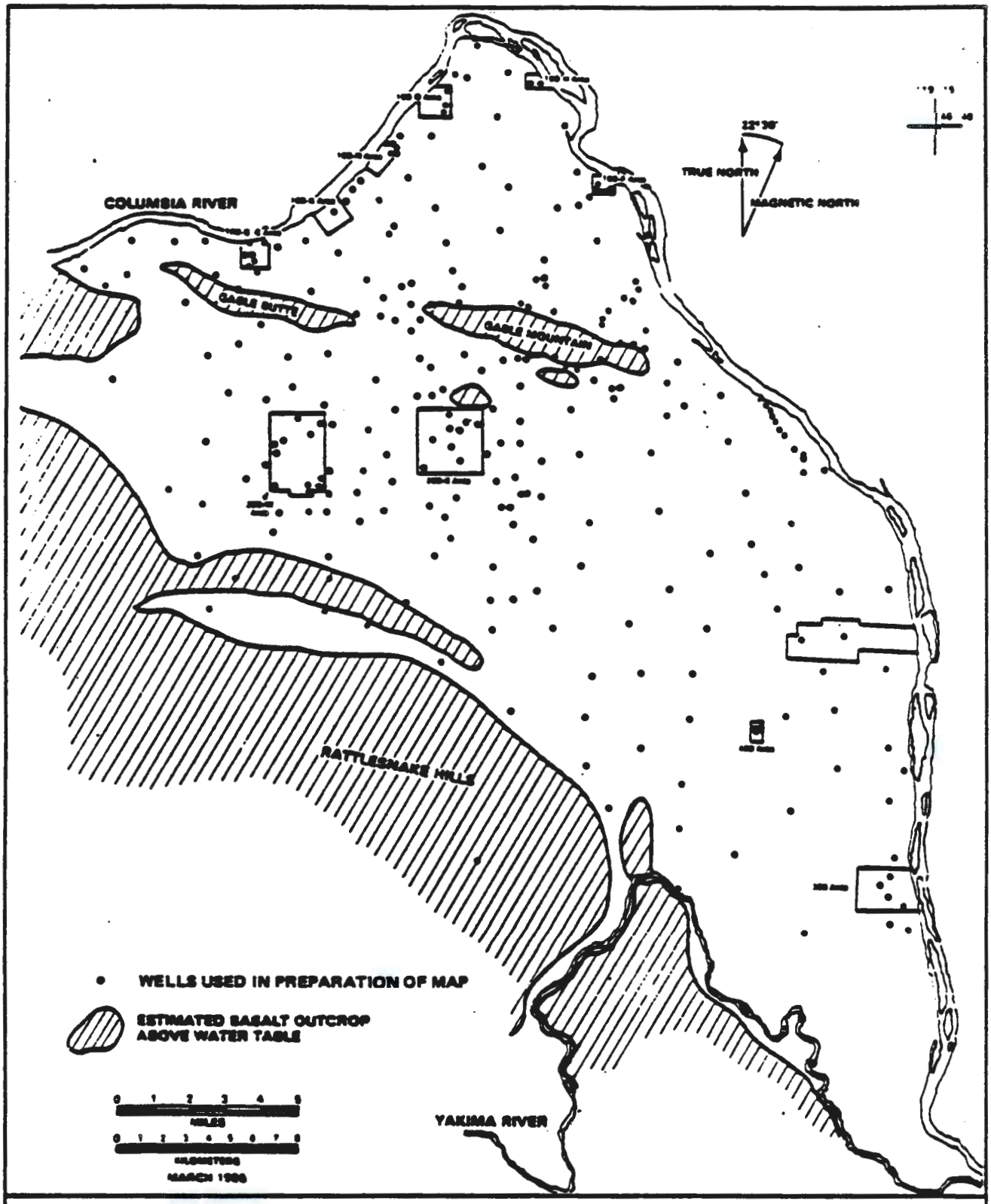
Three major stratigraphic (geologic) units underlie the Hanford Reservation site. These units in ascending order are the Columbia River Basalt Group, which forms the bedrock beneath the site; the Ringold Formation, which overlies the basalt sequences, and a series of glaciofluvial sediments (known informally as the Hanford Formation or Pasco Gravels). Eolian sands veneer the Hanford Formation but are difficult to separate from the Hanford Formation on the basis of well samples. A generalized cross-section of the geology is shown on Figure 3-13. Recent subsurface geologic studies have detailed the subsurface stratigraphy beneath the Non-radioactive Dangerous Waste Landfill, located near the center of the Hanford Reservation site. Figure 3-14 is a stratigraphic column of the subsurface. The complexity of the area is shown on the next three Figures (3-15; Cross-Section Location map: 3-16; NW-SE Section: 3-17; SW-NE Section). The varying geologic and hydrologic properties of the formations underlying the site affect the movement of water and wastewater in the area. Brief descriptions of the geology and hydrogeology of each of the three major formations are given below.



Source: Fuchs et al., 1985

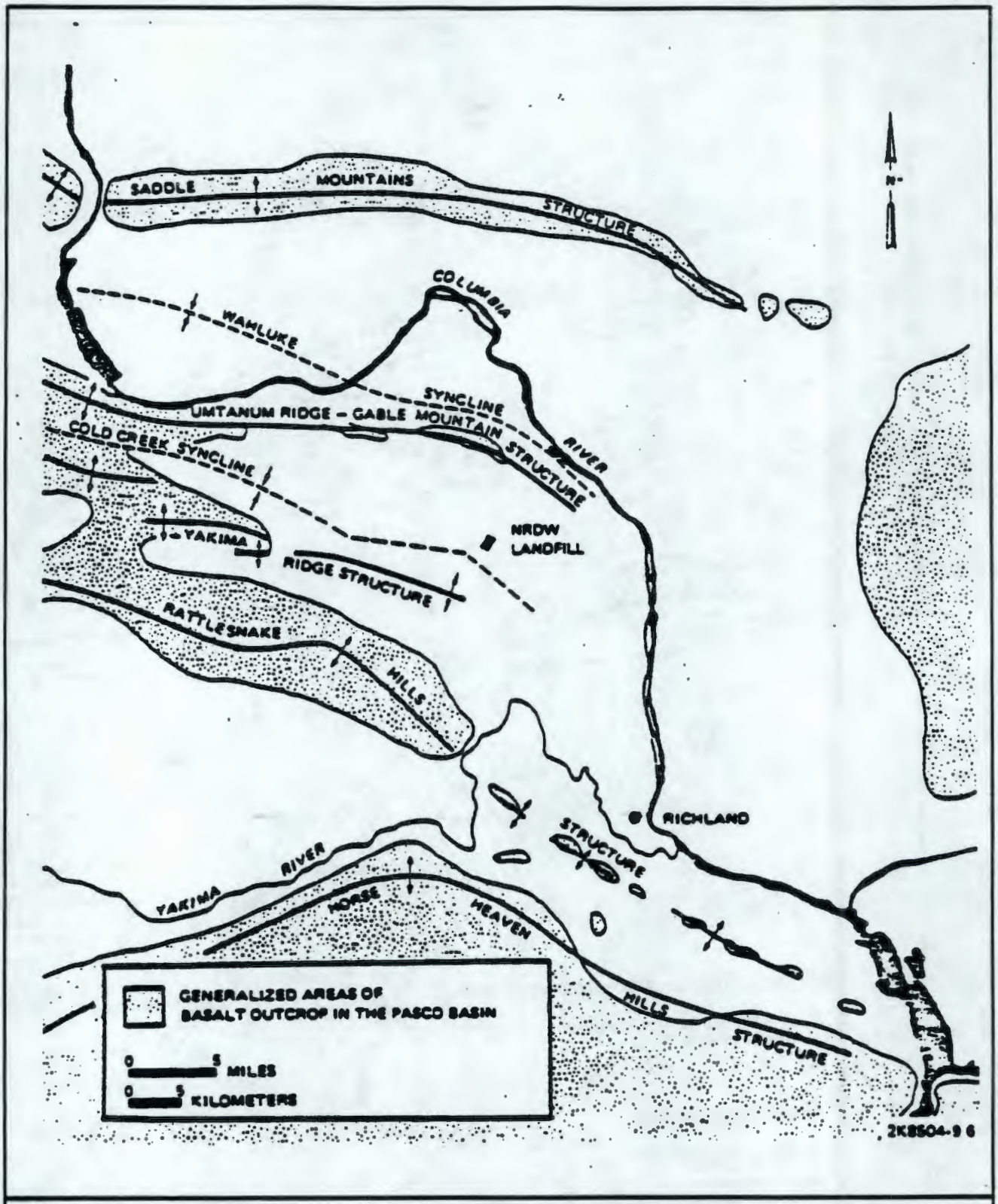
GENERAL TOPOGRAPHY OF THE HANFORD SITE, WASHINGTON

FIGURE 3 - 10



Source: Graham, 1986

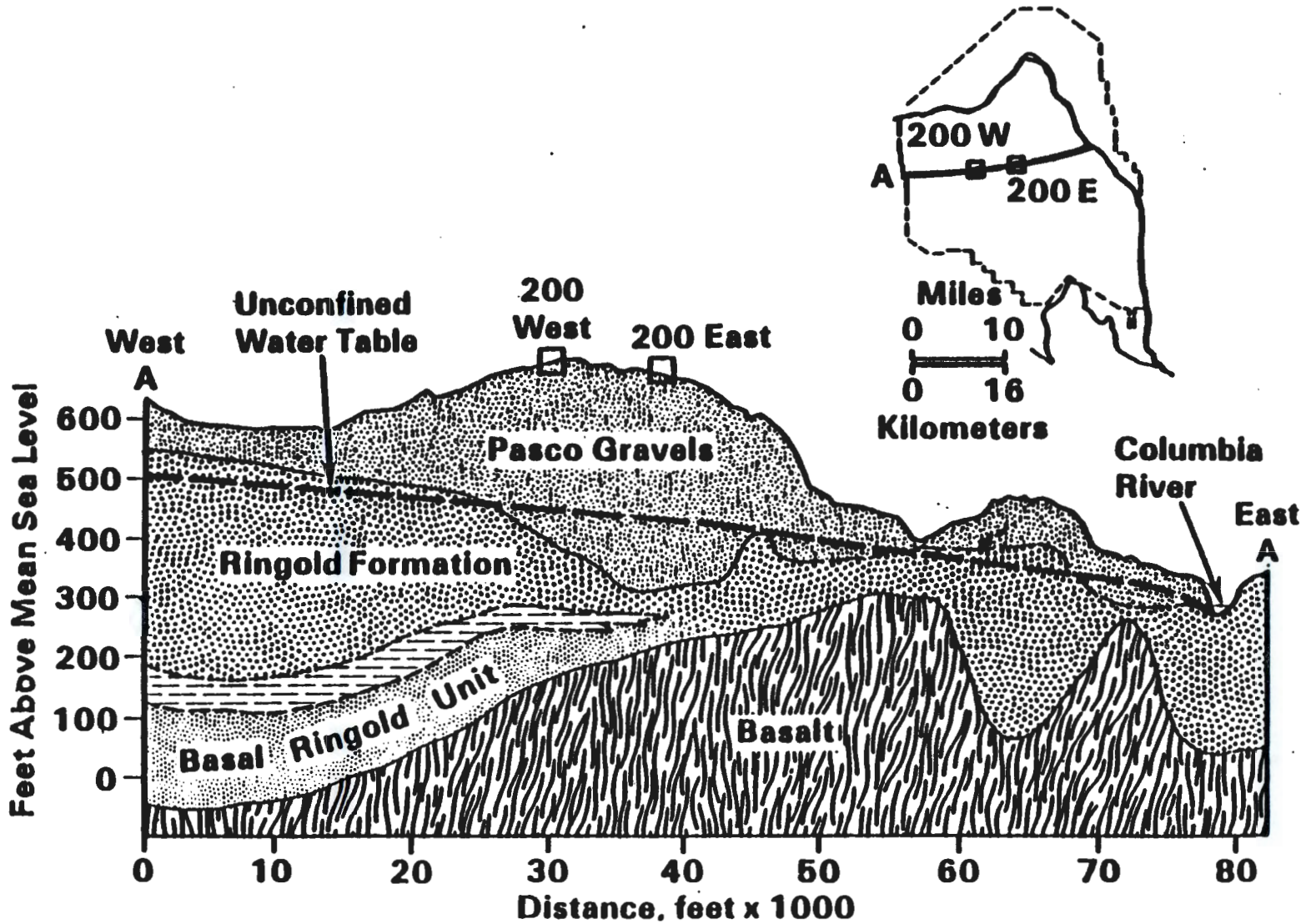
BASALT OUTCROP ABOVE THE WATER TABLE IN THE HANFORD SITE, WASHINGTON **FIGURE 3 - 11**



Source: Fuchs et al., 1985

GENERALIZED STRUCTURAL FEATURES OF THE PASCO BASIN, WASHINGTON **FIGURE 3 - 12**

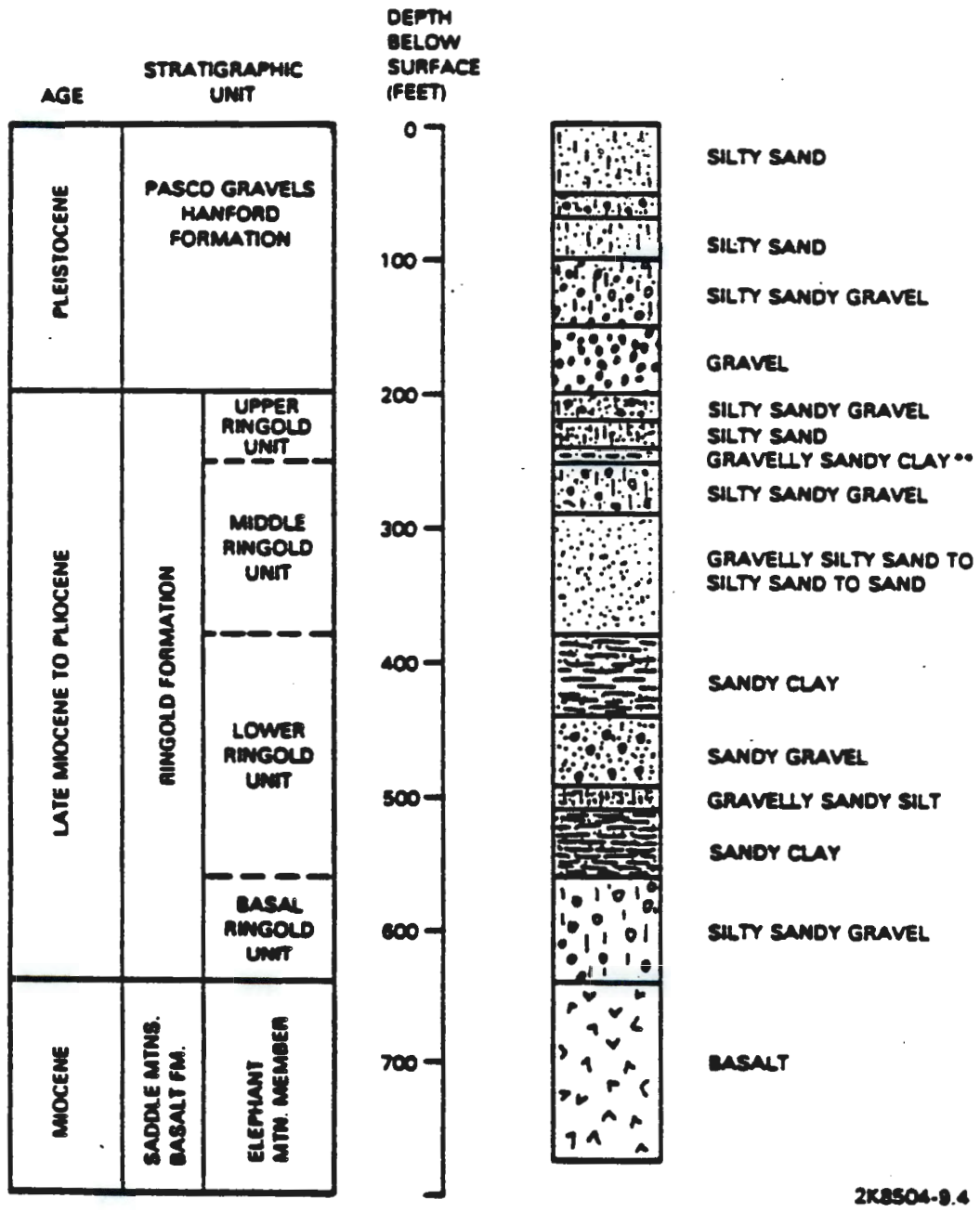
9 2 1 2 4 6 1 1 5 6 0



Source: Graham, 1986

GENERALIZED GEOLOGIC CROSS SECTION OF THE HANFORD SITE

FIGURE 3 - 13

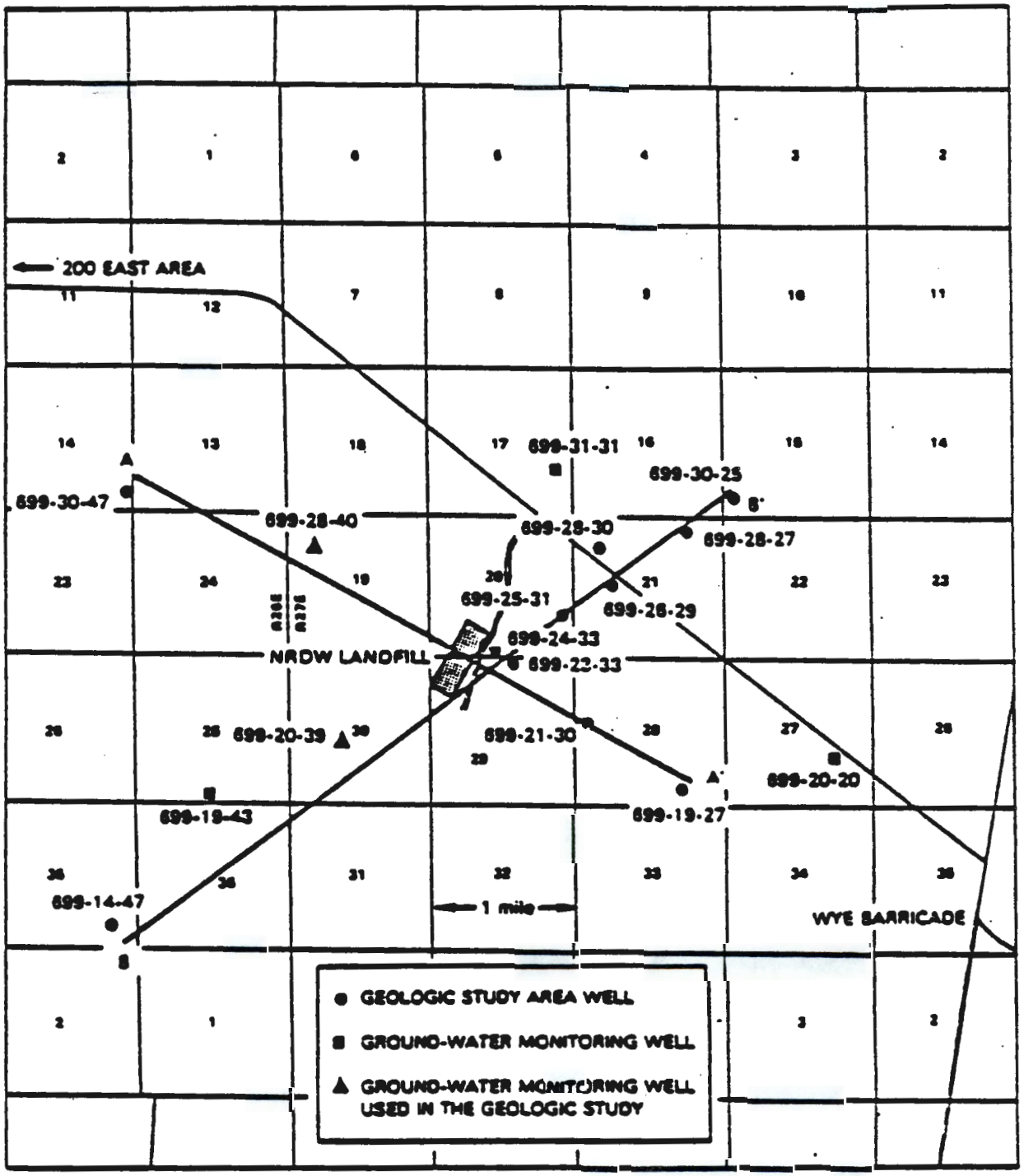


**POSSIBLE LOW PERMEABILITY LAYER PRESENT IN SEVERAL NEARBY WELLS

Source: DOE, 1986

GENERAL STRATIGRAPHY AT THE CENTER OF THE HANFORD SITE

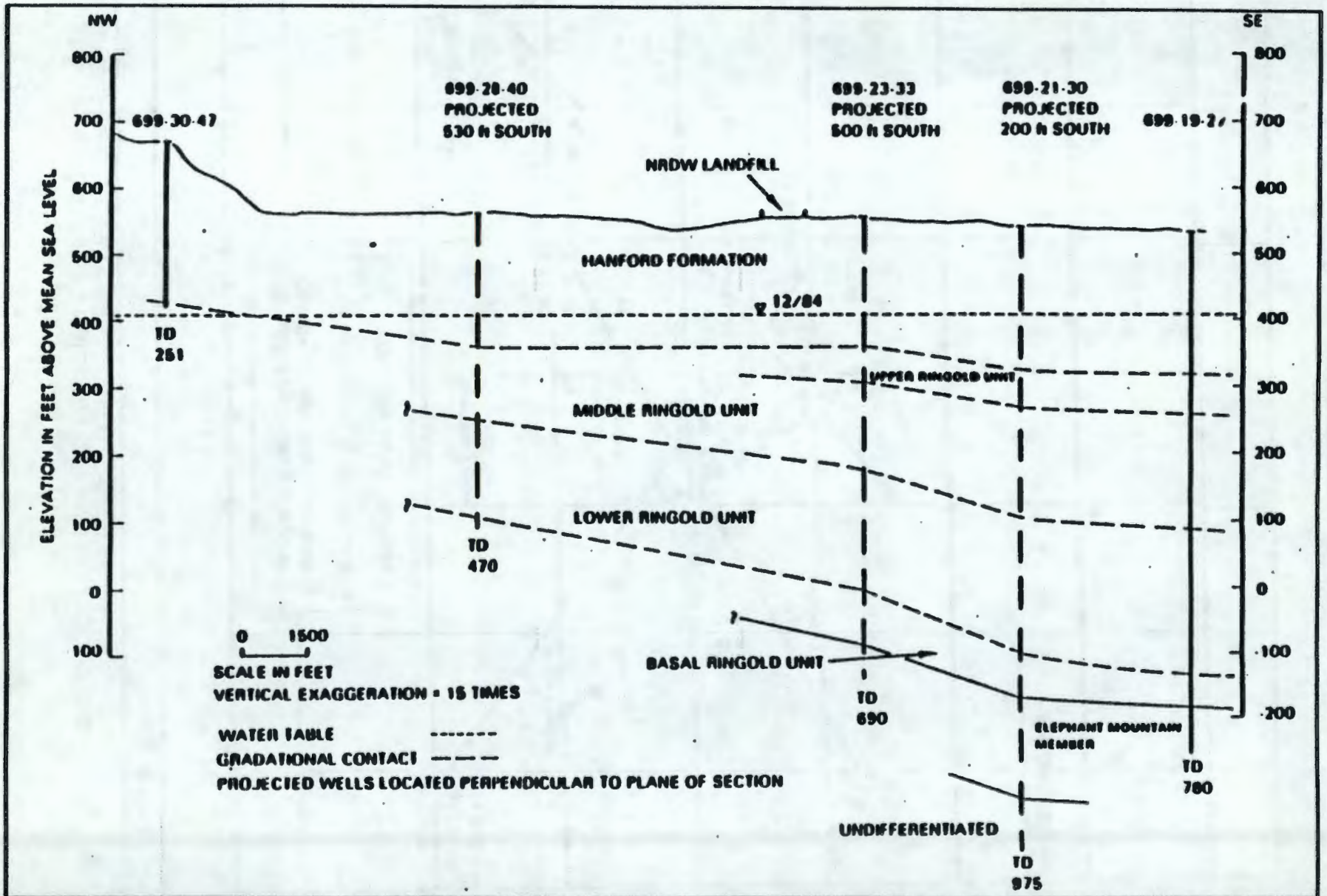
FIGURE 3 - 14



Source: Fuchs et al., 1985

CENTER OF HANFORD SITE STUDY AREA WELL LOCATION MAP AND LOCATION OF GEOLOGIC CROSS SECTIONS A-A' AND B-B'

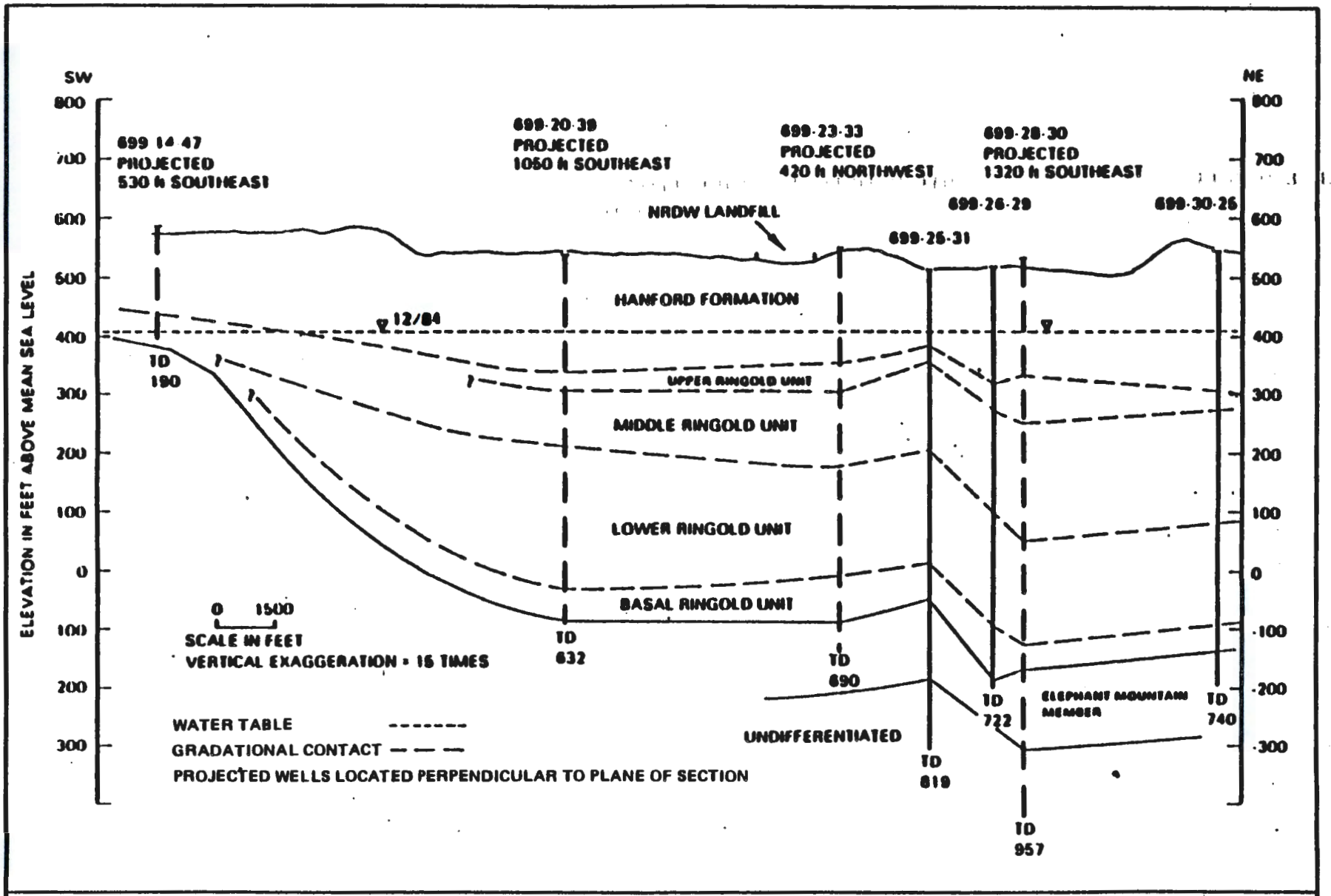
FIGURE 3 - 15



Source: Fuchs et al., 1985

CENTER OF HANFORD SITE STUDY AREA
GEOLOGIC CROSS SECTION A-A'

FIGURE 3 - 16



Source: Fuchs et al., 1985

CENTER OF HANFORD SITE AREA
GEOLOGIC CROSS SECTION B-B'

FIGURE 3 - 17

Columbia River Basalt Group

The Columbia River Basalt Group is a thick series of lava flows that were extruded from fissures. These basalts have been warped and folded, producing anticlines which in some places crop out at the land surface. Beneath the Hanford Site, the basalt has a general saucer-shaped structure; this broad syncline forms the bedrock frame of the Pasco Basin. Based on oil test drilling in the area, the basalt is known to be more than 4500 feet thick. The basalt is a gray/black coarsely fractured rock that differs a little in color, texture, and jointing from flow to flow, but has a rather uniform appearance within any single flow layer. In general, the rock is dense and hard and may be brittle and flintlike in places. The most flinty basalt contains up to 50 percent glass.

Ringold Formation

The Ringold Formation overlies the basalts in the Hanford Site area except in some localized areas. This formation, consisting of fluvial and lacustrine sediments, is divided into four lithologic units (basal, lower, middle, and upper units). The basal and middle units consist mostly of semiconsolidated gravels and sands, whereas the lower and upper units consist mainly of bedded silts and sands. Beneath the 200-West Area, sediments of the upper Ringold Formation have been reworked by the wind and redeposited as a silt layer called a Palouse soil. The glaciofluvial sediments rest atop the Ringold Formation or Palouse soil, and in places where the Ringold has been removed, the basalts.

Hanford Formation

The Hanford Formation (informal) overlies the Ringold Formation in portions of the Hanford Site. These sediments are glaciofluvial in origin. They were deposited by the ancestral Columbia River when it was swollen by glacial meltwater. The Pasco Gravels facies of the Hanford Formation is the only facies present and the texture ranges from gravel to silty sandy gravel to sand. The coarser portion of the Pasco Gravels is composed of boulder to fine-pebble-sized gravels with relatively high basalt percentages (up to 50 percent). The finer portions of the Pasco Gravels are composed of either gray, medium to very coarse sand, with high basalt percentages, or brown, very fine to very coarse largely nonbasaltic sands. The

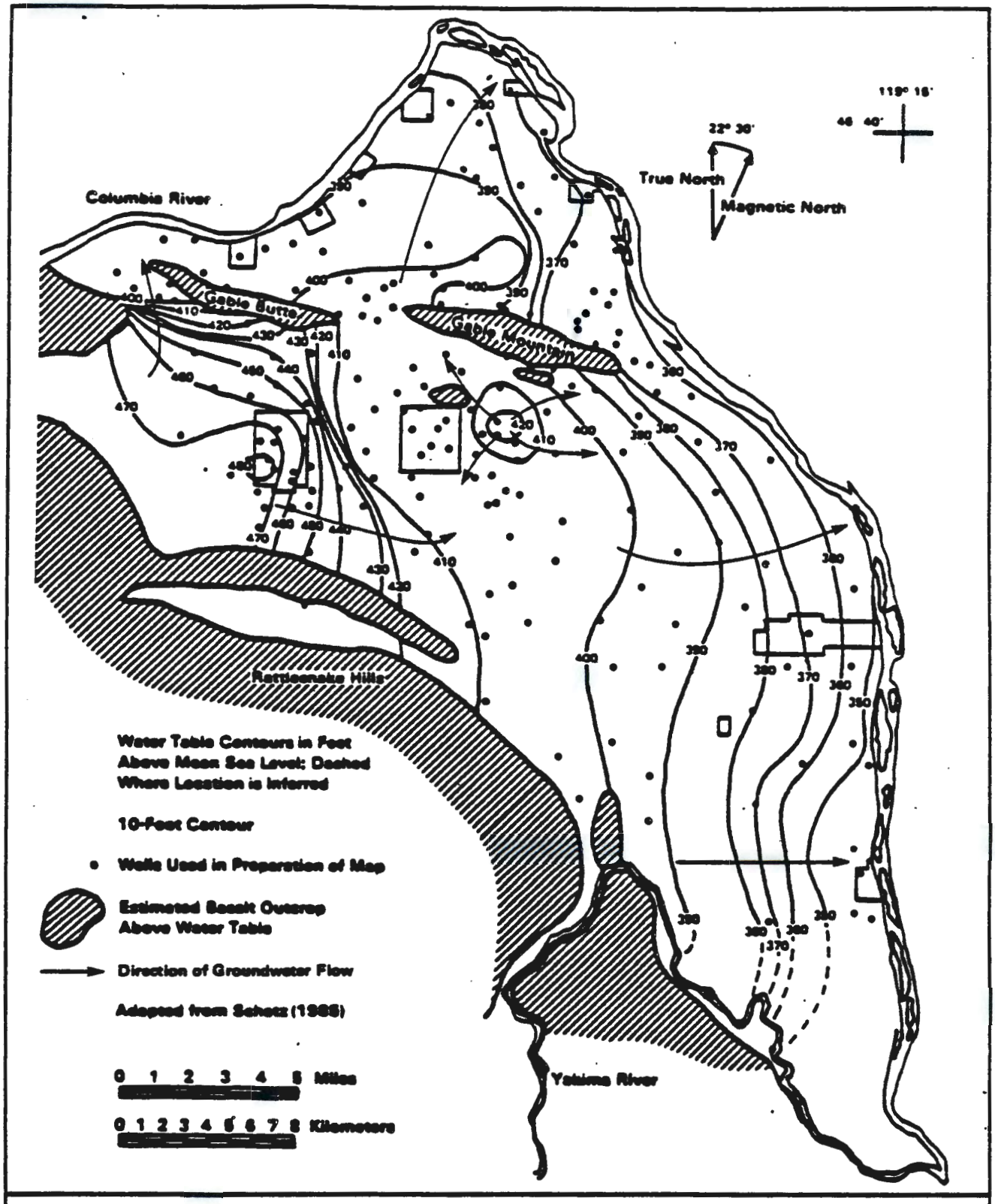
uppermost textural unit present is a sand to sandy gravel. The sand units are thicker toward the east and southeast while gravels and silty sandy gravels are more abundant westward. Lower in the section, gravels and silty sandy gravel units are more abundant. Openwork gravels are common near the base of the Hanford Formation.

Hydrogeology

Both confined and unconfined aquifers are present beneath the Hanford Site. The confined aquifers, in which the groundwater is under pressure greater than that of the atmosphere, are found primarily within the Columbia River basalts. In general, the unconfined or watertable aquifer consists of the Ringold Formation and glaciofluvial sediments, as well as some more recent alluvial sediments in areas adjacent to the Columbia River. The unconfined, relatively shallow aquifer has been the aquifer most affected by Hanford Site operations. Therefore, the emphasis of the groundwater monitoring efforts at the Hanford Site have been focused on the shallow water-table aquifer.

The base of the unconfined aquifer is bounded by either the basalt surface, or in places, the relatively impervious clays and silts of the lower unit of the Ringold Formation. Laterally, the unconfined aquifer is bounded by the anticlinal basalt ridges which ring the basin, and by the Columbia River, where it eventually discharges. The saturated portion of the unconfined aquifer reaches a thickness of over 200 feet in some places and pinches out along the flanks of the basalt anticlines. With their low permeability, the basalt ridges above the water table act as a barrier to lateral flow of the groundwater. On the Hanford Site, the depth to the water table ranges from less than 1 foot near the Columbia River to over 350 feet in the center of the site.

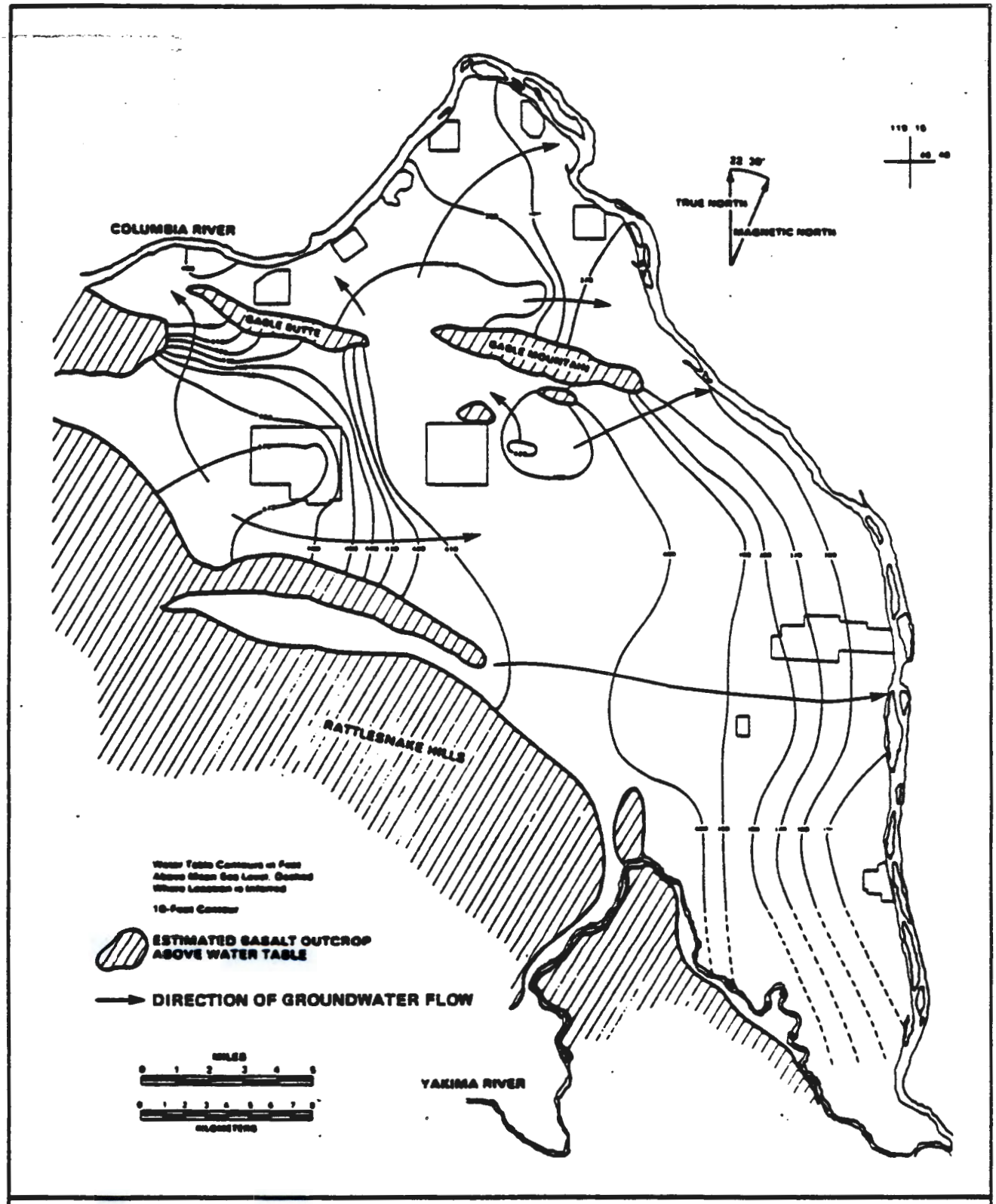
Figure 3-18 is a water-table elevation contour map showing the approximate direction of flow of the shallow unconfined aquifer (December 1984). Figure 3-19 shows the water table as of December 1985. Under natural conditions (which are now altered by artificial recharge), the water table sloped eastward and northward at an average of 10 to 15 feet per mile from where Cold Creek and Dry Creek flowed onto the terrace lands and where the Yakima River flowed along the higher side of the southern part of the terrace lands. This water-table slope continued to



Source: Cline, Rieger, and Raymond, 1985

WATER TABLE ELEVATIONS UNCONFINED AQUIFER (DECEMBER 1984)

FIGURE 3 - 18



Source: Price, 1986

WATER TABLE ELEVATIONS UNCONFINED AQUIFER (DECEMBER 1985)

FIGURE 3 - 19

within about 2 miles of the Columbia River, where it flattened. The flatter gradient of the groundwater near the river continues to be present, but the water table there fluctuates widely with the annual flood stages of the river. Some bank-stored groundwater in the northern part of the reservation is diverted across the large river bend and returns to the river further south and east. Natural recharge to the unconfined system comes from several sources. The principal source is precipitation and runoff to the west from the Cold Creek and Dry Creek areas. The Yakima River recharges the unconfined aquifer as it flows along the southwest boundary of the site. The Columbia River recharges the unconfined aquifer during its high stages when the riverwater is transferred to bank storage. The unconfined system is reported to receive little recharge from precipitation within the perimeter of the Hanford Site, although present studies, such as those described by Gee and Heller (1985), suggest that precipitation may contribute more recharge to the groundwater than was originally thought (Cline, Rieger, and Raymond, September 1985).

Artificial recharge occurs predominantly from liquid waste disposal operations in or adjacent to the 200W- and 200E-Areas. For example, during 1984, 8.56×10^9 gallons of nonradiological and radioactive liquid waste were discharged to the ground in the 200-Areas. The total nonradiological and radioactive liquid wastes discharged to the ground from the beginning of operations over 40 years ago to December 31, 1984, were 1.95×10^{11} gallons. It has been estimated that recharge to the groundwater from the 200-Areas (which has included U-Pond, B-Pond, and Gable Mountain Pond, as well as the various cribs and trenches in the 200W- and 200E-Areas) adds 10 times the annual volume of water to the unconfined aquifer that is contributed by natural inflows to the area from precipitation and irrigation waters to the west (Graham et al., 1981). The discharge of water has created groundwater mounds near each of the major wastewater disposal facilities in the 200-Areas and in the 100- and 300-Areas. These mounds alter the general flow pattern in the aquifer, from the recharge areas in the west to the discharge areas (primarily the Columbia River) in the east. Groundwater levels have changed continuously over the years because of variations in the volume of wastewater discharged. Consequently the movement of the groundwater and its associated constituents has also changed with time.

Although the groundwater mounding occurs in the 100- and 300-Areas, the volume of liquid discharged to the ground is less. The mounding is also affected by the proximity of these areas to the Columbia River, where river stages play a part. Therefore, groundwater mounding in the 100- and 300-Areas may not be as significant as in the 200-Areas. The effect on the quality of the groundwater that enters the Columbia River from the 100- and 300-Areas may be more pronounced because of the short travel times involved, compared to the longer travel times required to move possible contaminants from the 200-Areas (Cline, Rieger, and Raymond, September 1985).

All sediment layers within the statigraphic column below the Hanford Site are not equally transmissive. A difference of three to four orders of magnitude in hydraulic conductivity occurs between the clays of the lower Ringold Formation and the coarse sediments of the Hanford Formation. The following material presents representative hydrologic properties of the unconfined aquifer (from Compliance Groundwater Monitoring Plan for the Nonradioactive Dangerous Waste Landfill on the Hanford Reservation Site, March 1986).

Stratigraphic Interval	Hydraulic Conductivity (ft/day)
Hanford Formation (informal name)	500-20,300
Undifferentiated Hanford Formation and Middle Ringold Unit	100-7,000
Middle Ringold Unit	20-600
Lower Ringold Unit	0.1-10

3.4.2 General Description of Pollution Sources and Controls

Sources of groundwater pollution at Hanford Reservation consist of various known and unknown releases of contaminants, both historical and current. The largest impacts to groundwater from known sources have occurred as a result of discharges of liquid wastes to the ground through cribs, drywells, reverse wells, septic fields, ditches, trenches, and ponds. Additional releases to groundwater have occurred as a result of leaking or broken pipes, leaking retention basins, and spills. The major source of groundwater pollution has been attributed to the 200-Areas. Additional pollution has been documented as originating in all the 100-Areas and the 300-Area.

Specific potential sources of groundwater contamination are discussed in general terms by site area in Section 3.4.3.2. Additional discussion can be found under the other various media and waste discussions in this report.

3.4.3 Environmental Monitoring Program and Data

This section presents a summary of the Hanford Reservation monitoring program and the environmental monitoring data obtained routinely from the program. The following subsections discuss: (1) the groundwater monitoring program with regard to well location and construction, sampling frequency, procedures and monitoring parameters, and sampling observations and analyses; and (2) the environmental monitoring data with regard to contaminant conditions in the confined and unconfined aquifers.

3.4.3.1 Hanford Reservation Monitoring Program

The groundwater monitoring program at the Hanford Site is divided among three contractors. These contractors are: PNL, Rockwell International (RHO), and UNC.

PNL monitors groundwater at Hanford Reservation as part of the site-wide Hanford Environmental Monitoring Program. PNL also provides groundwater sampling for both RHO and UNC although each of these other contractors is responsible for its own separate program. Additionally, PNL assists the Hanford HEHF with sampling of drinking water supplies, which include groundwater supply wells.

PNL is responsible for groundwater monitoring in all areas of the site except for the 100N-Area and 200-East and 200-West Areas, where it has partial responsibility. RHO is responsible for the 200-Areas and UNC is responsible for 100N. Additional groundwater sampling associated with production-related surveillance is performed by RHO and UNC. This surveillance typically is intended to assess the performance of disposal sites.

Well Locations

In excess of 2900 wells have been constructed at the Hanford Site. According to published documents (Cline, Rieger, and Raymond, 1985, and McGhan, Mitchell and Argo, 1985), approximately 1100 were drilled to groundwater. In 1984, it was reported that about 900 of the 1100 wells contained water. Approximately 330 wells are actually sampled as part of the groundwater monitoring program. Wells not used as part of the monitoring program are used for a variety of other purposes. A 1984 summary (McGhan et al., 1985) of well use at the Hanford Reservation site is as follows:

Well Use	Number of Wells
Groundwater Contamination Surveillance	±328
Groundwater Hydrological Data Collection	382
Drywells for Monitoring Waste Management Facilities	1170
Basalt Stratigraphy Characterization	146
Water Supply Wells	11
Wells for Geologic and Seismic Studies	503

The tabulation above should be considered approximate, since wells continue to be installed as part of ongoing monitoring activities. Additionally, a small number of wells were also used as disposal wells or "reverse wells" over 30 years ago. Although most were drywells, some penetrated the groundwater.

The material below indicates the distribution of wells by site area. The number of wells sampled by area in 1984 is included for comparative purposes (Cline et al., McGhan et al., 1985).

Distribution and Number of Wells Sampled by Site Area

Area	Number of Wells Constructed	Number of Existing Wells-October 1984	Number of Wells Sampled - 1984
100	139	94	59
200	1455	1376	22
300	39	32	28
400	16	4	6
600	1177	1012	(1)224
1100 (Richland)	105	16	(1)
3000 (N. Richland)	8	6	(1)
Totals	2939	2540	339

(1) The number of wells sampled shown in the 600-Area total encompasses all areas not included in the 100-, 200-, 300-, or 400-Areas.

The majority of wells sampled (313) are installed in the unconfined aquifer. In 1984 approximately 22 wells were sampled that were installed in the confined aquifer. An additional four wells were sampled that monitored both the confined and unconfined aquifer, thus providing a composite sample.

Wells at Hanford Site are designated by specific suffixes and prefixes that identify the general location of the well. All wells are identified by the number 99. The number preceding the 99 indicates the area in which the well is located. For example, a well located in the 600-Area is designated by a 699 prefix. Numbers following the first locator number further identify the well either by sheetmap and structure or by coordinate. For example, Well 5 at 100F-Area would be designated as Well 199-F5.

Although a large number of wells are located at the Hanford Site, many waste disposal facilities do not have monitoring wells adequately located or constructed to meet the current regulatory requirements (e.g., RCRA). Examples of areas where PNL is installing new wells to mitigate these deficiencies include the 183H Solar Evaporation Basins, the 300-Area Process Trenches, and the Central Landfill. Numerous other older burial grounds do not have monitoring wells located for the purpose of monitoring these facilities. For example, the Central Landfill until recently relied on downgradient wells in which the closest well was located 1/4-mile from the facility.

The lack of wells located adjacent to some facilities is due, in part, to the results of historic site studies. These studies indicated that there was no net recharge to the unconfined aquifer from precipitation and therefore no driving force for contaminants to reach the groundwater from the Hanford Site. Although still an area of some disagreement at the the Hanford Site, ongoing site studies with lysimeters are indicating that recharge from precipitation does indeed occur.

Well Construction

The majority of wells used as part of the various monitoring programs are either 6 inches or 8 inches in diameter and are steel cased. Many of the wells have been perforated after casing placement as opposed to having been installed with screens.

9 2 1 2 4 5 1 1 5 7 4

Except for installations within the last few years, most of the wells have no annular seal outside the casing. In some cases (85 wells total in 1984), piezometer tubes have been installed in cased wells to measure groundwater levels at various depths within the aquifer.

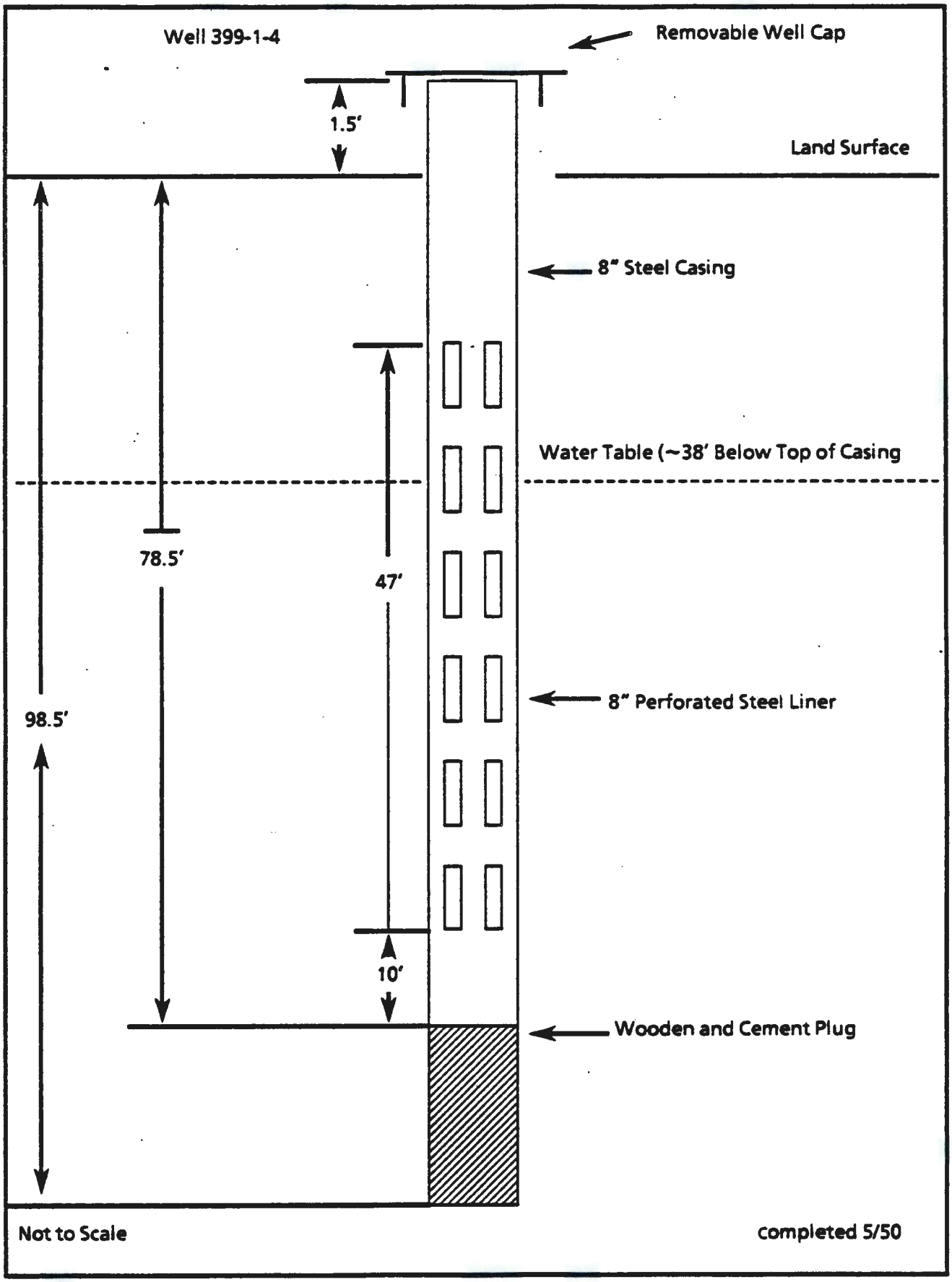
Wells completed in the 1940s, 1950s, and 1960s typically are steel cased and have perforations to allow entry of groundwater into the well. Figure 3-20 depicts a typical construction detail for a well installed in 1950. Wells installed during the 1970s and up to the present have used stainless-steel screens and steel casing. Figures 3-21 and 3-22 depict typical construction details for a well installed in 1975 and one installed in 1983. Note that a partial annular cement seal and cement surface seal have been added to the 1983 well.

A complete inventory of installation reports for wells is maintained by PNL. Virtually every well installed as part of the Hanford Site project has an installation record. Specifics on the geology and finer construction details are often lacking for the wells. However, geophysical logging has generally been performed on many of the wells.

PNL provides an active well inspection and reconstruction program. This program allows PNL to inspect all the wells in its monitoring program at least once every 5 years utilizing a borehole TV camera. A complete videotape library is maintained of each well inspection. The well reconstruction program provides for the cleaning or reconstruction of wells identified in the inspection program as requiring remediation. Reconstruction of older wells typically involves grouting and placing of new stainless-steel screens.

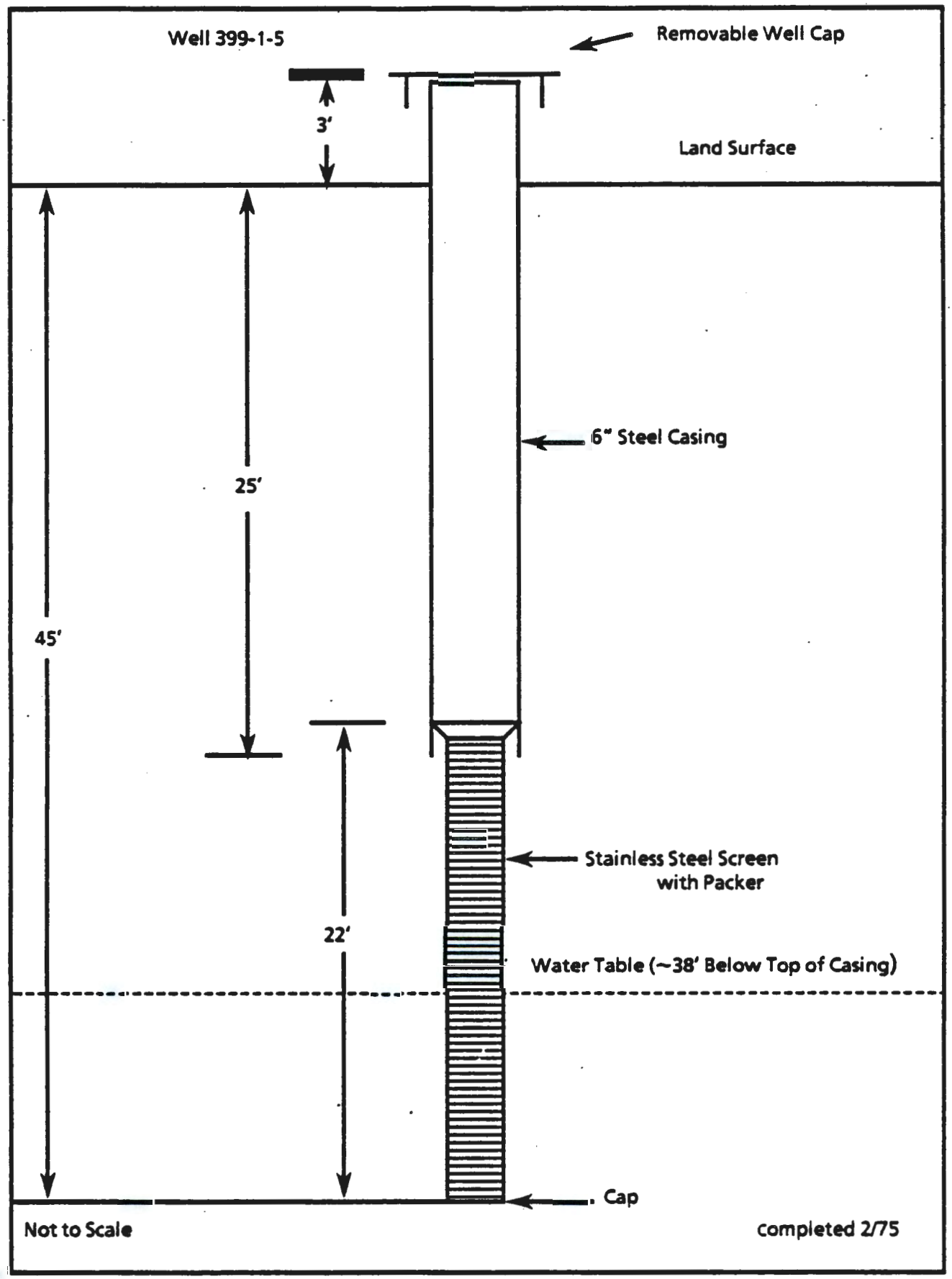
Sampling Frequency

Sampling frequency and monitored parameters vary considerably at the Hanford Site. This is the result of having different contractors responding to different requirements (e.g., RCRA and DOE Orders). The major sampling programs and the associated responsible contractor are shown below.



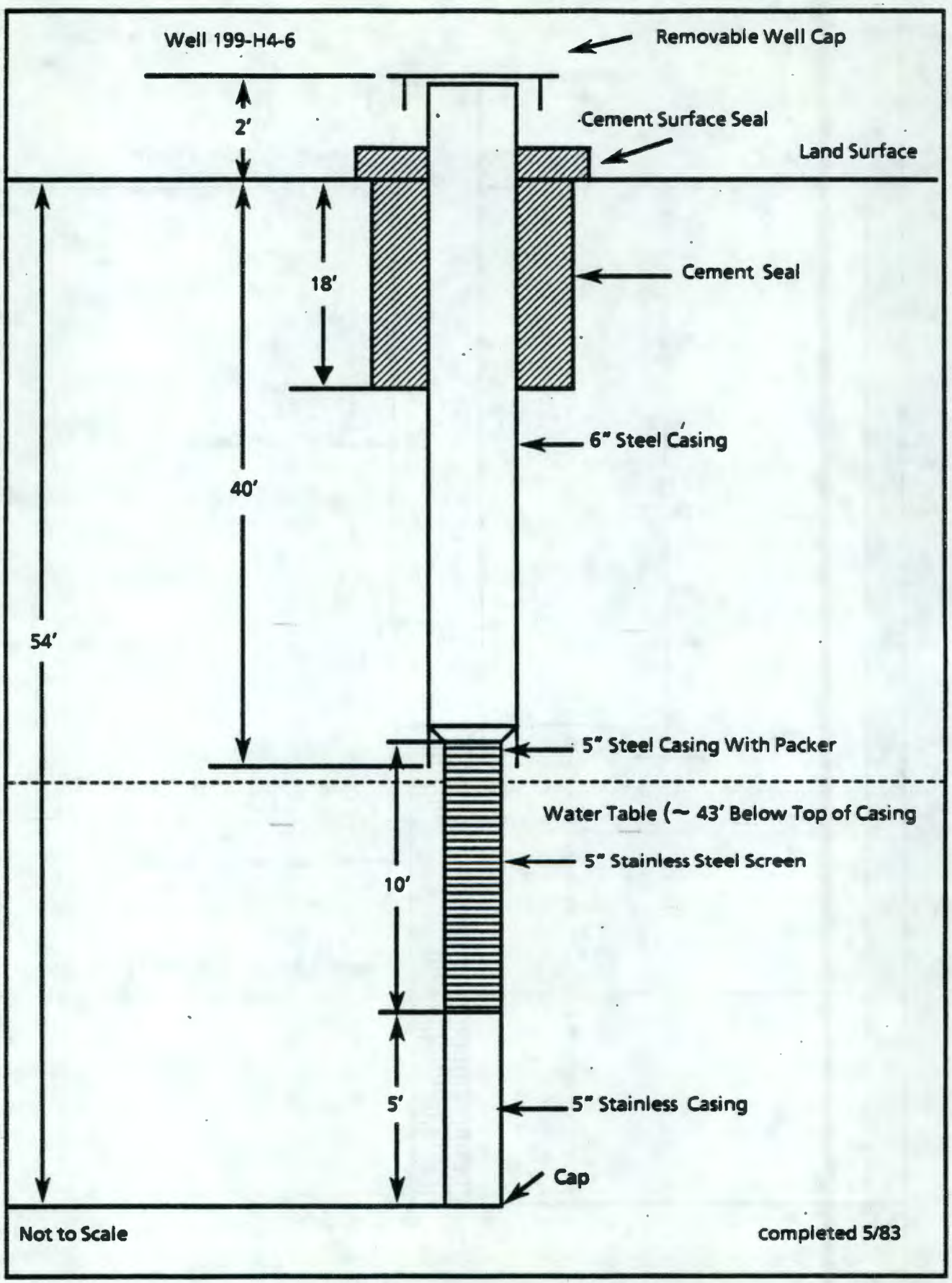
TYPICAL CONSTRUCTION DETAIL OF WELL INSTALLED IN 1950 (WELL 399-1-4)

FIGURE 3-20



TYPICAL CONSTRUCTION DETAIL OF WELL INSTALLED IN 1975 (WELL 399-1-5)

FIGURE 3-21



TYPICAL CONSTRUCTION DETAIL OF WELL INSTALLED IN 1983 (WELL 199-H4-6)

FIGURE 3-22

9 2 1 2 4 6 1 1 5 7 8

Sampling Program	Responsible Contractor
Groundwater monitoring program-Hanford Reservation site (GWMP)	PNL
Site-wide hazardous waste groundwater monitoring (SWHW)	PNL
RCRA compliance monitoring program (300 + 183H) (RCRA)	PNL
Separations Area Monitoring Program (SAMP)	RHO
100N-Area N-Springs monitoring (NSM)	UNC
Shoreline seepage monitoring (SSM)	PNL
Drinking Water (DW)	PNL/HEHF

A general summary on the number of wells sampled by each contractor and the sampling frequency is included below. Note that this summary is intended to cover only the major programs and is not intended to be all-inclusive.

Summary of Sampling Frequencies

		Frequency				Total Number of Wells (1)
Program	Area	Annually	SemiAnnually	Quarterly	Monthly	
GWMP	100	2	-	59	2	63
GWMP	200	-	22	-	-	22
GWMP	300	-	-	28	-	28
GWMP	400	-	-	6	-	6
GWMP	600	1	33	178	12	224
SWHW	All	90	-	-	-	90(2)
RCRA	100H	-	-	-	5	5(2)
RCRA	300	-	-	-	15	15(2)
SAMP	200	-	5	71	43	119
SAMP	600	-	11	6	13	30
NSM	100N	-	-	(weekly composite)		1
SSM	Col. River	-	-	-(3)	-	N/A
DW	Variable	-	-	10	-	10

(1) 1986 Hanford Environmental Monitoring Schedule

(2) Groundwater Monitoring Data for RCRA Compliance and Site-Wide Network-June 1985 to April 1986, PNL-July 11, 1986.

(3) Spring sampling is usually accomplished only once yearly due to river stage. Total number of samples is variable

Monitoring Parameters

As noted in the previous section, there are a number of major sampling programs at the Hanford Site. Since each program usually has a specific goal, the groundwater analytical parameters selected by each program vary based on these goals. The table below presents a summary of the major sampling programs and the associated general monitoring parameters. Specific lists of all the groundwater analytical parameters in each program are included in the referenced tables.

Sampling Program	Approximate Number of Parameters Monitored	Primary Types of Parameters	List of All Parameters
GWMP	2-8	radionuclides, inorganics	Appendix E-1
SWHW	36	inorganics	Appendix E-2
RCRA	306	organics, inorganics, pesticides, etc.	Appendix E-3
SAMP	9	radionuclides	Appendix E-4
NSM	22	radionuclides	Appendix E-5
SSM	3	radionuclides	Appendix E-6
DW	24	radionuclides, inorganics	Appendix E-7

Based on the tables, it can be seen that the primary emphasis of the programs has been to analyze groundwater samples for radionuclides. Only the SWHW and RCRA programs have provided a data base on many nonradiological parameters for a large number of wells. The SWHW program provides samples only once a year from 90 wells on-site. Only one round of analyses (1985) is presently available. The RCRA program, although providing monthly samples and analyses (1985), only provides data in two site areas for 20 wells. A discussion of specific parameters and programs which are part of individual site areas is included in Section 3.4.3.2.

Sampling Procedures

Sampling of most wells at the Hanford Site is done by PNL employees. Radiation Protection Technicians (RPTs) collect 95 percent of the groundwater samples at

the site (exceptions are special sampling projects such as well drilling, N-Springs, etc.). The RPTs are trained in sampling procedures, and follow PNL procedures included in the Hazardous Waste Groundwater Monitoring Plan, July 1985.

Wells sampled are typically of two types: (1) those with dedicated pumps permanently installed (e.g., submersible pump for purging, and air-bladder-type pump (Well Wizard) for organic samples); see Figure 3-23; and (2) open holes.

Sampling procedures and protocol were observed during the Survey. A sampling and analysis worksheet was completed during sampling of Well 399-4-1. Collection of samples was observed during a typical sampling event performed by RPTs from PNL. General observations are included below:

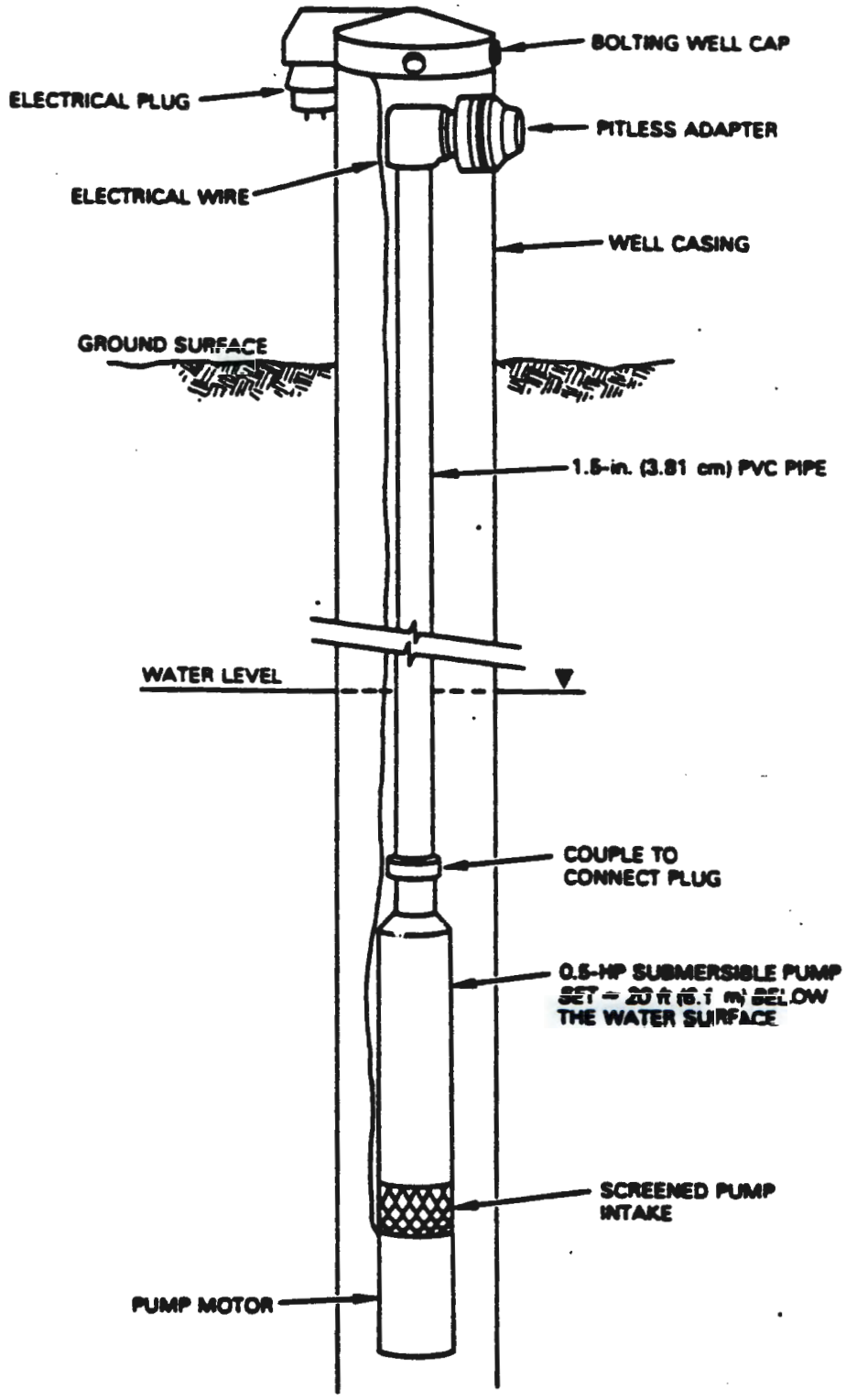
- o Groundwater sampling in most wells is accomplished by dedicated pumps. Survey personnel observed three wells during purging/sampling, and the system used is proper.

- o Groundwater sampling accomplished in wells without dedicated pumps was not specifically observed during the Survey. Information obtained from site personnel and as seen by other Survey Team members in various areas, indicated that:

  - "Most" of these open holes are purged prior to sampling via air line

  - "Some" of these open holes are not purged at all prior to sampling

- o Groundwater samples are collected in special containers prepared by the analytical laboratory to receive the samples for analysis. The containers are labeled and placed in separate boxes for each well to reduce possibilities of sample mixup. Containers were observed to be correctly filled, labeled, and placed in coolers. Lag-time in delivery of the samples to the laboratory was not excessive.



Source: Law, Schatz, Fuchs, and Dillon, 1984

CROSS-SECTIONAL VIEW OF A GROUNDWATER MONITORING WELL WITH PUMP

FIGURE 3 - 23

- In general, the sampling program conducted by PNL was observed to be proper. The sampling of wells without pumps by contractors other than PNL does not appear to follow established protocols. During collection of N-Springs samples through permanent casings, no purging occurs. In addition (according to personnel interviewed on-site), the bailer used to collect all the spring samples was rinsed in the Columbia River after sampling at each spring.

- Other general observations made during the Survey are as follows:

  - Wells on the Hanford Reservation site are not locked, and the tops of many are not protected from the elements.

  - Many of the wells (particularly older wells) have no concrete pads to prevent surface contamination.

  - Concrete pads poured around many of the new wells have severe cracking and provide little or no protection. Several pads were suspended in midair (due to erosion under the pad), and did not contact the ground.

3.4.3.2 Environmental Monitoring Data

Groundwater monitoring has been on-going at the Hanford Site such that records of contaminant concentrations in groundwater date back to the 1950s and water-level data extend back to 1948. The majority of data collected on groundwater quality have been developed for the unconfined aquifer. Tritium and nitrate have been the principal parameters selected for analysis. These parameters were chosen by the site as indicators of potential impact due to their mobility in groundwater and their general inability to be adsorbed or attenuated.

Historically, the primary groundwater monitoring parameters were radionuclides. In more recent years, the number of parameters has increased substantially to include more routine sampling for nonradiologic inorganic constituents. RCRA monitoring has resulted in an even more diverse set of parameters.

PNL maintains a computerized data base for all current and historic analytical results from groundwater samples. The data base can be utilized to retrieve contaminant data in tabular or graphic form for specific wells or sets of wells. Lists can also be developed for wells that have had groundwater analytical parameters exceeding certain concentration limits.

As part of the Survey, the team requested that PNL provide computer printouts for five groundwater analytical parameters that exceeded specified base concentrations. The selected parameters and base concentration levels are shown below.

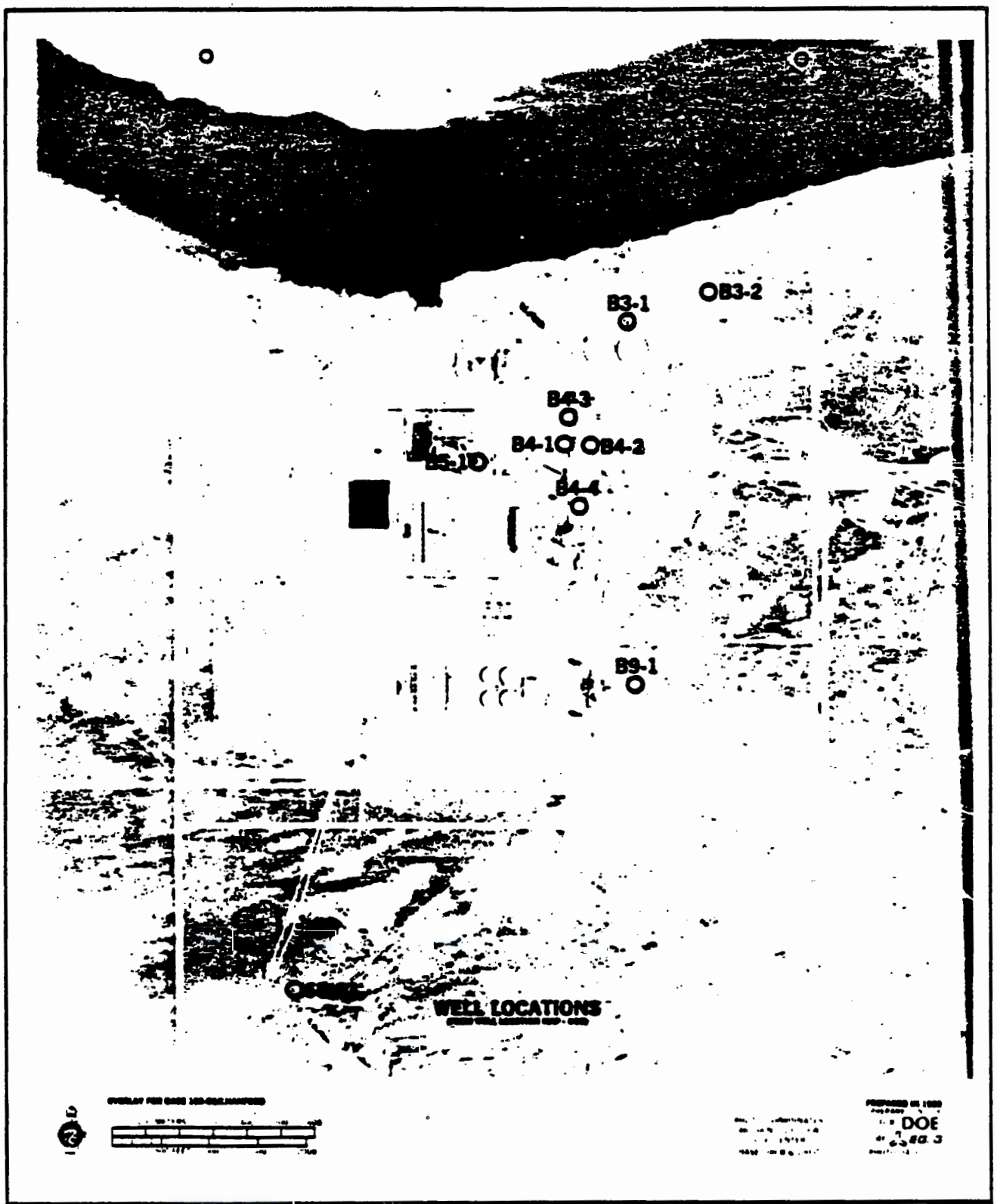
Parameter	Base Concentration Level
Gross Beta	50 pCi/L
Strontium	8 pCi/L
Cobalt	3000 pCi/L
Tritium	2000 pCi/L
Nitrate	45 mg/L

The results of this request were literally thousands of listings of every well where the concentration level specified was met or exceeded. These data, in addition to selected graphic plots provided by PNL, are used in the following area-specific discussions.

As discussed in Section 3.4.3.1, there are a number of major sampling programs at the Hanford Site carried out by different contractors. In order to simplify the results of the various programs, the data reviewed during Survey have been consolidated in summary form in the following subsections. Each subsection discusses the aspects of each site area in relation to groundwater monitoring data.

100B/C-Area

Figure 3-24 is an aerial view of the 100B/C-Area that shows well locations. A total of eight wells are located within the 100B/C-Area. Well 199-B3-2 actually serves as more than one sampling point due to the installation of two piezometer pipes in 1970.



Source: EG&G Graphic Overview System; Hanford Site

WELL LOCATIONS REACTOR AREA 100B/C, HANFORD SITE

FIGURE 3 - 24

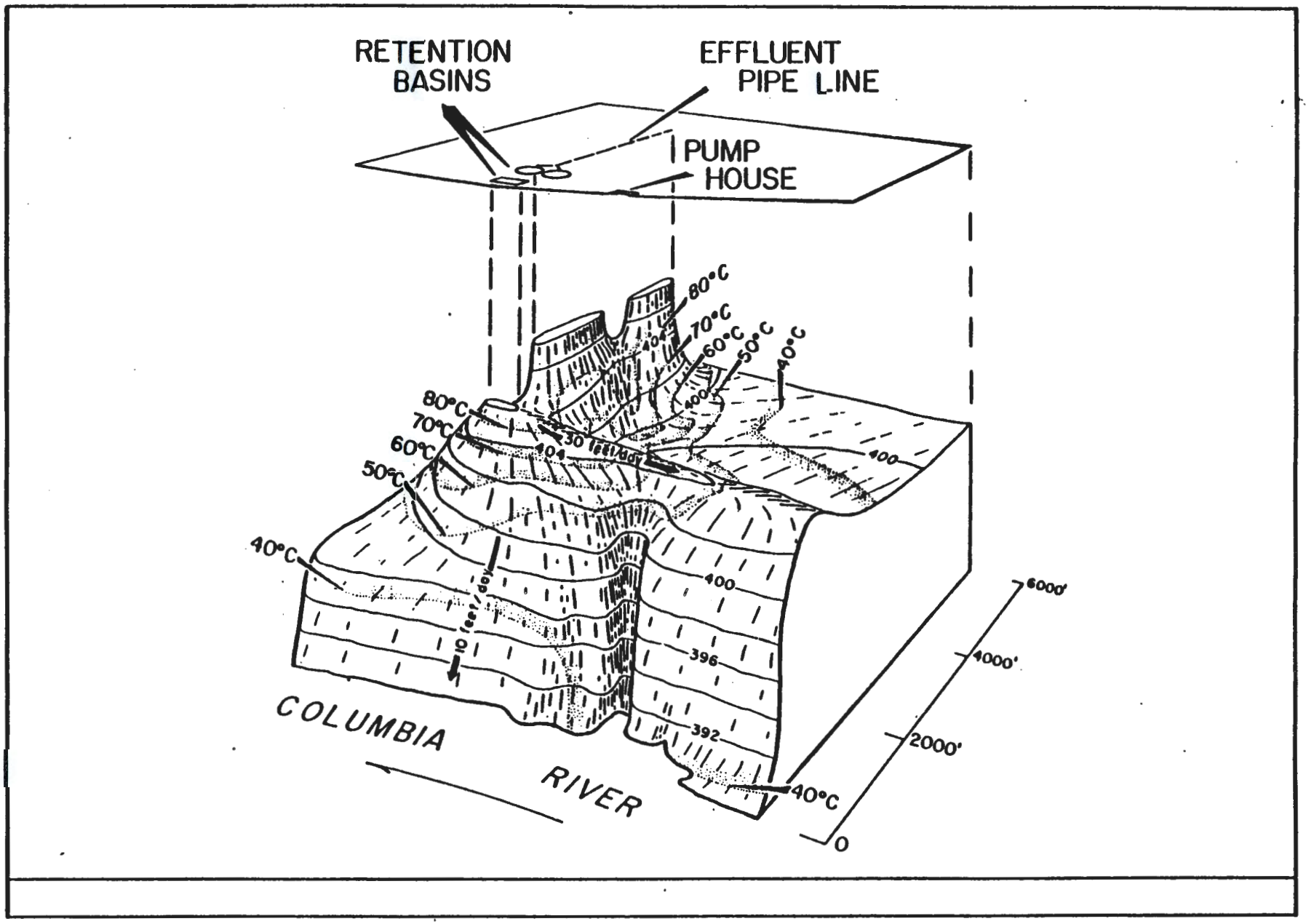
All the wells at the 100B/C-Area are sampled as part of the GWMP. In addition, Wells 199-B4-1 and 199-B9-1 are part of the SWHW. Data on groundwater seepage along the Columbia River are available for 1984. All wells except 199-B3-2 P and Q monitor the unconfined aquifer. Both 199-B3-2 P and 199-B3-2 Q monitor the confined aquifer.

Tritium, nitrate, and gross beta have been the most frequently monitored parameters in the 100B/C-Area. Tritium has been analyzed most frequently (maximum of 32 analyses since 1962). Other radioactive and nonradioactive constituents have typically been analyzed only once for approximately 23 parameters.

Historical data (Brown, 1963) indicate that significant impacts to the groundwater occurred during active operation of the reactors. Leaks in effluent lines and retention basins were estimated to contribute 1.5 million cubic feet per day of effluent cooling water to the ground and subsequently to the Columbia River. Substantial groundwater mounds and temperature gradients were observed beneath the site. Figure 3-25 depicts these impacts. Note that groundwater temperatures up to 80°C were recorded.

Tritium levels continue to exist above 20,000 picocuries per liter* in a portion of the unconfined groundwater in the vicinity of the effluent line identified in Figure 3-25.

(*) National Interim Primary Drinking Water Regulations (NPDWR) EPA-570/9-76-003.



PERSPECTIVE DRAWING OF THE WATER TABLE UNDERLYING THE 100B-AREA

FIGURE 3 - 25

Recent data for selected wells in the 100B/C-Area are shown below.

Well No.	Date	Tritium Concentration (pCi/L)
199-B4-1	4/10/86	54,000
199-B4-2	11/09/85	12,000
199-B4-3	4/10/86	20,000
199-B4-4	2/19/85	3,600

By comparison, the maximum historical tritium concentration observed occurred in Well 199-B4-4 in 1964 at 260,000 picocuries per liter.

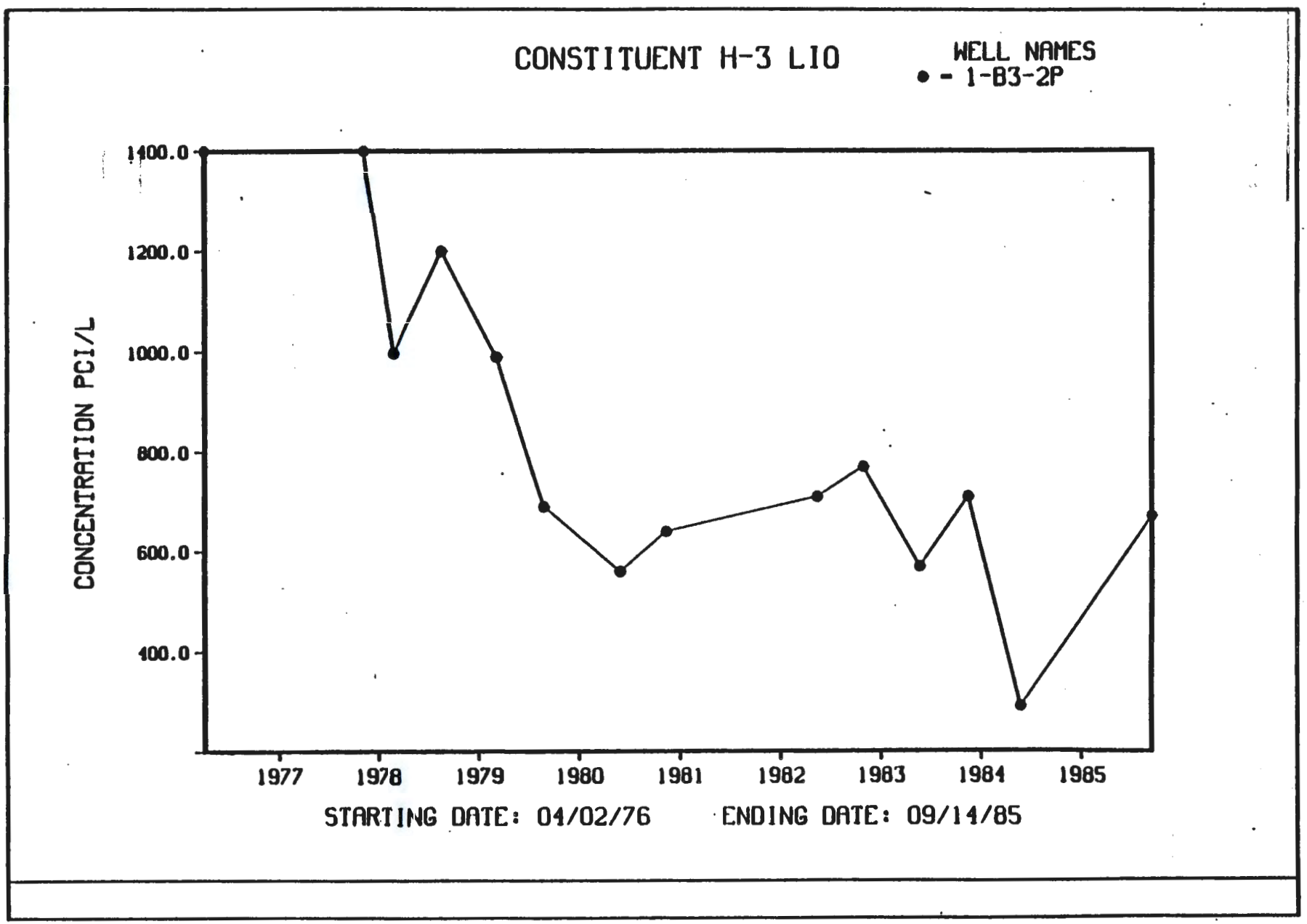
Tritium has shown a generally decreasing trend in Well 199-B3-2P, which may by inference be indicative of past or historic impacts on the confined aquifer (see Figure 3-26). Although tritium decreased through 1984 in groundwater in Wells 199-B4-1 and B4-2, increases have been observed since 1985 (see Figures 3-27 and 3-28). Nitrate levels have also been on the increase as exhibited in Figures 3-29 and 3-30.

Gross beta levels have historically exceeded 50 picocuries per liter. These exceedances occurred in seven of the wells between 1955 and 1981. The maximum level recorded was 8500 picocuries per liter in Well 199-B4-2 in 1956. The recent (1985) SWHW program found coliform above the NPDWR in groundwater in Well 199-B9-1 and gross beta at 101 picocuries per liter in the groundwater sample from Well 199-B4-1.

Figure 3-31, taken from McCormack and Carlile (1984), indicates that groundwater discharged from springs adjacent to 100B/C may still be impacted from historic activities.

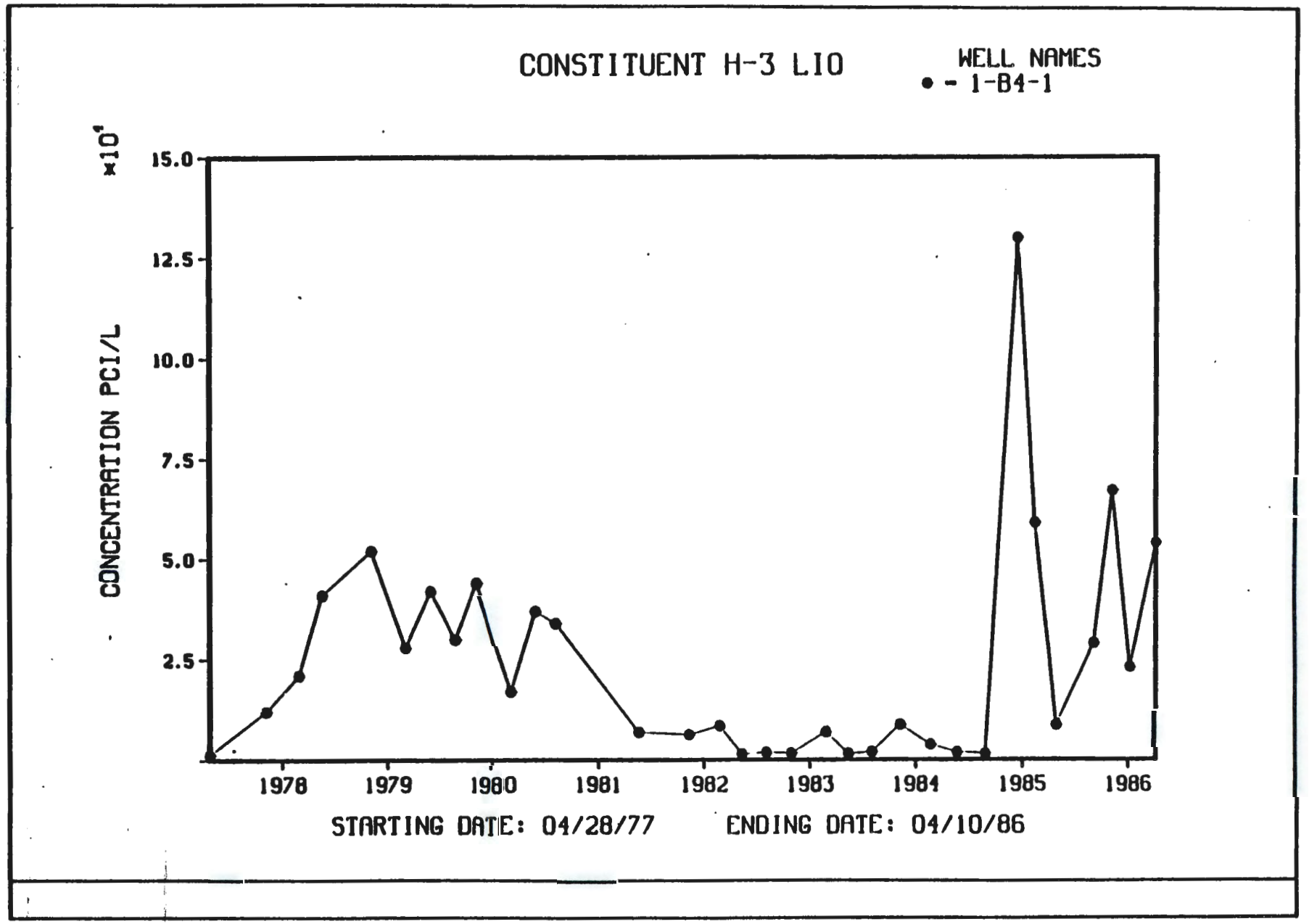
100D/DR-Area

Well locations are shown on an aerial plan of the 100D/DR-Area on Figure 3-32. A total of four wells are located within the 100D/DR-Area, although only limited data are available for Well 199-D8-2. All wells except 199-D8-2 are



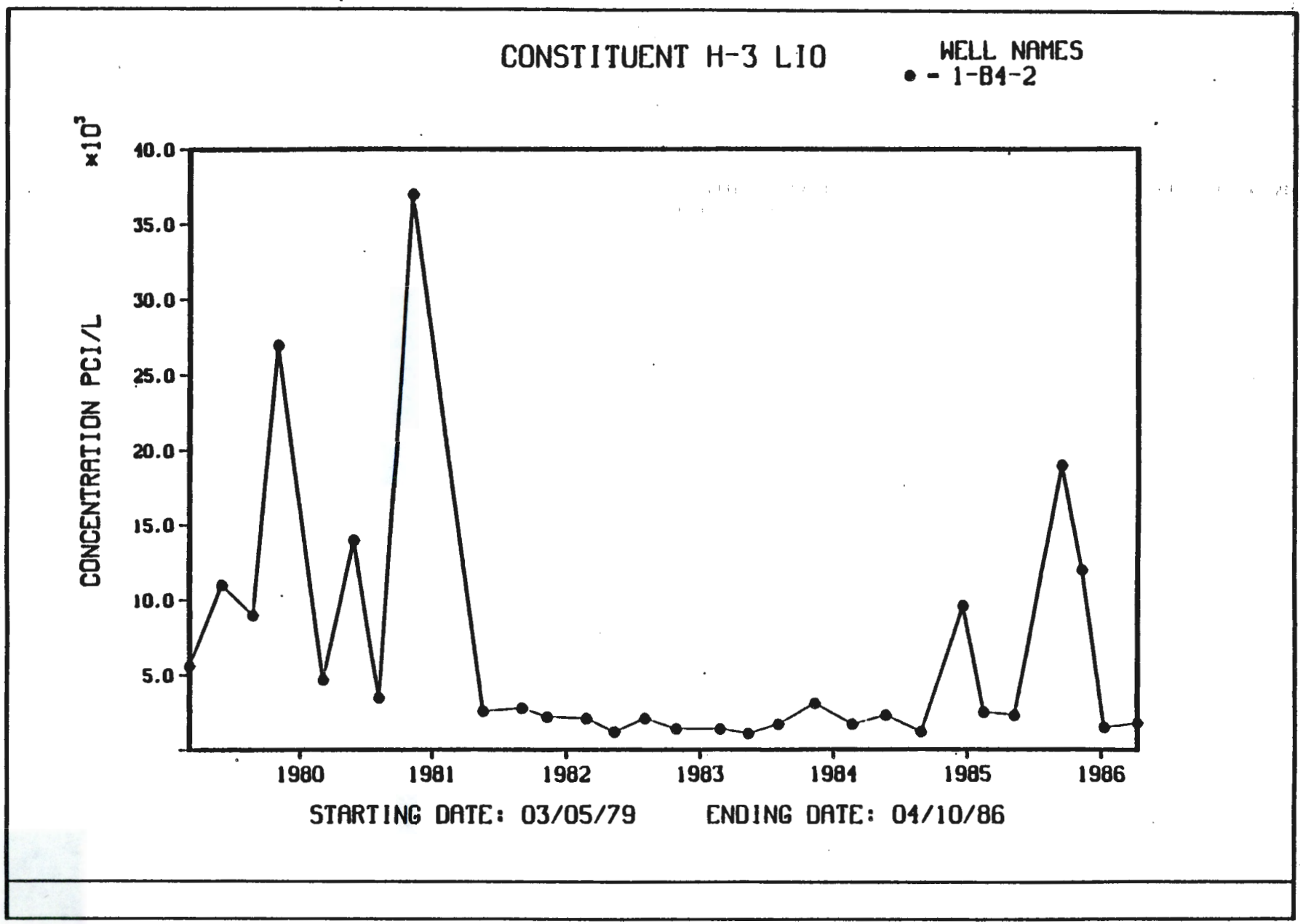
TRITIUM TREND IN WELL 199-B3-2P

FIGURE 3 - 26



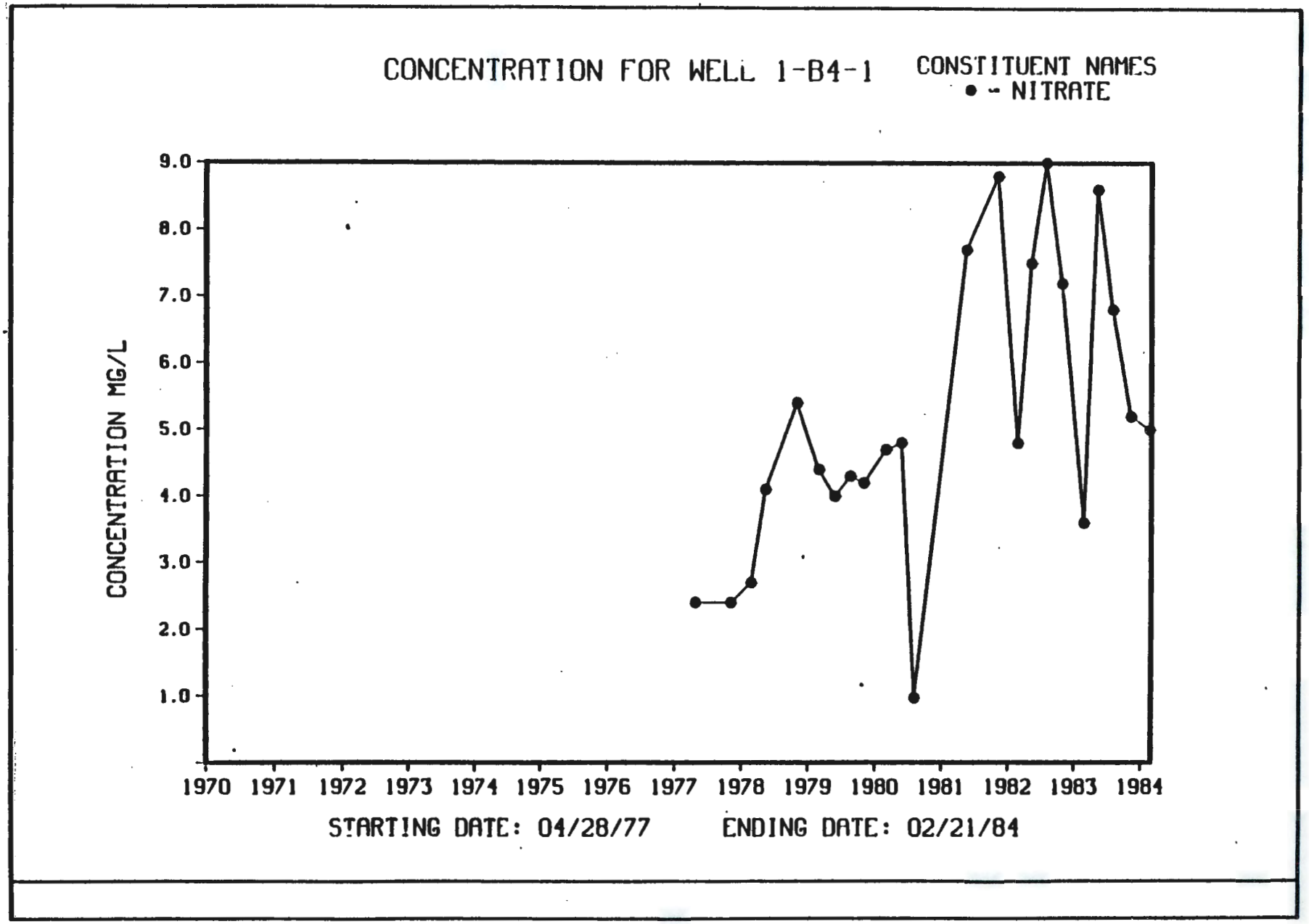
TRITIUM TREND IN WELL 199-B4-1

FIGURE 3 - 27



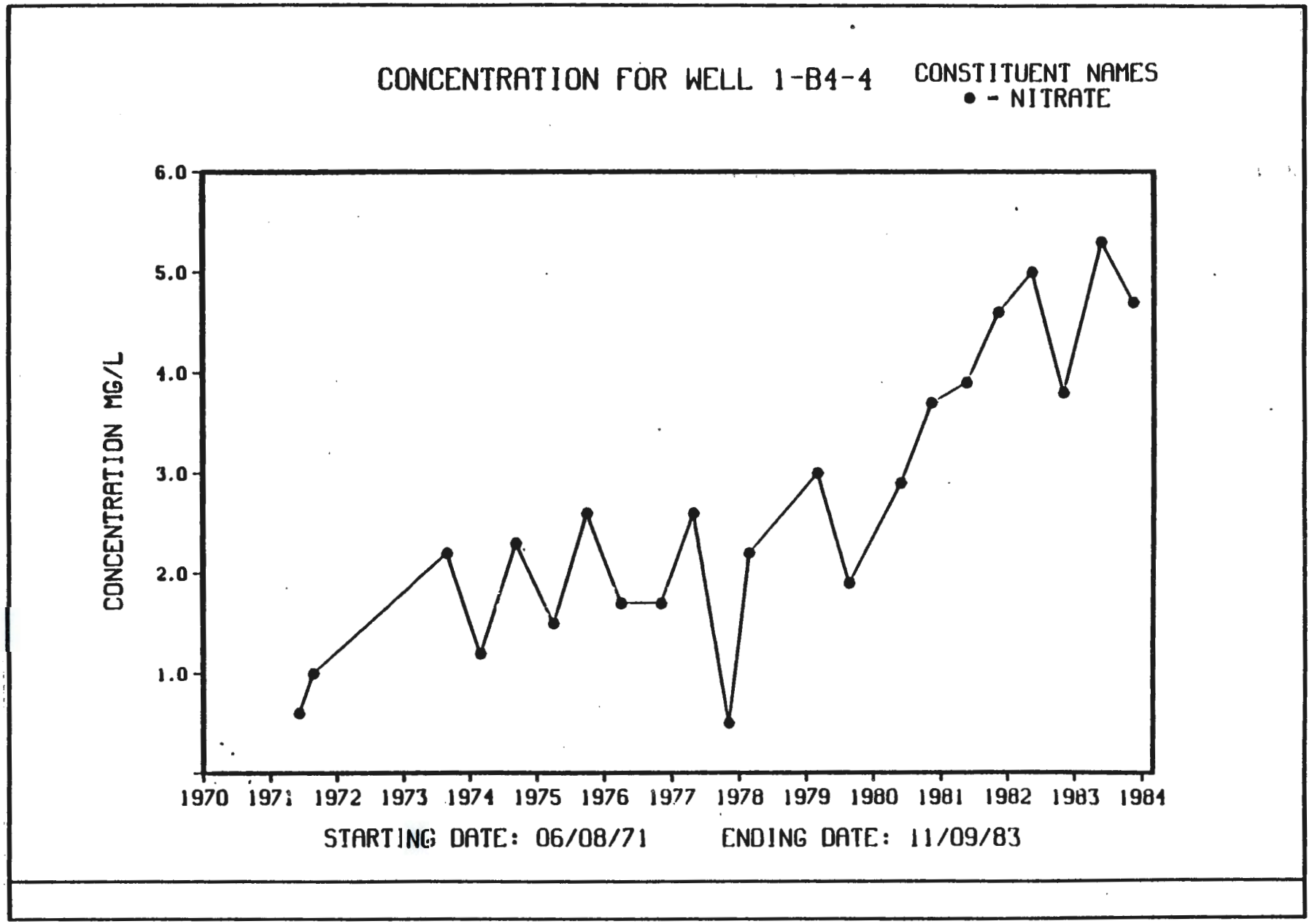
TRITIUM TREND IN WELL 199-B4-2

FIGURE 3 - 28



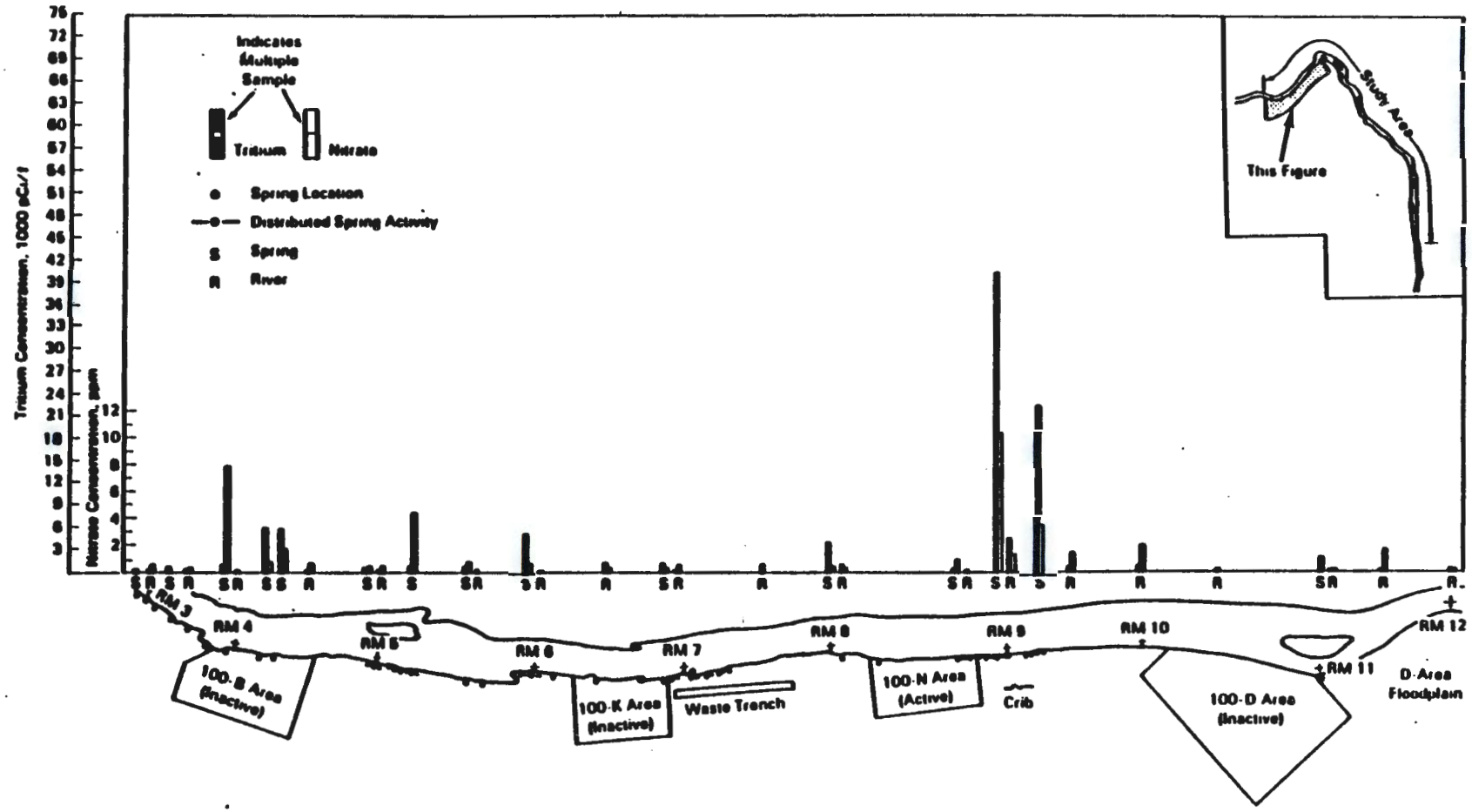
NITRATE LEVELS FOR WELL 1-B4-1

FIGURE 3 - 29



NITRATE LEVELS FOR WELL 1-B4-4

FIGURE 3 - 30



LOCATIONS AND ANALYTICAL RESULTS FOR SPRING AND RIVER SAMPLES FROM RIVER MILE 3 THROUGH RIVER MILE 12 (AFTER McCORMICK AND CARLILE, 1984)

FIGURE 3 - 31

Source: EG&G Graphic Overview System; Hanford Site

WELL LOCATIONS REACTOR AREA 100D AND 100DR, HANFORD SITE **FIGURE 3 - 32**

part of the GWMP. Wells 199-D5-12 and D8-3 are part of the SWHW. Only the unconfined aquifer is monitored by these wells.

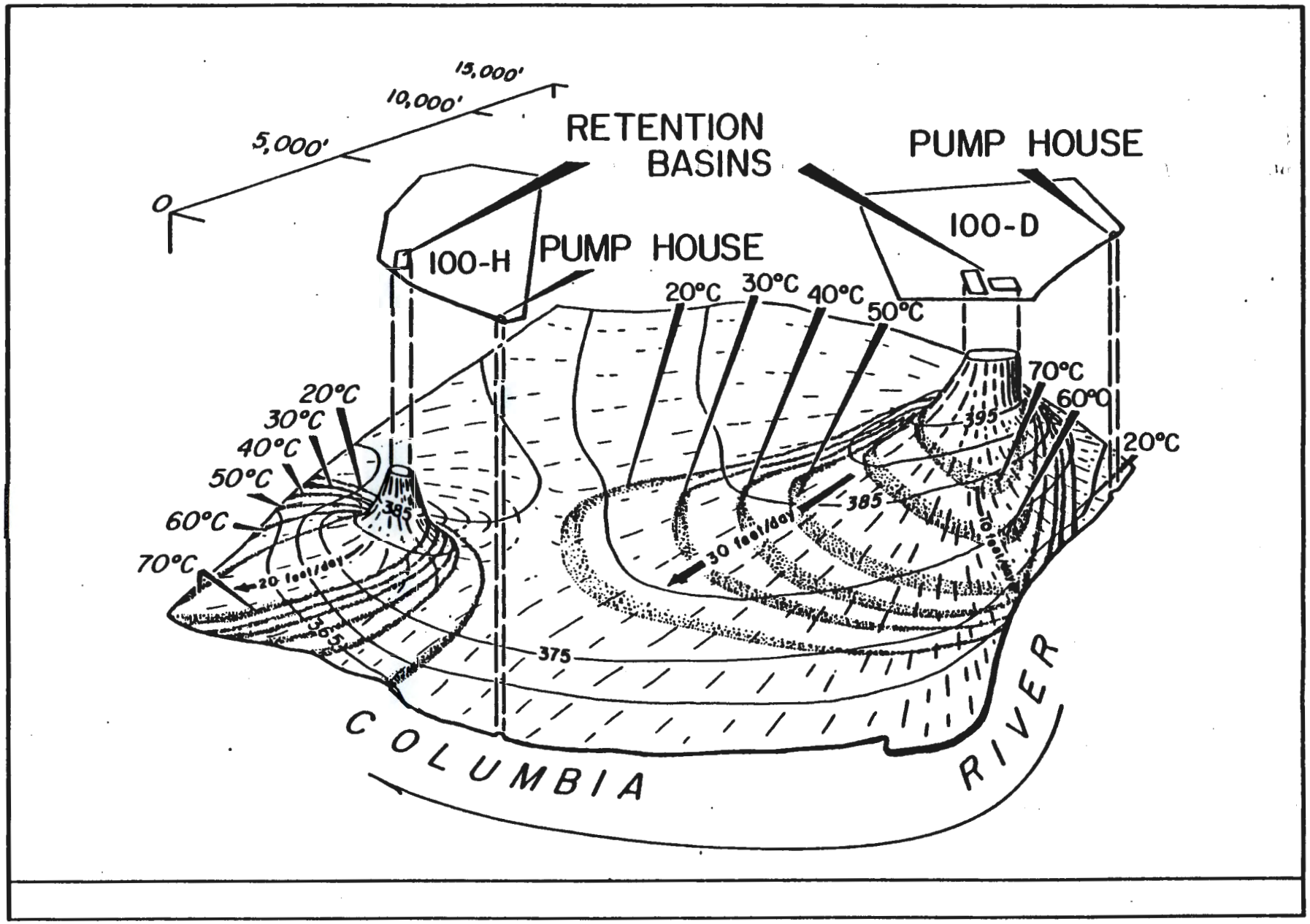
As with the 100B/C-Area, tritium, nitrate, and gross beta have been the most frequently monitored groundwater analytical parameters. Little data exist on other radionuclides and nonradioactive parameters. One set of analyses from the SWHW program is available for two wells.

Groundwater at the 100D/DR-Area has historically been impacted as is the case of the 100 B/C-Area (Brown, 1963). Leaking effluent cooling water from retention basins created groundwater mounds and temperature increases in the groundwater. Figure 3-33 depicts the effects on groundwater of historic (1962) leakage at the 100D/DR-Area.

The maximum historical tritium concentration occurred in 1963 in groundwater from Well 199-D2-5 at 70,000 picocuries per liter. Well 199-D2-5 also has exhibited the maximum historical concentrations of gross beta (48,000 picocuries per liter, 1966) and nitrate (100 milligrams per liter, 1979). Groundwater from Wells 199-D5-12 and D8-2 has also exhibited historical gross beta levels in excess of 1000 picocuries per liter.

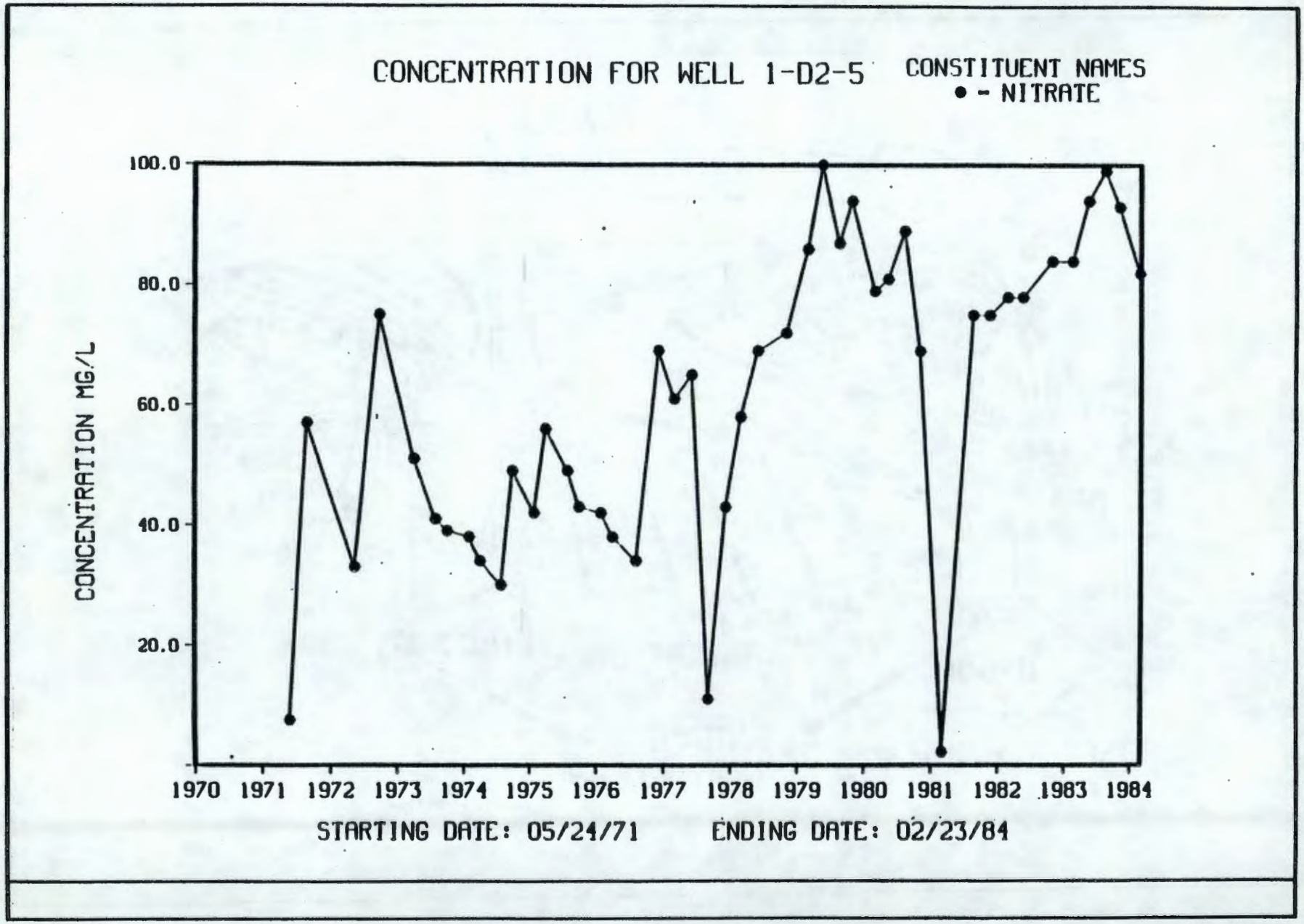
Recent data (1985-SWHW) found groundwater in Well 199-D5-12 to contain 95.6 picocuries per liter of gross beta and 1.02 milligrams per liter of chromium. Groundwater in Well 199-D8-3 also contained chromium (above the NPDWR of 0.05 milligram per liter) at 0.130 milligram per liter. As was the case in some of the groundwater sampled at 100B/C, nitrate levels have been increasing at some locations (see Figure 3-34). Tritium concentrations in groundwater, on the other hand, appear to be decreasing as shown in Well 199-D8-3 in Figure 3-35. No significant tritium or nitrate levels were observed in the spring sampling adjacent to the 100D/DR-Areas.

The lack of significant tritium or nitrate in the springs may be the result of groundwater movement toward the 100H-Area as opposed to movement directly toward the river.



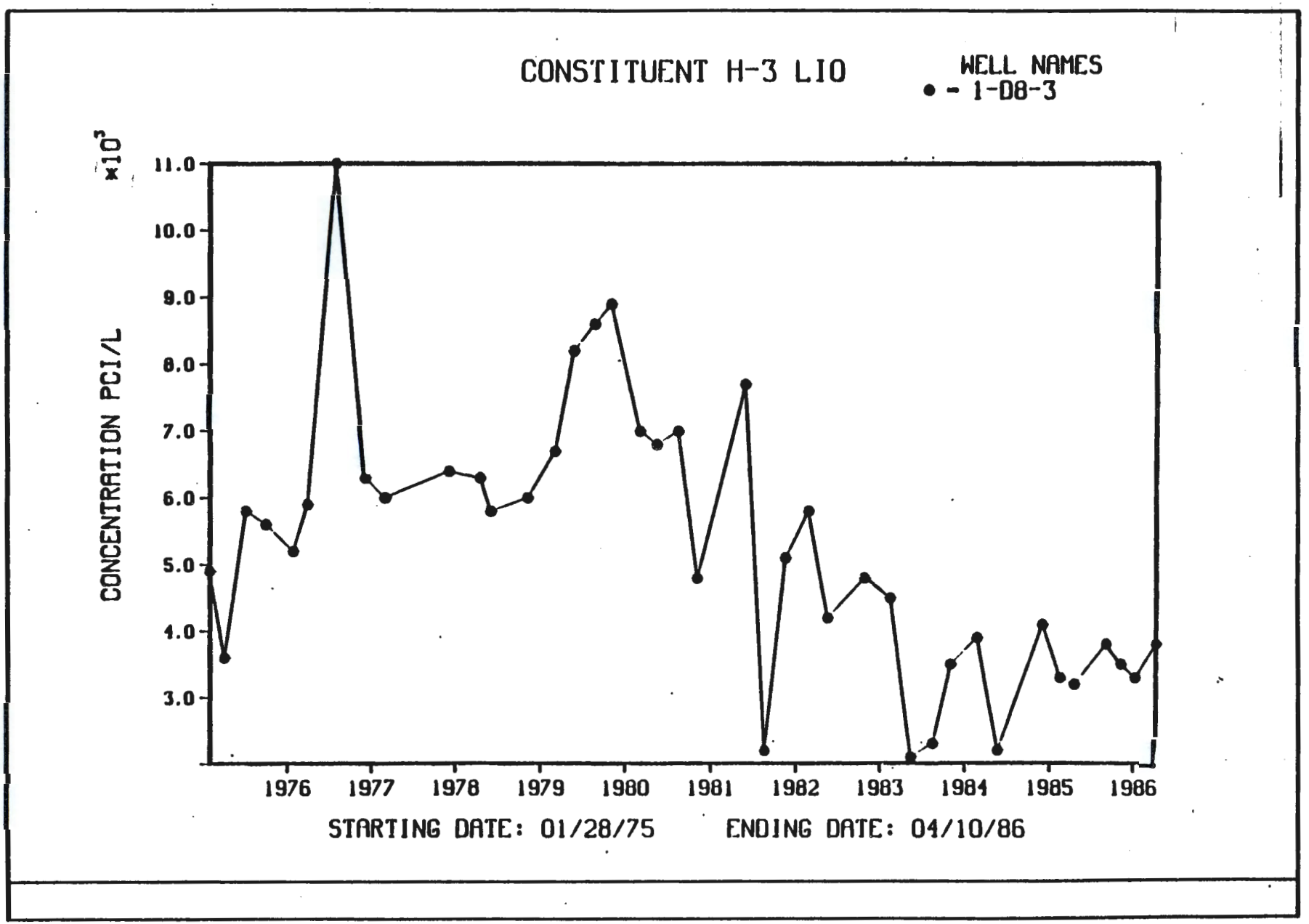
PERSPECTIVE DRAWING OF THE WATER TABLE UNDERLYING THE 100D- AND 100H-AREAS

FIGURE 3 - 33



NITRATE LEVELS FOR WELL 1-D2-5

FIGURE 3 - 34



TRITIUM CONCENTRATION FOR WELL 199-D8-3

FIGURE 3 - 35

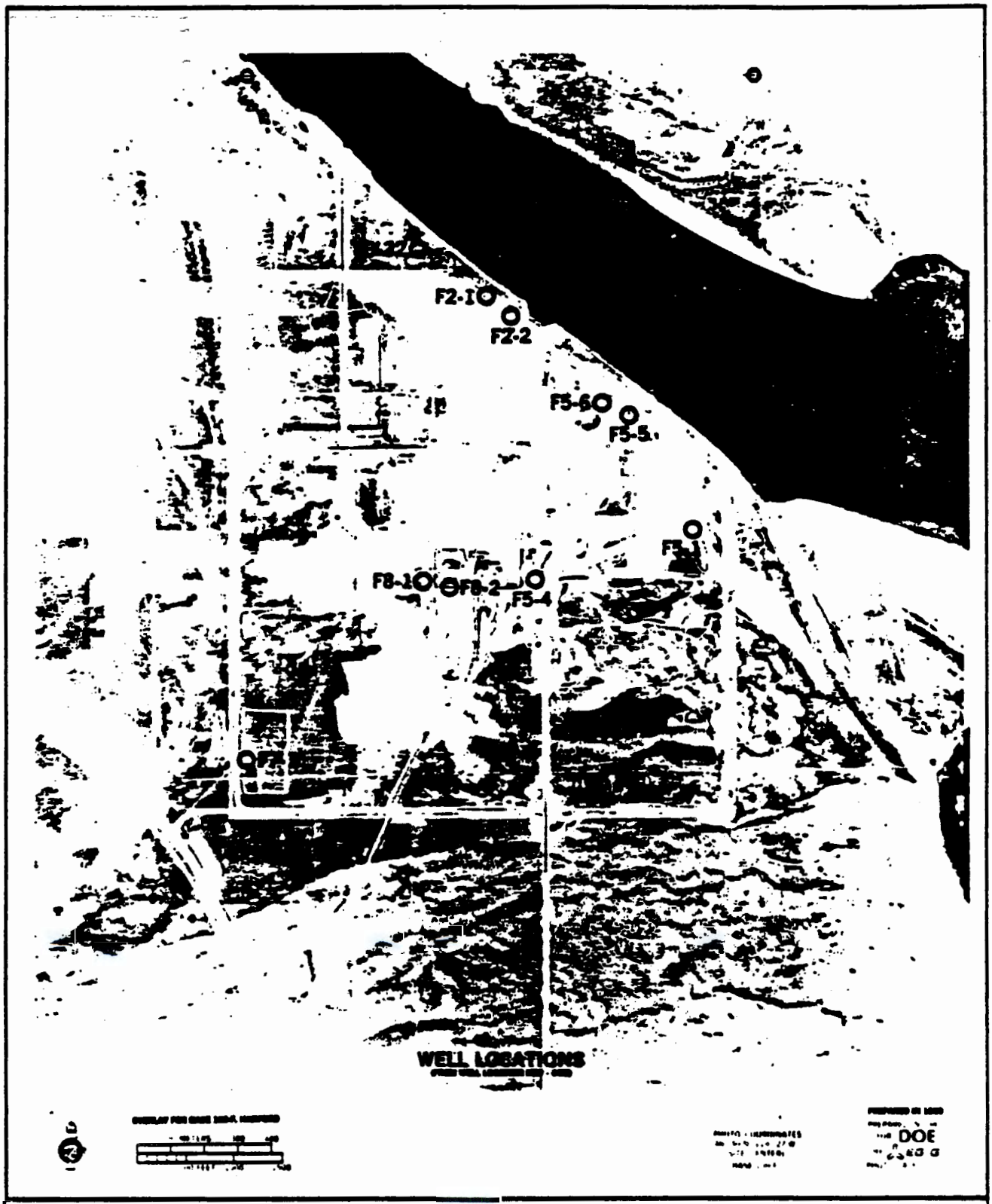
100F-Area

Nine wells have been used for providing groundwater samples at the 100F-Area, although the total number of wells in the area is 16. Many of the unused wells were installed in 1943. Two of the wells installed in 1943 are dry and one could not be located. Figure 3-36 is a well location plan for the 100F-Area. Note that not all wells have been located. Those used for monitoring in the GWMP are 199-F5-1, F5-3, F5-4, F5-6, F7-1, F8-1, and F8-2. Wells F8-1, F5-1, and F5-4 are part of the SWHW program. The wells monitor the unconfined aquifer.

Tritium, nitrate, and gross beta have been the most frequently monitored groundwater analytical parameters. Few or no additional data on other parameters are available except for the data developed in the SWHW program (one sampling event).

The 100F-Area sustained effects from leaking retention basins similar to those of the 100B/C and D/DR-Areas. Figure 3-37 (Brown, 1962) depicts these historic effects. The maximum historical gross beta concentration in groundwater was in Well 199-F5-2 in 1955 at a concentration of 810,000 picocuries per liter. The maximum historical tritium concentration in groundwater was in Well 199-F5-4 in 1978 at a concentration of 110,000 picocuries per liter. Tritium concentrations above 20,000 picocuries per liter persist in Well F5-4 (26,000 picocuries per liter in 1986) and Well F8-1 (42,000 picocuries per liter in 1986). Nitrate levels in groundwater have been consistently above 45 milligrams per liter (NPDWR) in Wells F7-1, F8-1, and F8-2.

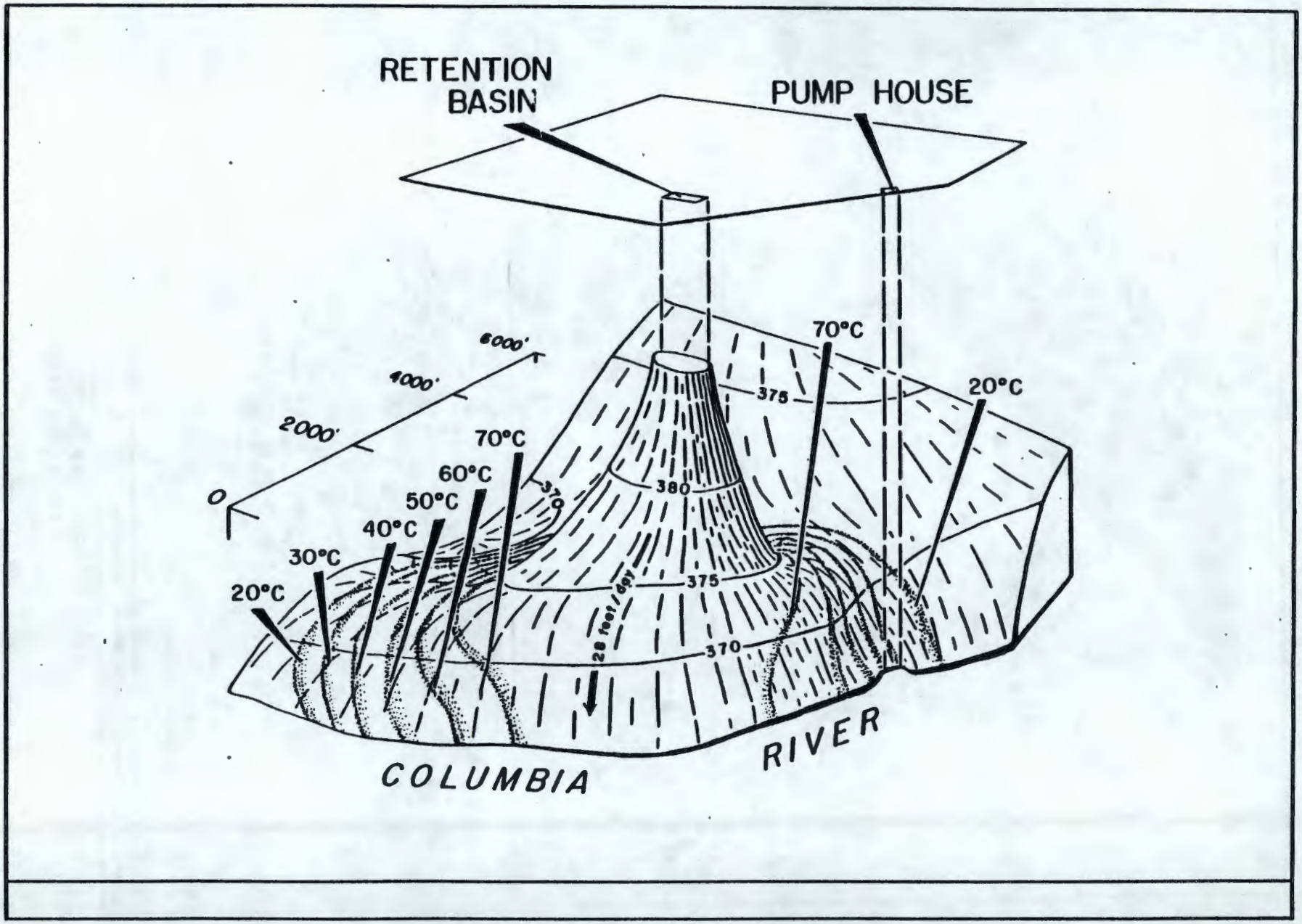
Data from the SWHW program indicated that nitrate in the groundwater in Wells F8-1 (159 milligrams per liter in 1985) and F5-4 (49 milligrams per liter in 1985) exceeded the NPDWR. Coliform bacteria counts exceeded the NPDWR in wells F5-1 and F5-4. Gross beta was 88.7 picocuries per liter and gross alpha 171 picocuries per liter in the groundwater in Well F8-1. As with the 100B/C and D/DR-Areas, nitrates have shown a general increasing trend in the groundwater in some wells (see Figure 3-38). Tritium has shown a general decrease with time. Figure 3-39 suggests that the groundwater manifesting as springs is still impacted by the 100F-Area.



Source: EG&G Graphic Overview System; Hanford Site

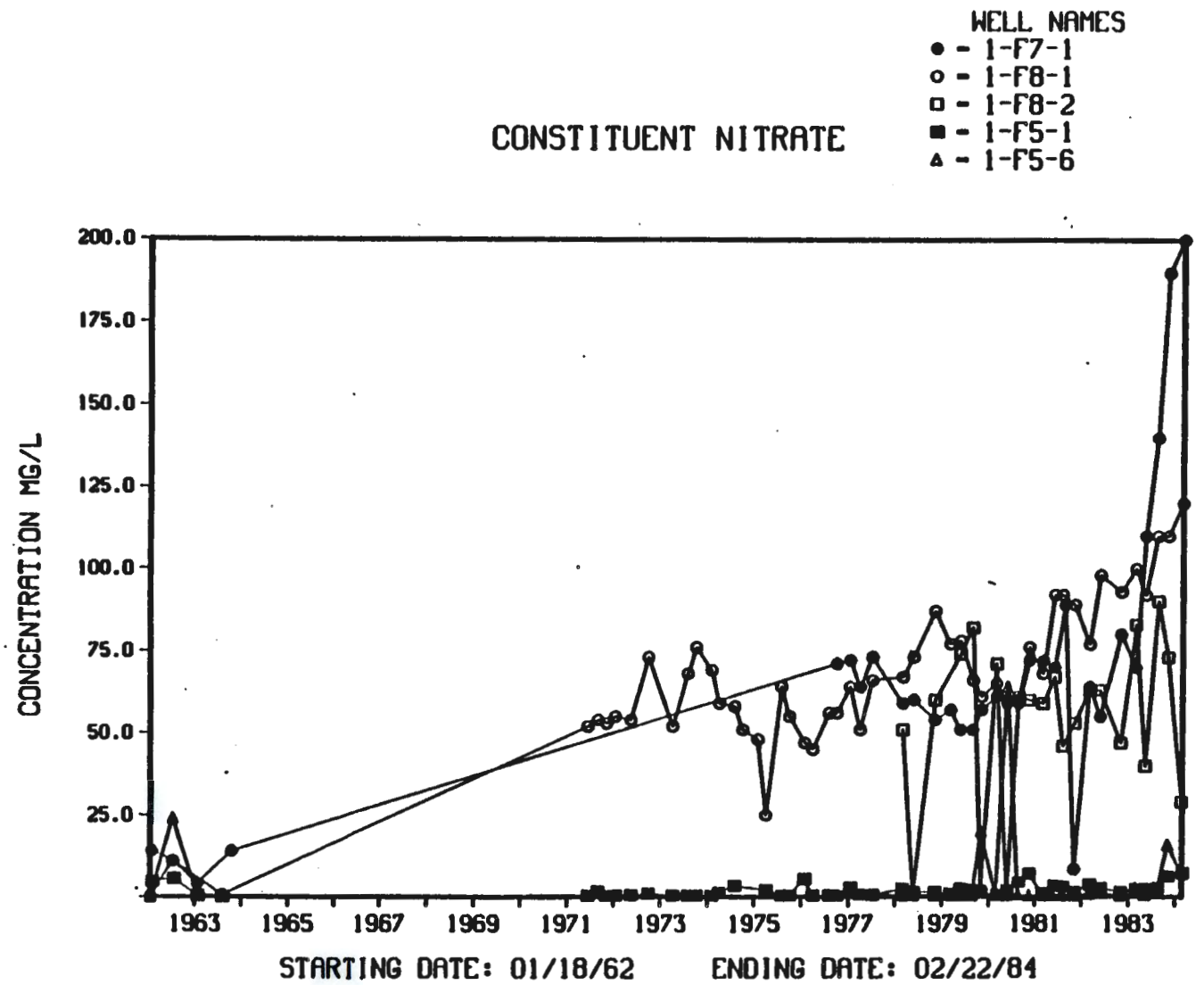
WELL LOCATIONS REACTOR AREA 100F, HANFORD SITE

FIGURE 3 - 36



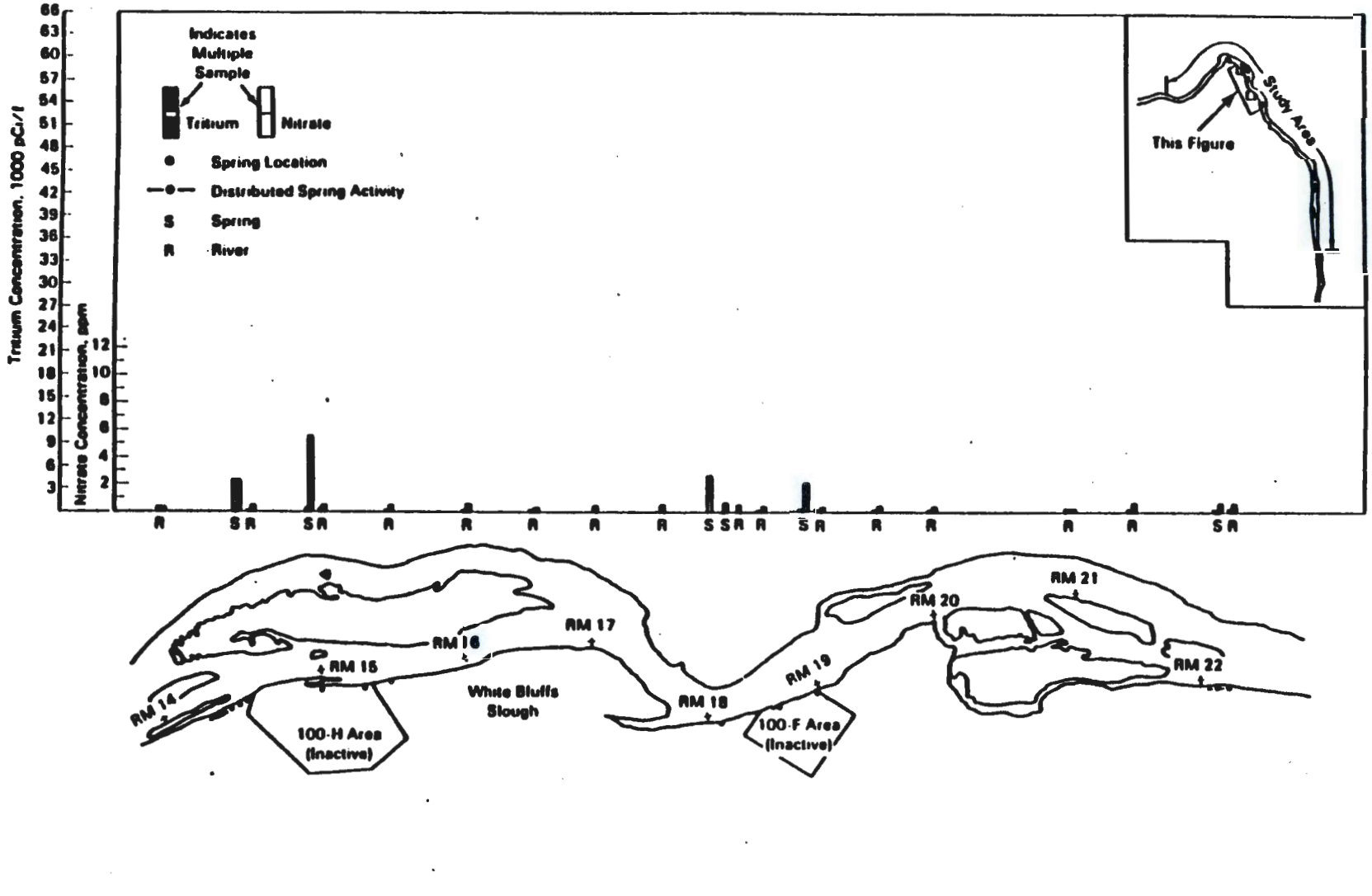
PERSPECTIVE DRAWING OF THE WATER TABLE UNDERLYING THE 100F-AREA

FIGURE 3 - 37



NITRATE LEVELS FOR 100F-AREAS

FIGURE 3 - 38



Source: McCormack and Carlile 1984

LOCATIONS AND ANALYTICAL RESULTS FOR SPRING AND RIVER SAMPLES FROM RIVER MILE 14 THROUGH RIVER MILE 22

FIGURE 3 - 39

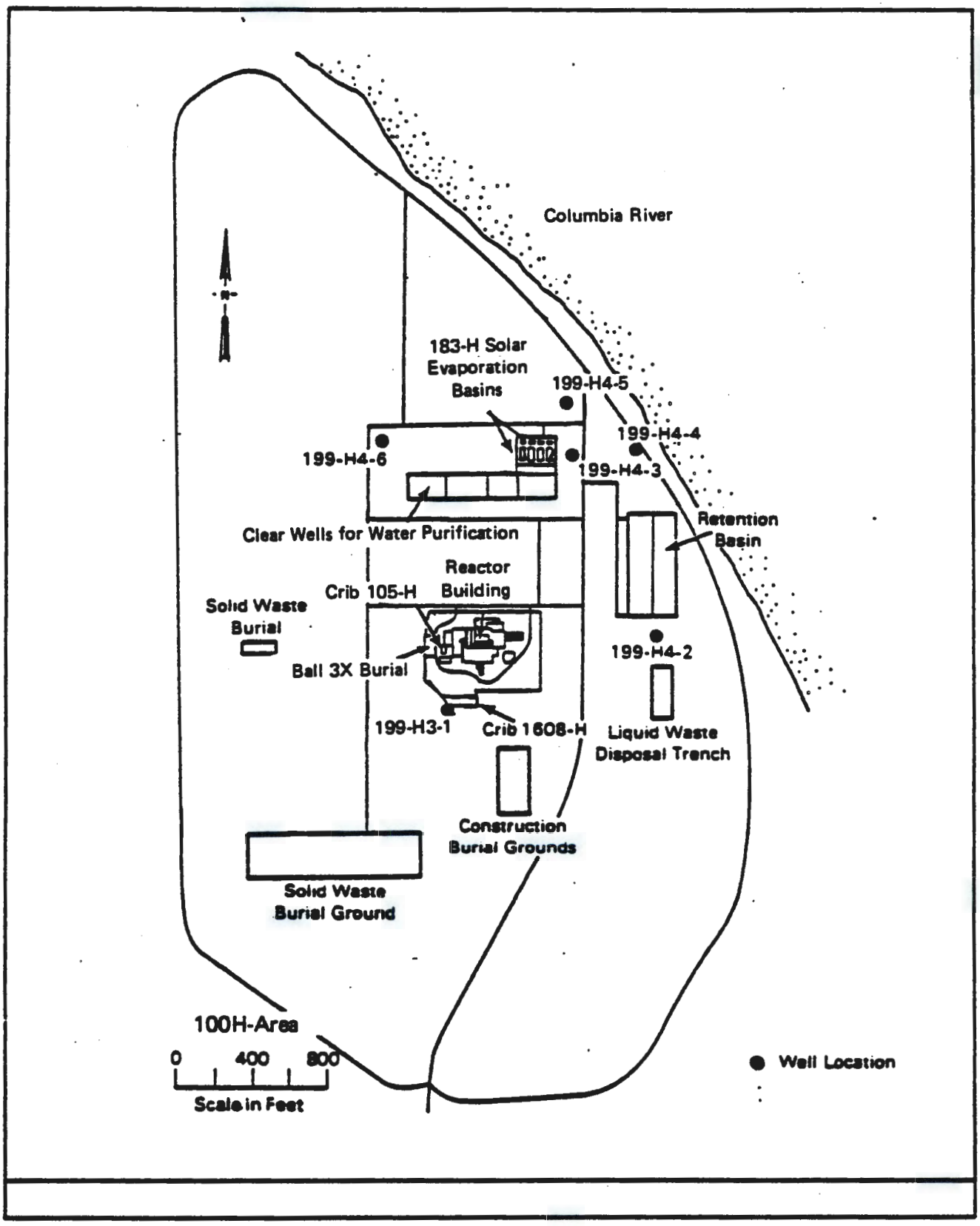
100H-Area

Five wells are currently used for monitoring at the 100H-Area. Well locations are shown on Figure 3-40. The wells used as part of the GWMP are all those shown on Figure 3-40 except 199-H4-2. Well 199-H4-2 monitors the confined aquifer and is used only for piezometric measurements. The remaining five wells monitor the unconfined aquifer. These five also serve the RCRA monitoring program for the 183H Evaporation Basins.

Unlike the other 100-Areas, the 100H-Area has a significant amount of recent data from the RCRA program. The majority of historic data concentrate on tritium, gross beta, and nitrate. Well 199-H4-3 has the largest data base in the 100H-Area and includes some inorganic parameters. A full year's worth of data on RCRA groundwater monitoring parameters exists for all five wells.

Groundwater at the 100H-Area has been impacted by both leaking effluent cooling water (see Figure 3-25) and the 183H Basins. Investigations begun in 1977 showed that nitrate and hexavalent chromium had entered groundwater from the leaking 183H Basins. The RCRA program has indicated the presence of "... metals, anions, radionuclides, and a few volatile organic chemicals" (Elderkin 1986) in the groundwater. Chromium, nitrate, and fluoride have consistently exceeded the NPDWR. Gross alpha and gross beta also have exceeded the NPDWR. Perchloroethylene (15 parts per billion), 1,1,1-trichloroethane (24 parts per billion), and chloroform (31 parts per billion) have also been detected. Other metals (e.g., mercury and cadmium) have also exceeded the NPDWR.

The maximum historic tritium concentration occurred in the groundwater from Well 199-H3-1 in 1962 with a concentration of 130,000 picocuries per liter. The maximum gross beta concentration occurred in 1959 in Well H4-1 with a concentration of 3200 picocuries per liter. Wells H4-3 and H4-4 continue to exhibit gross beta concentrations in excess of 50 picocuries per liter with H4-3 up to 1000 picocuries per liter and H4-4 a few hundred picocuries per liter. Nitrate at over 1000 milligrams per liter and gross alpha levels have consistently exceeded the NPDWR in both these wells.



100H-AREA MAP

FIGURE 3 - 40

Nitrate has (as with the other 100-Area sites) tended to increase in concentration in groundwater overtime. Tritium concentrations have generally declined. Continued groundwater impact is suggested by the nitrate and tritium levels observed in the springs adjacent to the 100H-Area (Figure 3-39).

100K-Area

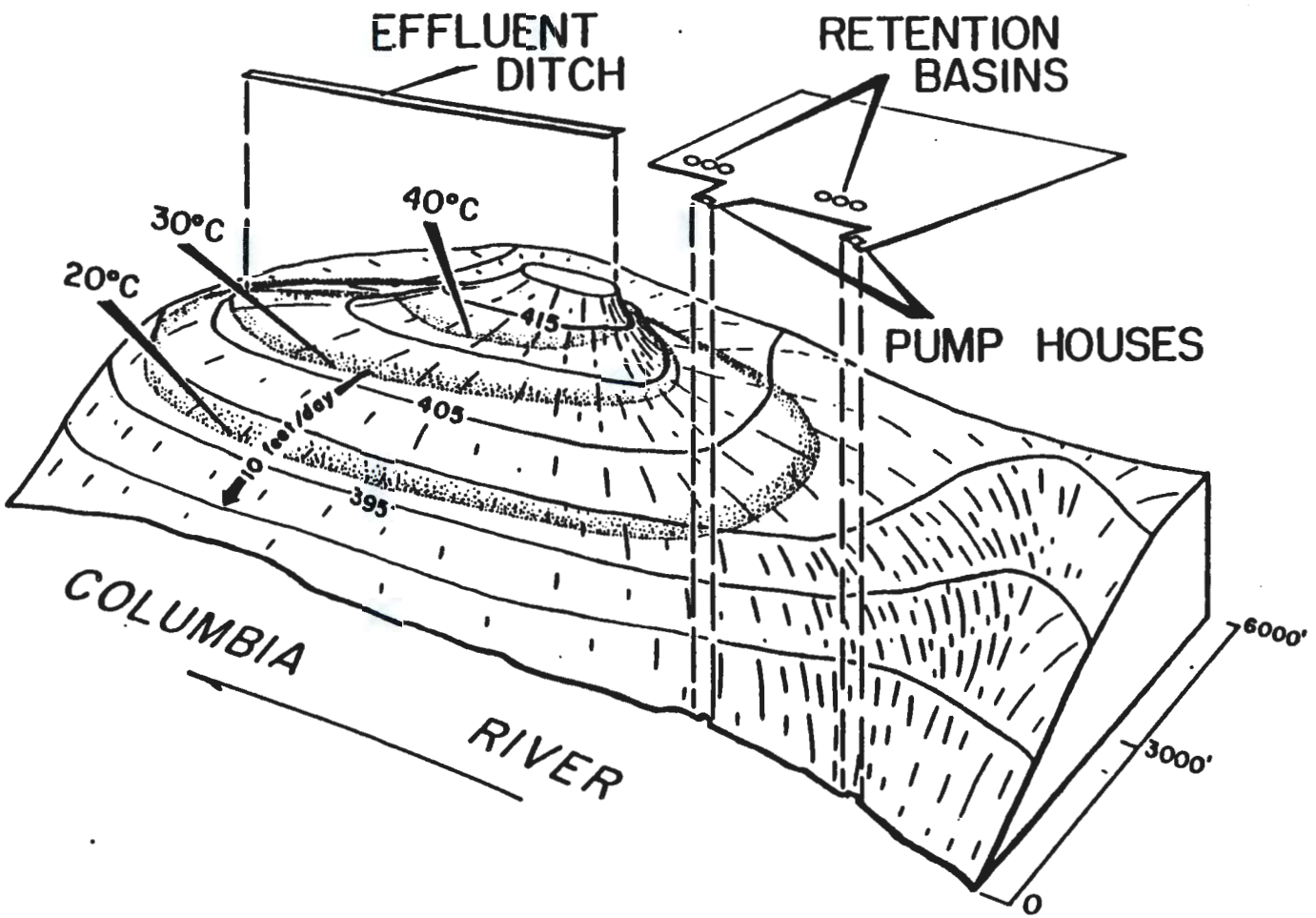
Twelve wells have been utilized for providing groundwater samples at the 100K-Area. A total of 17 wells exist in the 100K-Area. A well location plan that depicted the well locations adequately was not available to the Survey Team. The 12 wells where groundwater samples have been taken include:

199-K-10	199-K-25
199-K-11*	199-K-27*
199-K-19*	199-K-28*
199-K-20*	199-K-28*
199-K-21	199-K-30*
199-K-22*	199-K7 (destroyed)

All wells monitor the unconfined aquifer. Wells 199-K-20 and K-30 are part of the SWHW program. The most complete contaminant data record, over time, occurs in Wells 199-K-11, K-19, K-20, and K-22. The wells that are part of the GWMP are given an asterisk in the table above.

Tritium, nitrate, and gross beta have been the groundwater analytical parameters monitored most frequently. Except for the SWHW program, very few additional data exist for other parameters.

Historically, the 100K-Area sustained the same impacts on groundwater as the other 100-Areas. However, the major groundwater mounding and temperature increases occurred from infiltration from a 4000-foot ditch that received effluent cooling water (see Figure 3-41). The maximum reported tritium concentration in groundwater occurred in Well 199-K-27 in 1981 at a concentration of 2,900,000 picocuries per liter. Groundwater tritium concentrations in Well 199-K-30 have



Source: Brown 1963

PERSPECTIVE DRAWING OF THE WATER TABLE UNDERLYING THE 100K-AREA, 1962

FIGURE 3 - 41

consistently exceeded 20,000 picocuries per liter since 1981, with an April 1986 concentration of 82,000 picocuries per liter. The maximum reported gross beta concentration in groundwater was 6600 picocuries per liter in Well 199-K-20 in 1969.

Data from the SWHW program indicate that Well 199-K-20 exceeded 50 picocuries per liter of gross beta (52 to 66 picocuries per liter) and also exceeded the NPDWR for chromium (.152 to .173 milligram per liter) in 1985. Nitrate has shown consistent increases in concentration in groundwater, over time, in some wells. Figure 3-42 shows the nitrate increases in Well 199-K-20. Similar to many of the other 100-Area Wells, some wells have shown decreases in tritium concentration over time (Figure 3-43). Also of note is that oil was found in Well 199-K-13, according to the February 1985 PNL-5397 Hanford Wells Report.

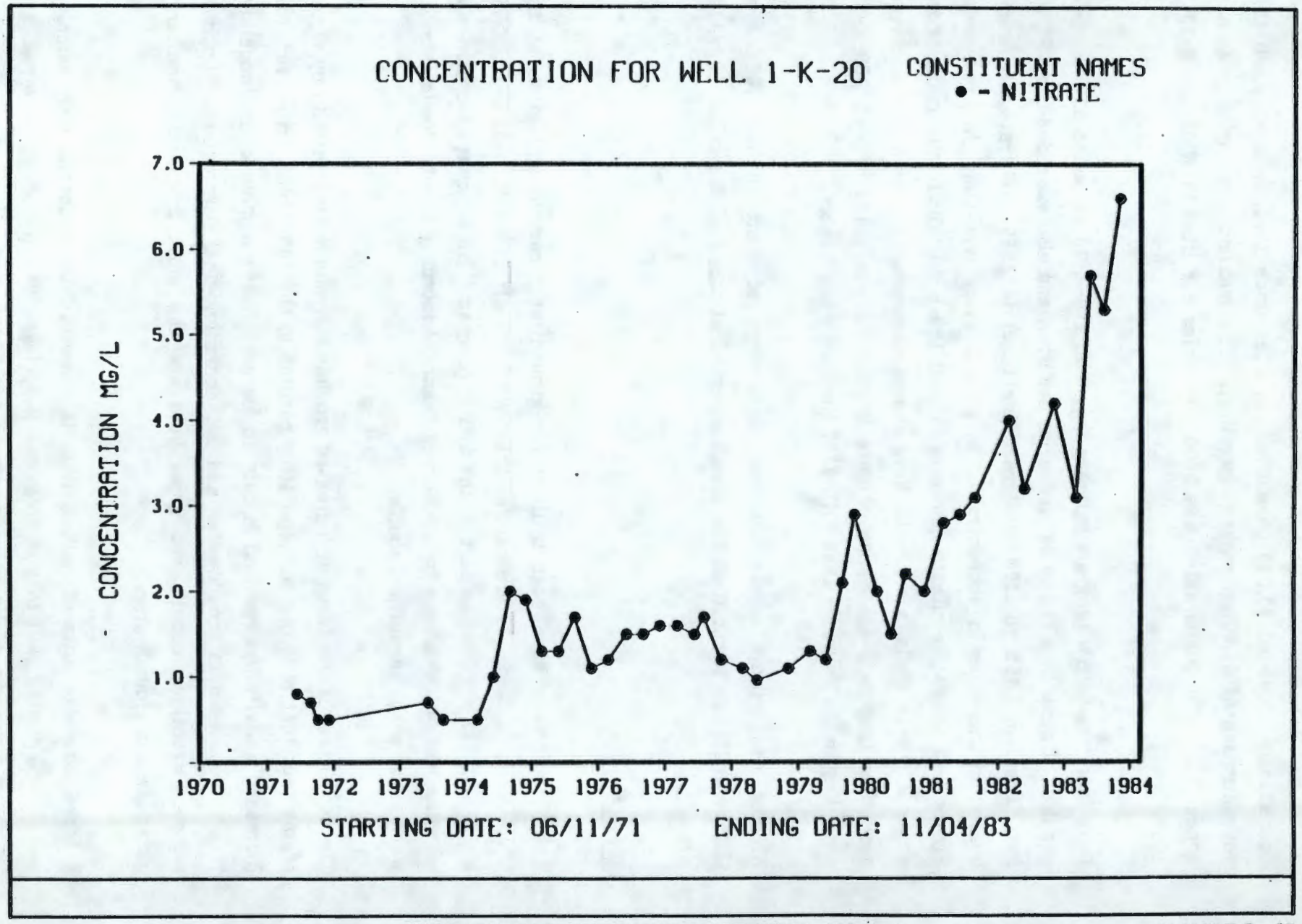
Nitrate and tritium levels observed in springs adjacent to the 100K-Area (Figure 3-23) are lower than the levels observed at many of the other 100-Area sites.

100N-Area

Thirty-five wells have been utilized for groundwater sample collection at the 100N-Area; of these, 31 are part of the GWMP. Wells 199-N-3, N-6, N-14, N-28, N-29, and N32 are used as part of the SWHW program. An adequate location map of wells was not available to the Survey team. According to site documents, all wells monitor the unconfined aquifer.

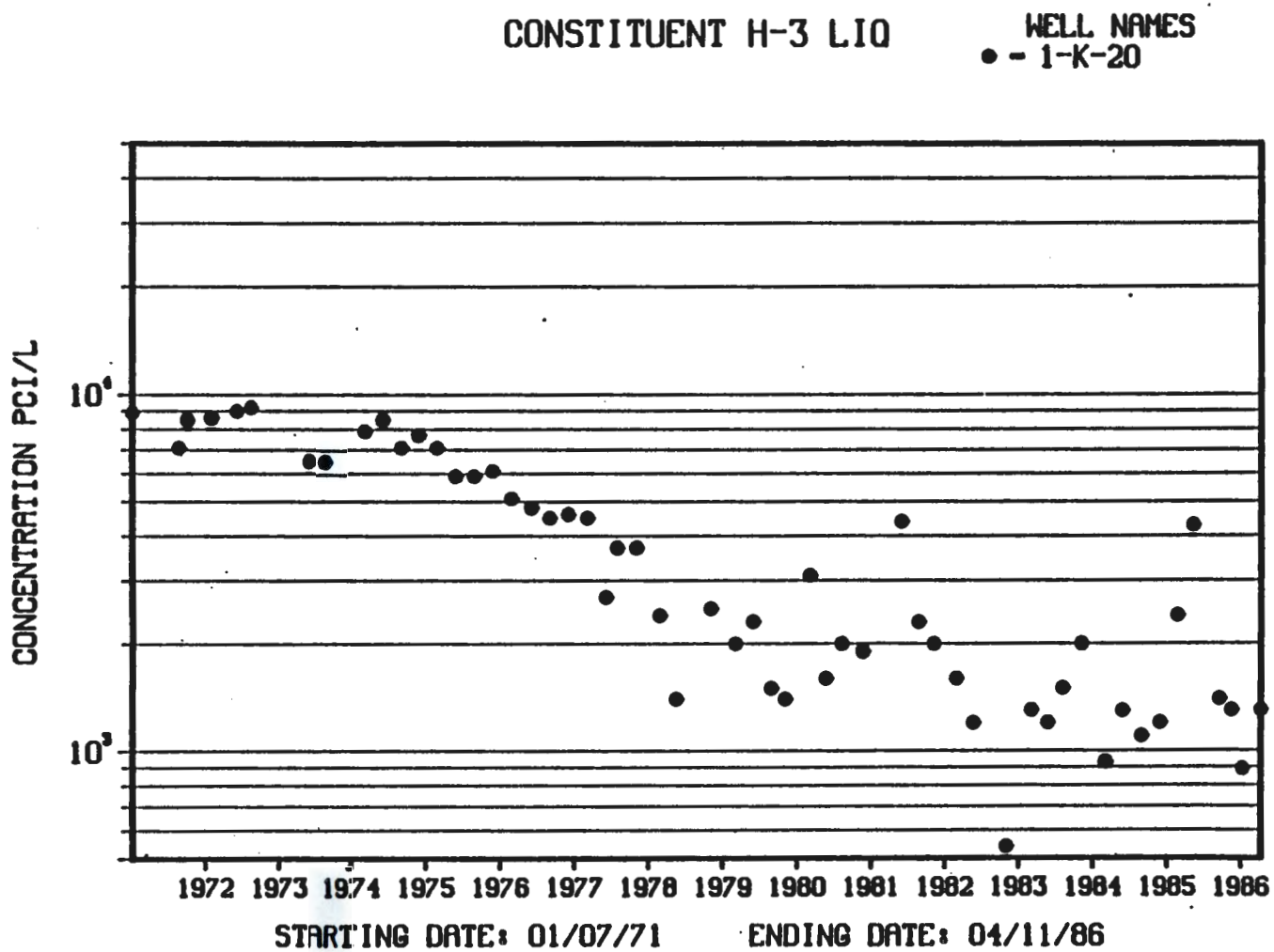
The 100N-Area is the focus of increased groundwater monitoring activity by virtue of the fact that it is the only operating reactor in the 100-Areas. However, this increased activity has resulted in only an increase in the number of radionuclides that are assessed in groundwater and not nonradiological parameters. Tritium, nitrate, strontium, cobalt, and gross beta are the most frequently monitored parameters in groundwater.

A more extensive suite of radionuclides is assessed from a continuously sampled weekly composited well that samples the N-Springs. The N-Springs have resulted from the discharge of liquid effluents to the 1301N Crib, which has raised the



NITRATE CONCENTRATION FOR WELL 199-K-20

FIGURE 3 - 42



DECREASING TRITIUM CONCENTRATION FOR WELL 199-K-20

FIGURE 3 - 43

water table in a manner similar to the historic groundwater mounds created in the other 100-Areas.

The monitoring of the N-Springs results in a yearly summary of analyses. Listed in the following table are the parameters from the 100-Area N-Springs monitoring that exceeded the NPDWR. In the case of radionuclides, the NPDWR is based on the concentration of the radionuclides yielding 4 millirem per year for a 2-liter daily intake (EPA-570/9-76-003).

Parameter	Max Reported Concentration(1)	NPDWR Standard
Tritium	300,000 pCi/L	20,000 pCi/L
P-32	59 pCi/L	30 pCi/L
Sr-89	6,000 pCi/L	80 pCi/L
Sr-90	6,100 pCi/L	8 pCi/L
Ru-103	430 pCi/L	200 pCi/L
Ru-106	250 pCi/L	30 pCi/L
I-131	11,000 pCi/L	3 pCi/L
Chromium	0.16 mg/L	0.05 mg/L

(1) UNC, 1985

A review of the groundwater parameters requested from the data base (gross beta, cobalt-60, strontium-90, tritium, and nitrate) was performed. The maximum concentration for each parameter is listed in the following table along with the date of occurrence and the well number.

Parameter	Maximum Concentration	Well No.	Date
Tritium	4,000,000 pCi/L	199-N-3	8/17/72
Gross beta	60,000 pCi/L	199-N-3	3/08/74
Cobalt-60	170,000 pCi/L	199-N-15	9/03/81
Nitrate	53 mg/L	199-N-22	8/03/83
Strontium-90	4,950 pCi/L	199-N-2	3/12/86

The wells sampled as part of the SWHW program in 1985 all had gross beta concentrations in groundwater above 50 picocuries per liter. The NPDWR standards for nitrate were exceeded in three of the five sampled wells.

Unlike the other 100-Area sites, the tritium concentrations in groundwater do not appear to be decreasing (see Figure 3-44). Strontium-90 appears to be increasing in some wells (Figure 3-45) while gross beta has fluctuated somewhat over the same time period in these wells (Figure 3-46).

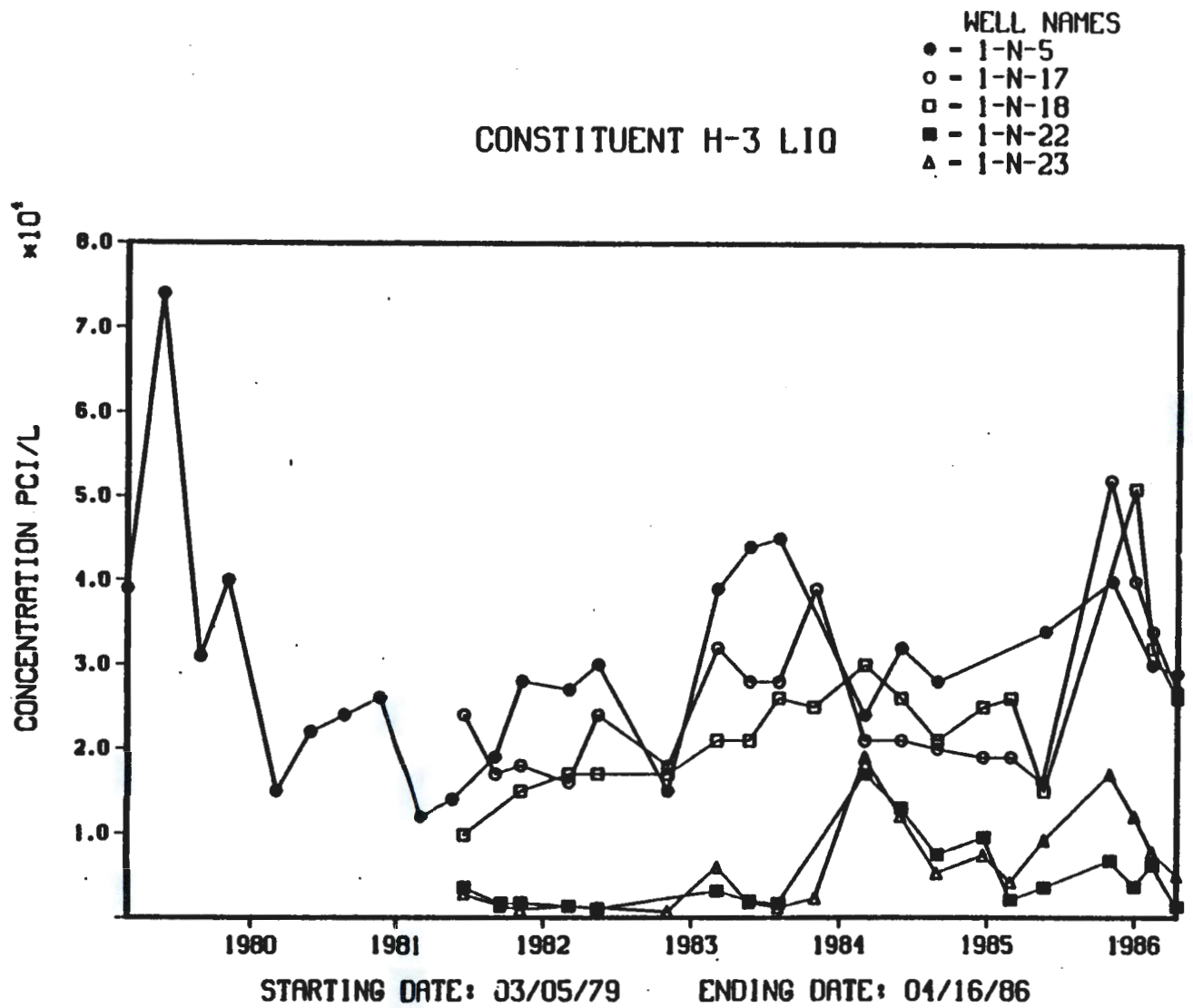
Of significant interest are the tritium and nitrate levels shown on Figure 3-31. Note the relatively higher concentrations found in the springs adjacent to 100N than in the other 100-Areas.

9 2 1 2 1 1 5 1 3

200-Area

The 200-Area is divided into east and west, but for the purposes of this discussion are treated as one entity. A total of 119 wells were proposed to be sampled by RHO under the SAMP in 1986. Twenty-two wells in the 200-Area are also sampled by PNL, although these 22 are not necessarily in addition to the 119 sampled by RHO. The unconfined aquifer is monitored by all these wells. Figure 3-47 is a well location map.

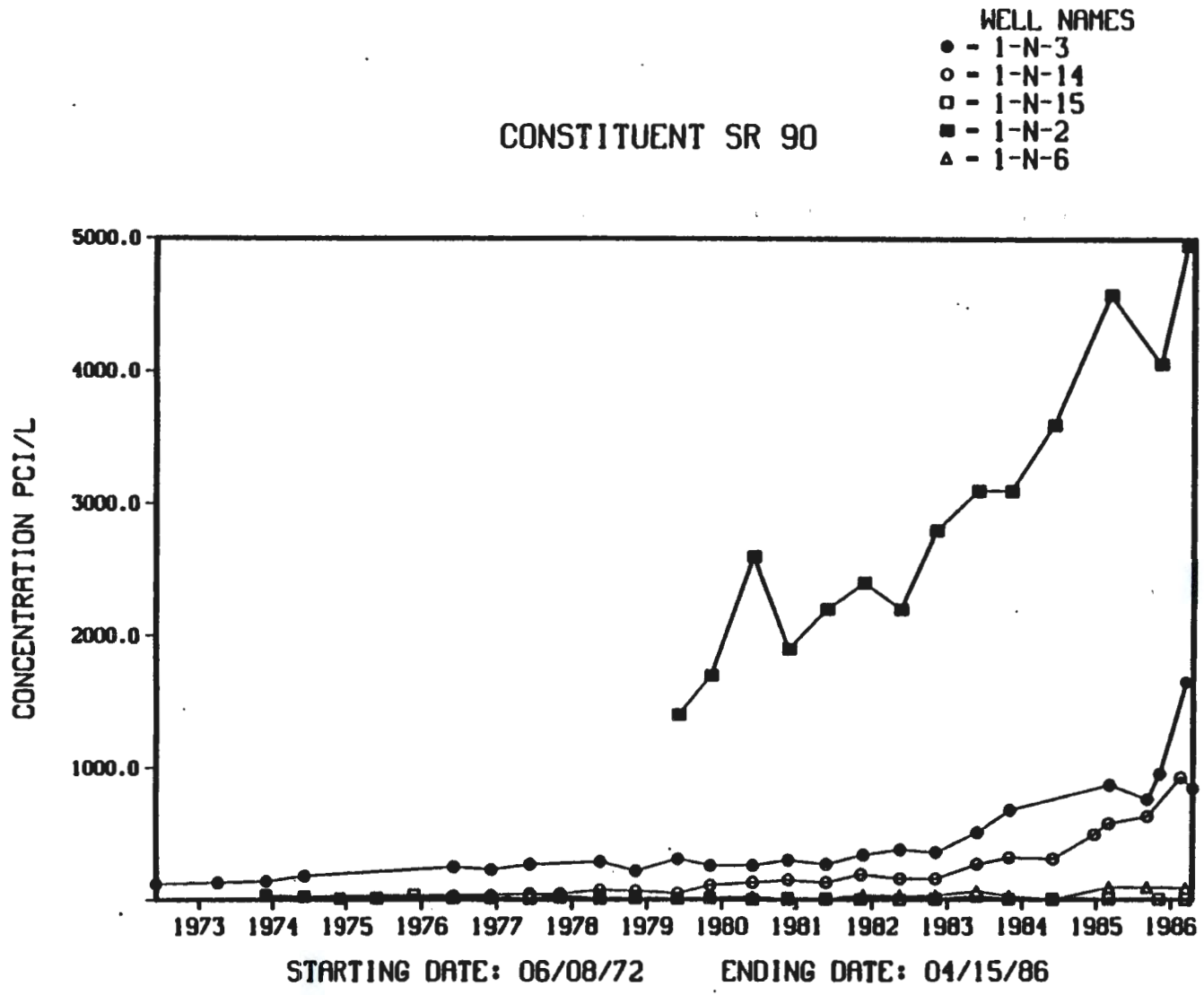
The 200-Area is monitored frequently due to the fact that both areas have been (and continue to be) used for disposal of significant quantities of both solid and liquid waste. Additional monitoring (other than groundwater sampling) is typically carried out through the use of scintillation logging in drywells adjacent to active liquid disposal areas. The overall data base of monitored parameters is greater than in some other areas of the site. However, the primary monitoring parameters are radionuclides. The most frequently monitored parameters are tritium, gross beta, nitrate, cesium, strontium, cobalt, ruthenium, gross alpha, uranium, and plutonium. Few data exist on nonradiological parameters. The SWHW program does not extend into the 200-Area.



Source: Law et al., 1986, RHO-RE-SR-85-24P

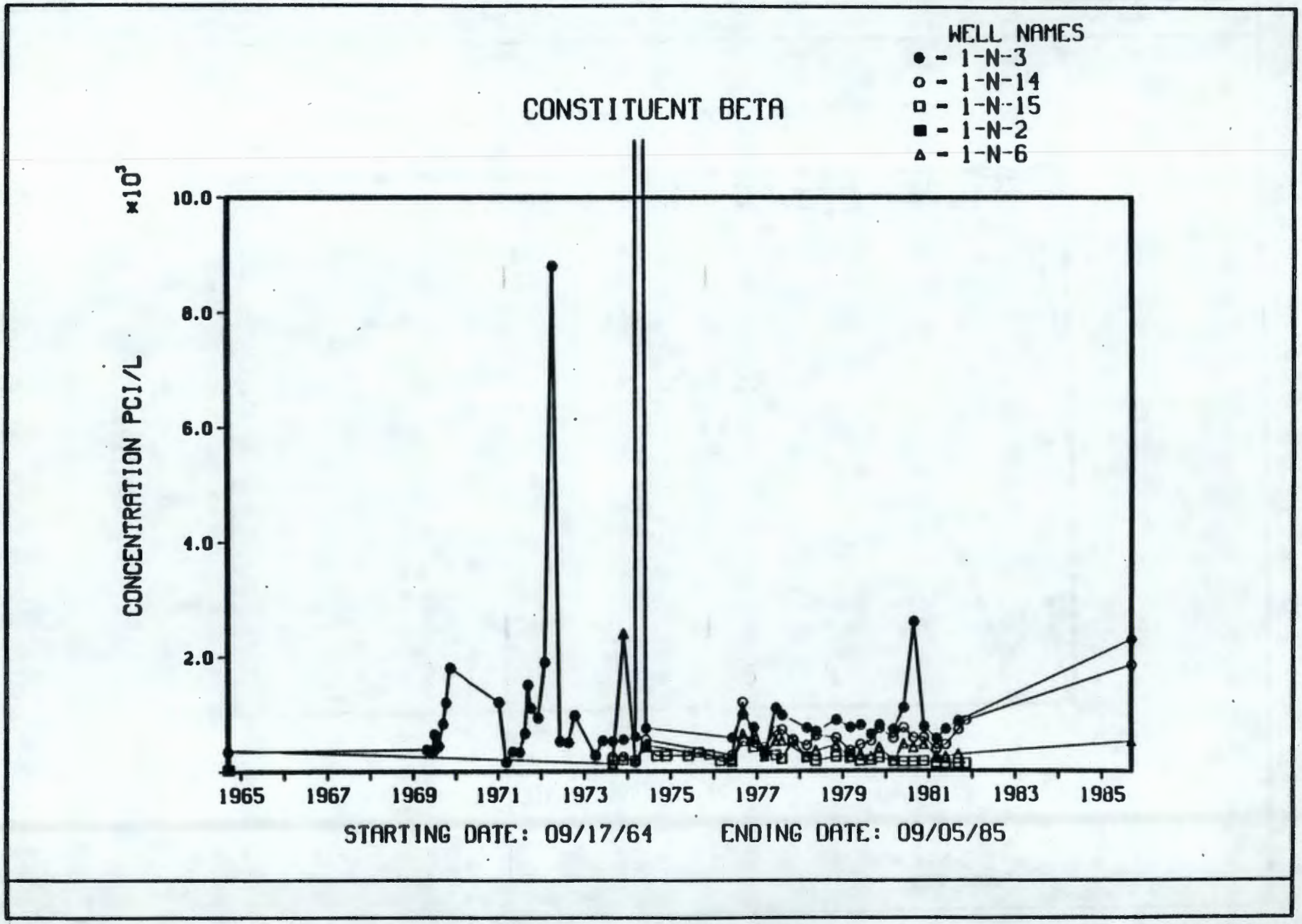
TRITIUM CONCENTRATIONS FOR 100N-AREA

FIGURE 3 - 44



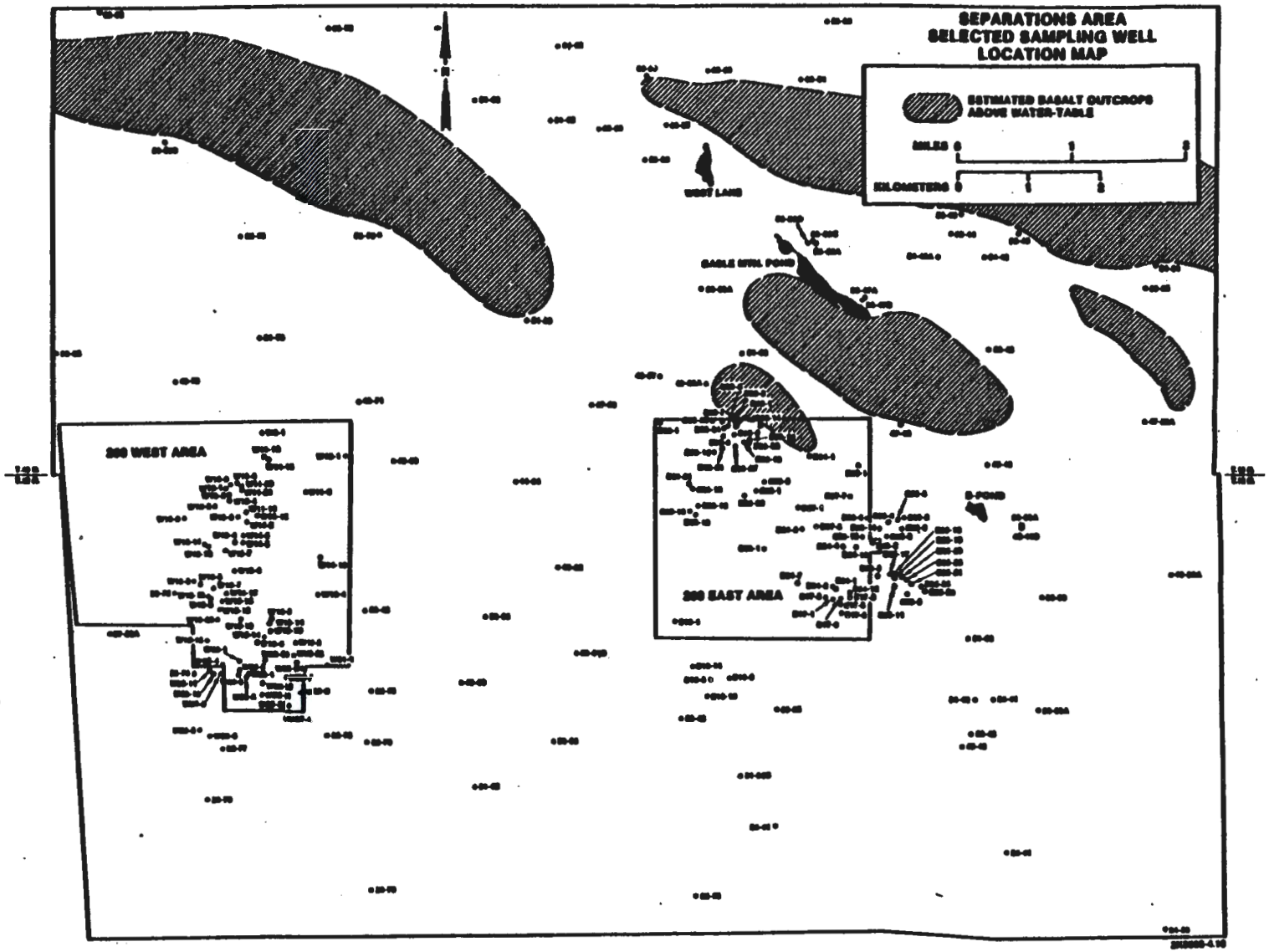
STRONTIUM CONCENTRATIONS FOR 100N-AREA

FIGURE 3 - 45



GROSS BETA FOR 100N-AREA

FIGURE 3 - 46



SELECTED SAMPLING WELLS IN THE SEPARATIONS AREA

FIGURE 3 - 47

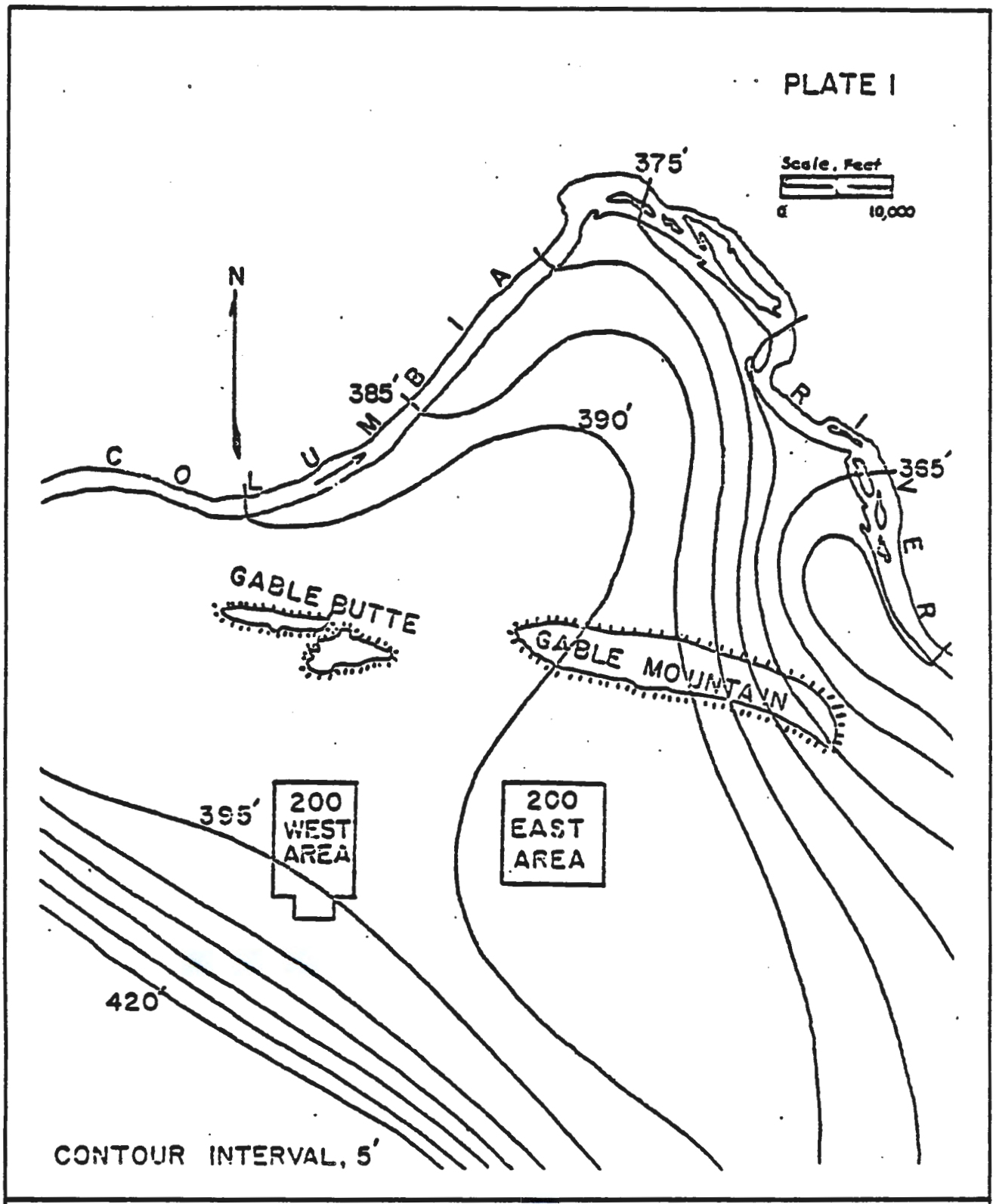
The 200-Area contains the principal processing and disposal sites for the Hanford Site. From a groundwater standpoint, the disposal of liquid wastes on and into the ground has had, and continues to have, substantial impacts on the groundwater system. Liquid effluents and process waters are discharged to the ground through cribs, ditches, ponds, septic systems, and reverse wells. Other liquid wastes are stored in tanks and solid wastes are placed in burial grounds.

The discharge of liquid to the ground has historically created major changes in the groundwater flow regime. These changes continue to persist beneath and adjacent to the 200-Area. In 1984, 6.8 billion gallons of water were discharged to the various disposal facilities in the 200-Areas. Historical increases in the groundwater table have approached 90 feet in the 200-West (200W) Area. The changes in the groundwater flow regime have resulted in diverging contaminant plumes from both the 200-East (200E) and 200W-Areas.

An example of the groundwater table changes can be seen by comparing Figure 3-48 to Figure 3-49. The 1944 groundwater table contours indicate the flow direction was to the east and/or northeast from the 200-Area. The 1984 water table map shows flow in virtually every direction as a result of groundwater mounding. In fact, a groundwater divide has developed in the 200-East Area.

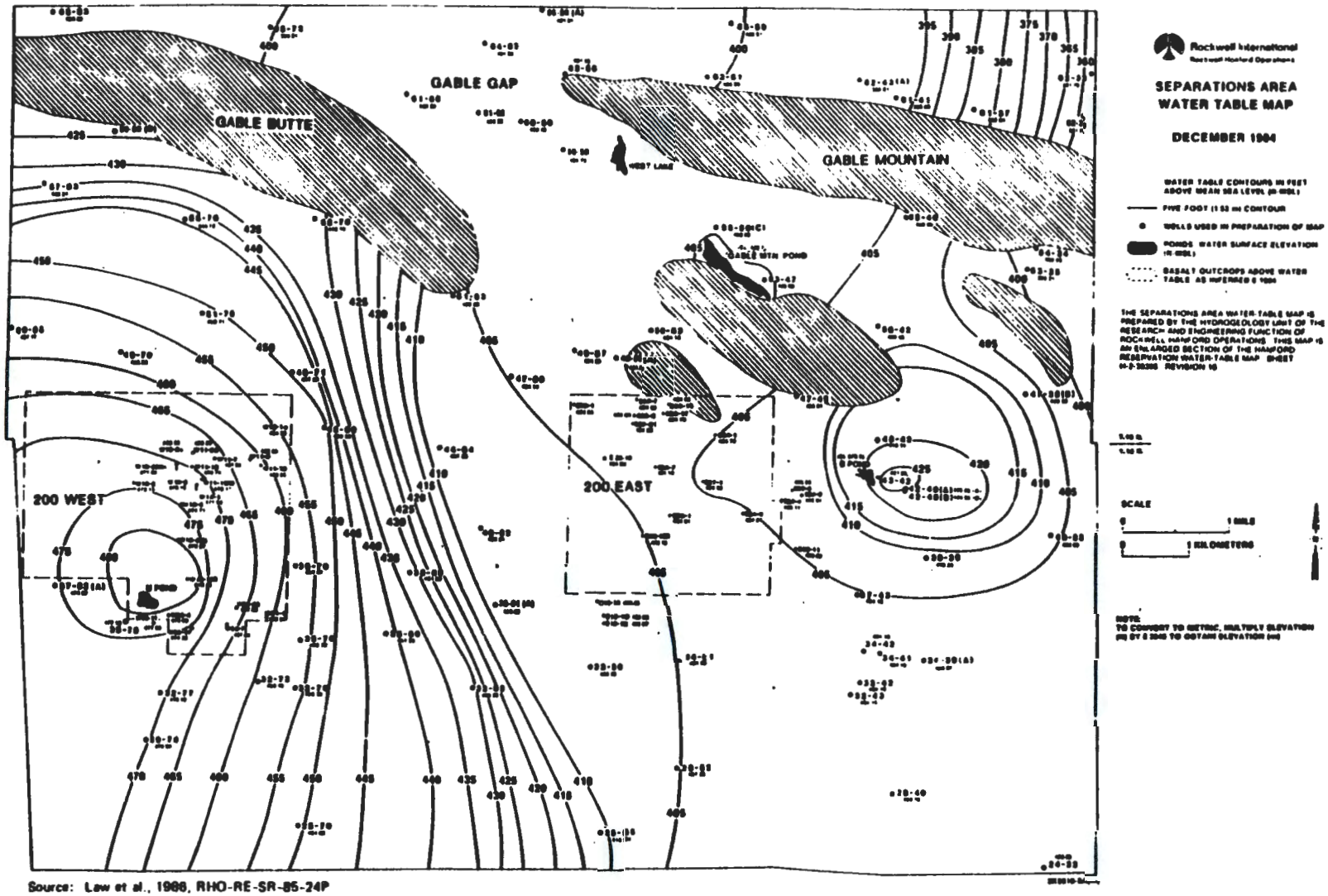
The impacts on groundwater have not been limited to changes in the groundwater table. Contaminants have also infiltrated downward to the groundwater. Although only a limited number of parameters are monitored in the groundwater, the use of tritium and nitrate as indicator parameters has proved invaluable in identifying the major contaminant plumes. The water level changes have also created downward vertical gradients from the unconfined to the confined aquifer, which has allowed contaminants to move into the confined aquifer. This relationship can be seen in Figure 3-50 in the vicinity of B-Pond.

Since tritium and nitrate provide the most pervasive data base for the 200-Area, they are used in the following discussion regarding contaminants in the unconfined aquifer. The lack of discussion of other contaminants is not by virtue of their absence from the groundwater regime but due to their historic absence from the monitoring program for the 200-Area. Additionally, the following discussion is



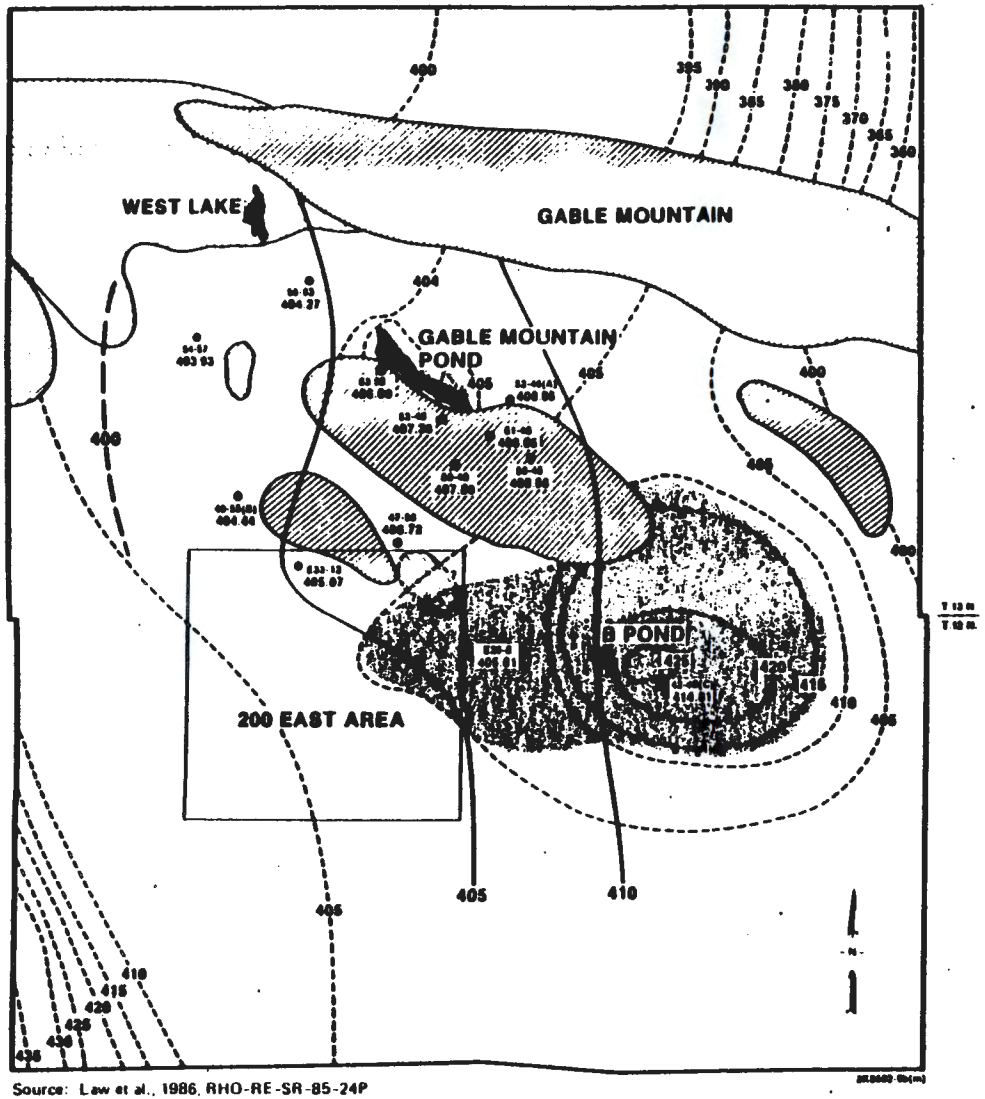
Source: McConiga, 1955

1944 - GROUNDWATER TABLE CONTOURS FIGURE 3 - 48



Source: Law et al., 1986, RHO-RE-SR-85-24P

FIGURE 3 - 49
WATER TABLE MAP FOR THE
SEPARATIONS AREA,
DECEMBER 1984



Source: Law et al., 1986, RHO-RE-SR-85-24P

Rockwell International
Rockwell Hanford Operations

COMPARISON OF POTENTIOMETRIC SURFACE OF THE RATTLESNAKE RIDGE CONFINED AQUIFER WITH THE WATER TABLE OF THE UNCONFINED AQUIFER

DECEMBER 1984

—400— POTENTIOMETRIC SURFACE OF THE RATTLESNAKE RIDGE IN FEET ABOVE MEAN SEA LEVEL (ft MSL)

---420--- WATER-TABLE CONTOURS IN FEET ABOVE MEAN SEA LEVEL (ft MSL)

AREAS OF COMPLETE EROSION OF THE ELEPHANT MOUNTAIN BASALT (from RHO-RE-ST-12)

AREAS OF DOWNWARD HYDRAULIC GRADIENT

CONFINED WELLS USED IN PREPARATION OF MAP

POND

BASALT OUTCROPS ABOVE WATER TABLE, AS INFERRED 6-1984

THE RATTLESNAKE RIDGE AQUIFER WHICH IS CONFINED BY THE ELEPHANT MOUNTAIN BASALT IS MONITORED MONTHLY IN THE EASTERN PORTION OF THE SEPARATIONS AREA. THE DECEMBER, 1984, WATER-LEVEL MEASUREMENTS IN 13 WELLS COMPLETED IN THE RATTLESNAKE RIDGE INTERBED WERE USED TO CONTOUR THE POTENTIOMETRIC SURFACE OF THE AQUIFER. AREAL EXTENT OF DOWNWARD HYDRAULIC GRADIENT FROM THE UNCONFINED AQUIFER TO THIS CONFINED AQUIFER IS INFERRED FROM THE WATER-TABLE MAP AND THE CONTOURS OF THE POTENTIOMETRIC SURFACE OF THE RATTLESNAKE RIDGE. THIS AREA REPRESENTS THE ZONE IN WHICH DOWNWARD FLOW MIGHT OCCUR IF A PATHWAY IS AVAILABLE, SUCH AS ABSENCE OF THE ELEPHANT MOUNTAIN BASALT DUE TO EROSION. SINCE DECEMBER 1983 THE ZONE OF THE DOWNWARD HYDRAULIC GRADIENT HAS EXPANDED INTO THE EASTERN PORTION OF 200 EAST AREA DUE TO EXPANSION OF THE WATER-TABLE MOUND BENEATH THE B POND SYSTEM.

THE POTENTIOMETRIC SURFACE OF THE RATTLESNAKE RIDGE CONFINED AQUIFER MAP IS PREPARED BY THE HYDROGEOLOGY UNIT OF THE RESEARCH AND ENGINEERING FUNCTION OF ROCKWELL HANFORD OPERATIONS. DATA IS COLLECTED BY THE ENVIRONMENTAL EVALUATIONS SECTION OF PACIFIC NORTHWEST LABORATORY.

NOTE:
TO CONVERT TO METRIC, MULTIPLY ELEVATION (ft) BY 0.3048 TO OBTAIN ELEVATION (m).

SCALE
0 — 1 MILE
0 — 1 KILOMETERS
N

FIGURE 3-50
COMPARISON OF POTENTIOMETRIC SURFACE OF THE RATTLESNAKE RIDGE CONFINED AQUIFER WITH THE WATER TABLE OF THE UNCONFINED AQUIFER

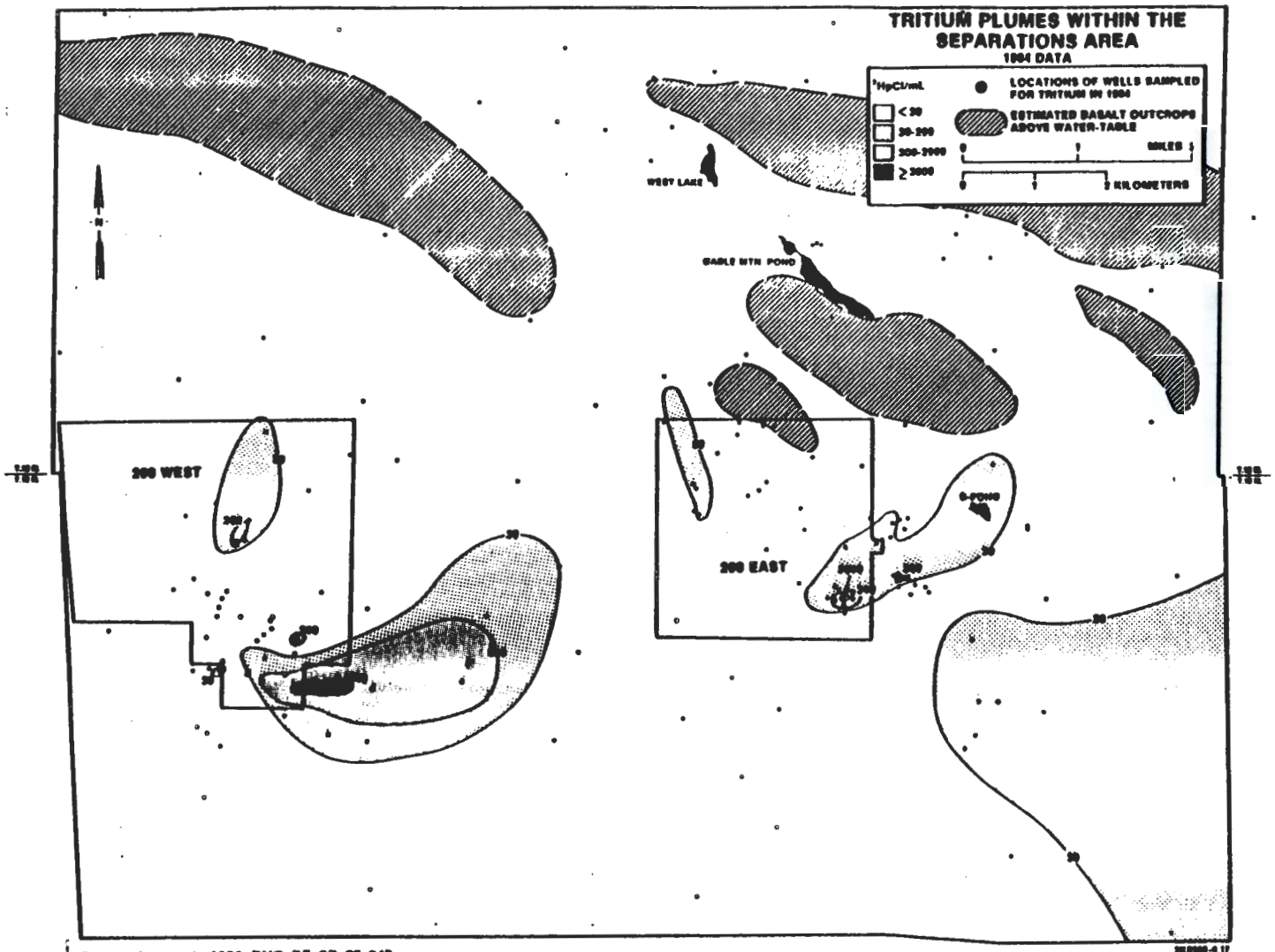
necessarily more general than the 100-Areas discussions. Individual wells, contaminants in these wells, and specific sources are not discussed.

Prior to discussing the major contaminant plumes in the 200-Area, it should be noted that the 200-Area is the source of a major contaminant plume that exists to the east of the 200-Area (in the 600-Area). This plume (for tritium alone) covers some 60 square miles at a concentration level of 20,000 picocuries per liter. The plume is substantially larger if the impacted area alone is considered.

Tritium. Figure 3-51 depicts the tritium concentrations (plumes) in the unconfined aquifer in 1984. There are five major plumes shown in this figure; two are in the 200-West Area, two are in the 200-East Area and one exists southeast of the 200-East Area. It should be noted that the 30 picocuries-per-liter contour shown on this figure is actually equivalent to 30,000 picocuries per liter, which is above the NPDWR of 20,000 picocuries per liter. The two northernmost plumes are progressing toward the north while the plumes originating in the southern portions of each area are progressing to the east and northeast. The plume in the southeast corner of the figure is a remnant of past operations in the 200-Area and it progresses southeastward as shown in Figure 3-52.

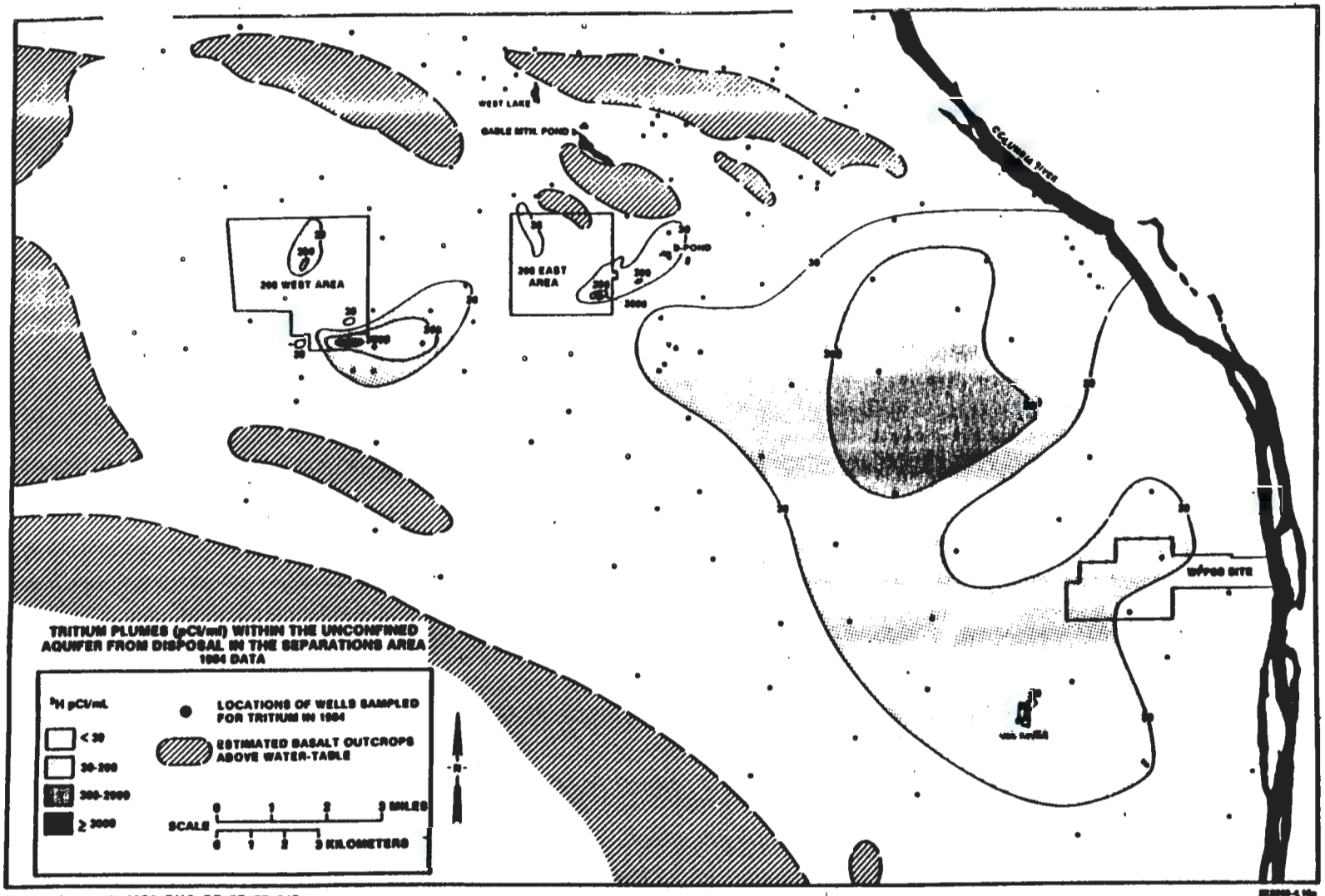
According to site documentation (Law et al., 1986), the current tritium plumes originate from six predominant sources in the 200-Areas. These sources include two inactive cribs, 216-S and 216-U, and four active cribs, 216A, 216-B-55, 216-B-62, and 216-U-12.

Also of note on Figure 3-43 is that the plumes range in length from 1 mile to over 3 miles (in the case of the southern 200-West plume). Tritium concentrations in groundwater near the source exceed 3,000,000 picocuries per liter in two cases. The concentration of tritium $\geq$3,000,000 picocuries per liter in the southern 200-West plume is 1/2 mile in length. The major tritium plume shown in Figure 3-44 is discussed in the 600-Area section.



Source: Law et al., 1986, RHO-RE-SR-85-24P

FIGURE 3-51
TRITIUM PLUME MAP (UNCONFINED AQUIFER) FOR THE SEPARATIONS AREA



Source: Law et al., 1986, RHO-RE-SR-85-24P

FIGURE 3 - 52
TRITIUM PLUME MAP
(UNCONFINED AQUIFER)
FOR THE AFFECTED AREA, 1984

Nitrate. Figure 3-53 depicts the nitrate concentrations (plumes) in the unconfined aquifer in 1984. Note that the plumes trend and progress in a manner similar to the tritium plumes shown in Figure 3-51, although the sources may not necessarily be coincident. The tritium plume appears to be less massive than the nitrate plume due to the contour interval used in the tritium contour plot.

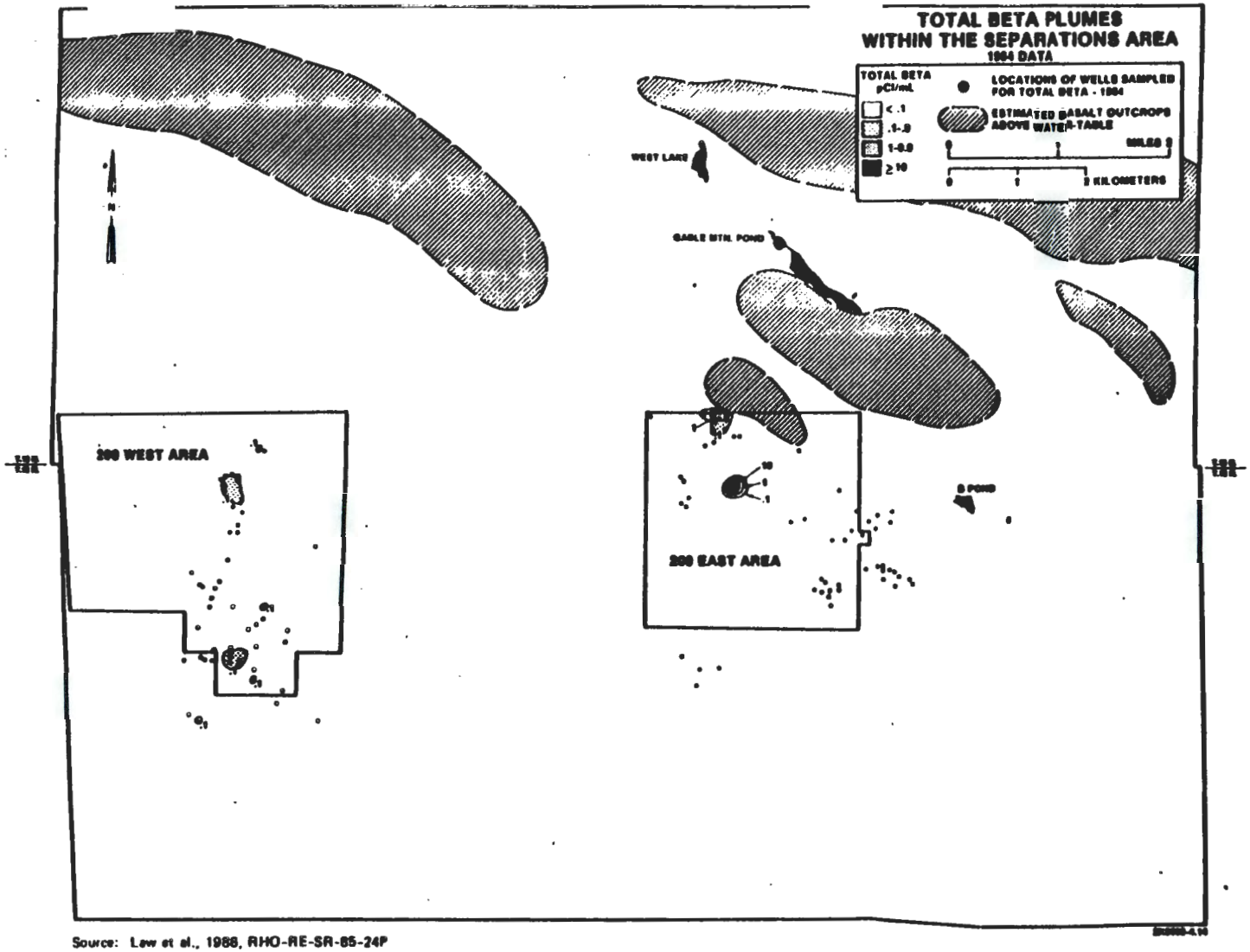
Figure 3-54 indicates how massive the 200-Area impact is on groundwater. The area of impact, if taken as a nitrate concentration $\geq$5 milligrams per liter, is on the order of 150 square miles. The greatest concentrations of nitrate in groundwater occur near the 216A, 216-B-62, and 216-BY Cribs in the 200-East Area, and the 216T, 216-Z, and 216-W-LVC Cribs in the 200-West Area.

Gross Beta. Gross beta concentrations greater then 100 picocuries per liter are shown on Figure 3-55. There are six locations identified in the 200-West Area and two in the 200-East Area. The areas identified in the 200-East Area include: the 241-BX Tank Farm and 216-BY cribs, and the 216-B-5 Reverse Well site. The areas identified in the 200-West Area include the 216-S, 216-T, 216-U, and 216-Z-20 cribs. Of further note is that the contour interval begins at 100 picocuries per liter which is above the 50 picocuries-per-liter site screening level for gross beta.

Other Contaminants. It is apparent that (with the magnitude of the contaminant plumes on-site) other contaminants are also present in the plumes originating in the 200-Areas. This is borne out by a number of factors which are listed below.

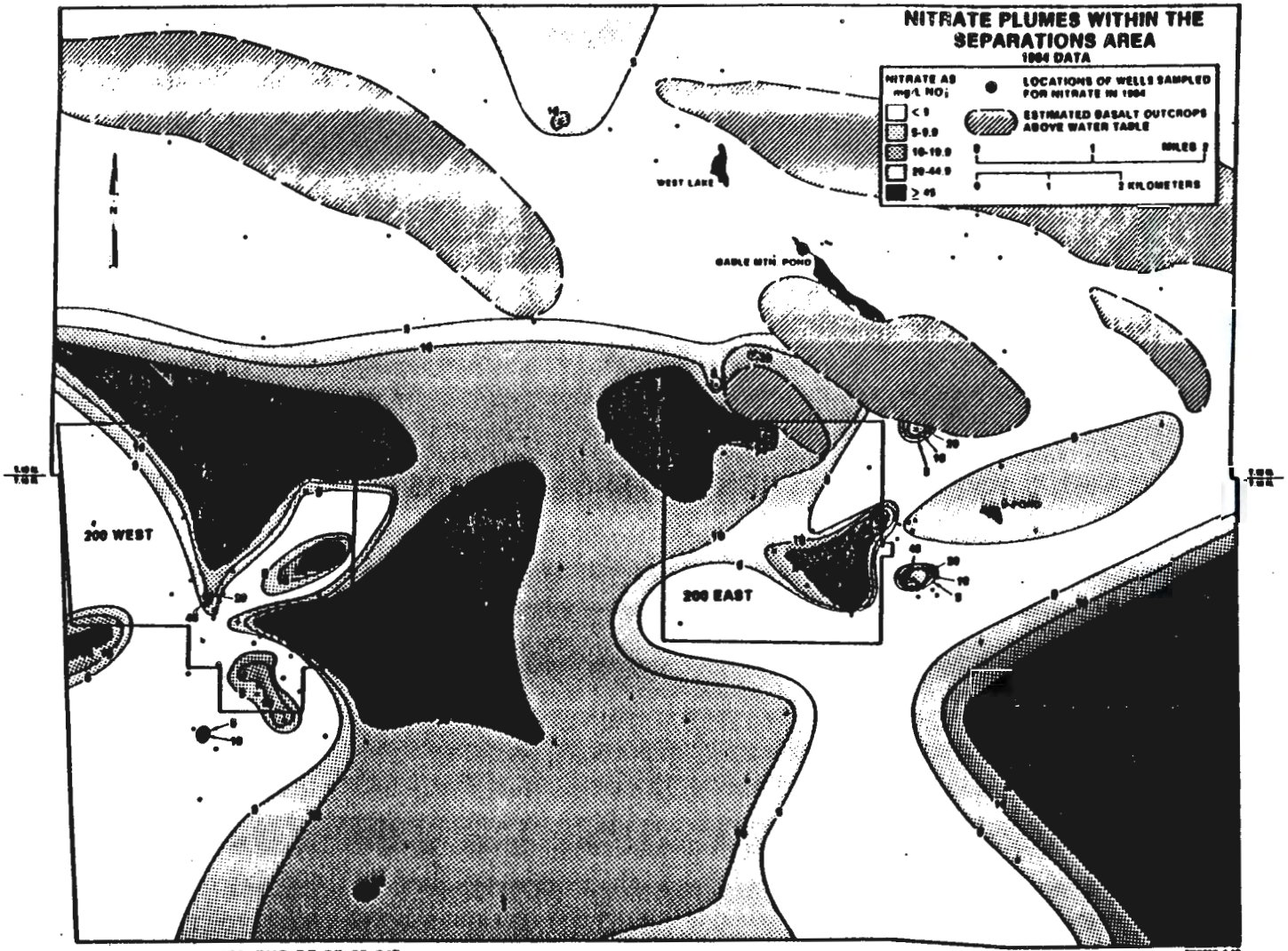
1. Site interviews during the Survey indicate that wells in certain portions of the 200-Area have had odors of organic vapors and/or kerosene. Carbon tetrachloride, hexone, and TBP-kerosene are all used in the 200-Area.

2. An RHO internal memo indicates that iodine-129 is a substantial contaminant in the major plume in the 600-Area. In fact, the iodine-129 levels exceed the NPDWR standards up to 10 kilometers southeast of the 200-Area along the major plume axis.



Source: Law et al., 1988, RHO-RE-SR-85-24P

FIGURE 3 - 53
TOTAL BETA PLUME MAP
(UNCONFINED AQUIFER)
FOR THE SEPARATIONS AREA, 1984



Source: Law et al., 1986, RHO-RE-SR-85-24P

FIGURE 3 - 54
NITRATE PLUME MAP
(UNCONFINED AQUIFER)
FOR THE SEPARATIONS AREA, 1984

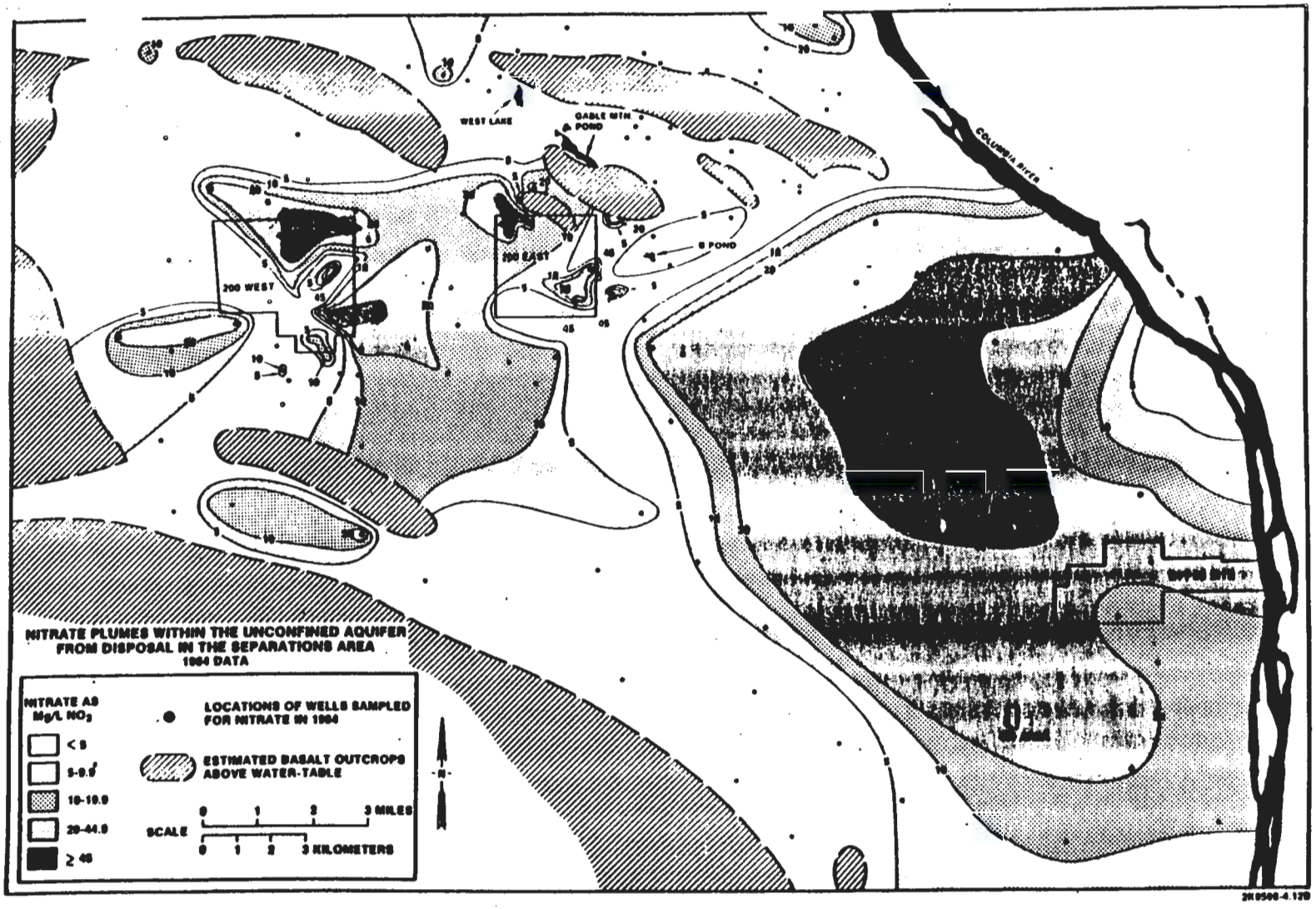


FIGURE 3 - 55
NITRATE PLUME MAP
(UNCONFINED AQUIFER)
FOR THE AFFECTED AREA, 19

3. Sampling results from wells in the 600-Area (adjacent to the 200-Areas) show that other nonradiologic contaminants exist. For example, Well 699-37-43 is located southeast of the 200-East Area. This well is in the major plume created by the historic 200-Area operations. It also has an average groundwater tritium concentration in excess of 30,000 picocuries per liter. The groundwater sample obtained in 1985 as part of the SWHW program exhibited exceedances of the NPDWR for barium, cadmium, chromium, and radium.

4. A study performed by PNL and RHO selected wells near the 200-Area for TOC and TOX analyses. Three of the wells with the highest TOC values (12.0, 10.9, and 10.1 milligrams per liter) were subsequently sampled and the groundwater analyzed for a number of chemicals. Table 3-33 is presented here (reproduced from the report). Of particular note is the number of volatile organics and solvent extractables that occurred.

   Well 699-38-70 is also of interest. The groundwater in this well has had historic tritium concentrations of up to 1,000,000 picocuries per liter. The nitrate level (273.0 milligrams per liter) on Table 3-32 is currently far in excess of the NPDWR. The gross beta was 276 picocuries per liter in August 1986. This well has obviously been influenced by the 200-Area and has a substantial number of detected volatile organic chemicals.

300-Area

Thirty-four wells have been used for groundwater sample collection in the 300-Area; of these, 28 are part of the GWMP. Fifteen wells are utilized for RCRA monitoring of the process trenches. A total of 32 wells are still in place according to site documents. Figure 3-56 shows the well locations. Well 399-5-2 monitors the confined aquifer. All other wells monitor the unconfined aquifer.

Table 3-33

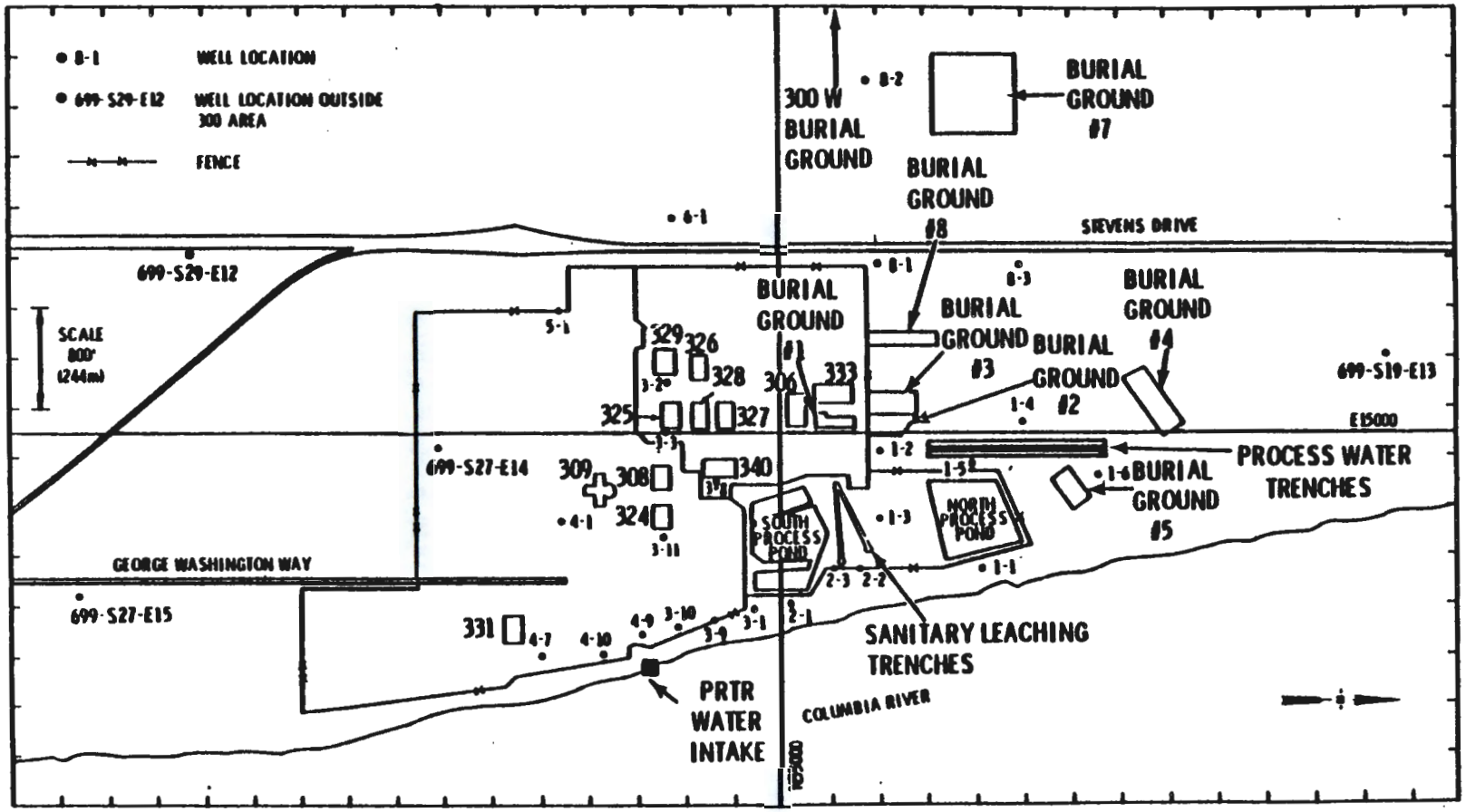
Constituents	699-35-78	699-38-70	699-49-79
Field Parameters			
pH	8.20	8.15	8.19
Spec. Cond. (μmhos/cm)	196	781	345
Anions/Cations			
F^- (mg/ℓ)	0.3	0.4	0.2
Cl^- (mg/ℓ)	2.3	30.0	11.0
NO_3^- (mg/ℓ)	1.1	273.0	41.0
SO_4^{--} (mg/ℓ)	11.4	39.0	48.0
Na^+ (mg/ℓ)	13.0	18.0	8.8
NH_4^+ (mg/ℓ)	—	—	—
Carbon Content			
Inorganic Carbon (mg/ℓ)	19.9	28.1	23.7
Total Organic Carbon (mg/ℓ)	3.4	3.8	1.0
Total Carbon (mg/ℓ)	23.3	31.9	24.0
Metals			
Cd (μg/ℓ)	10	10	10
Cr (μg/ℓ)	5	5	5
Pb (μg/ℓ)	20	20	20
Ag (μg/ℓ)	10	10	10
Hg (μg/ℓ)	0.14	0.08	0.19
Ba (μg/ℓ)	18	82	26
Ca (μg/ℓ)	17,600	88,700	41,500
K (μg/ℓ)	2,700	6,600	3,700
Mg (μg/ℓ)	5,200	30,900	13,000
Na (μg/ℓ)	16,200	20,700	8,700
S (μg/ℓ)	3,500	13,600	15,400
Si (μg/ℓ)	17,300	24,800	21,100
Sr (μg/ℓ)	76	500	179

Constituents	699-35-78	699-38-70	699-49-79
Volatile Organics			
Carbon Tetrachloride (μg/ℓ)		5.95	
Chloroform (μg/ℓ)	0.33	13.56	81.90
Dichloromethane (μg/ℓ)	1.15	2.94	0.29
Trichloroethene (TCE) (μg/ℓ)		0.90	
Cyclohexane (μg/ℓ)		0.71	
Methycyclohexane (MCH) (μg/ℓ)		12.19	20.48
Toluene (μg/ℓ)		9.51	
2-Butoxy-Ethanol (μg/ℓ)		11.33	
2-Ethyl-1-Hexanol (μg/ℓ)		2.56	
Solvent Extractables			
Tri-n-butylphosphate (TBP) (μg/ℓ)		3	
Di-n-octyladipate (μg/ℓ)	590		
Bis(2-Ethylhexyl) phthalate (μg/ℓ)		2	2
Di-n-octylphthalate (DOP) (μg/ℓ)	8		
Phthalates (μg/ℓ)	140		10
Chelating Agent			
Ethylenediaminetetra-acetic (EDTA) Acid (μg/ℓ)	0.1	0.1	

(a) No entry indicates compound is below detection level.

From: Cline et al., 1985 - PNL-5408

CHEMICAL ANALYSIS OF GROUNDWATER SAMPLES FROM THREE SELECTED WELLS [a]



Source: Lindberg and Bond 1979

LOCATIONS OF 300-AREA WELLS

FIGURE 3 - 56

The 300-Area has been monitored for the most extensive number of parameters at the Hanford Site. There are, generally, at least a few data sets for both the major radionuclides and on the order of 15 nonradiologic parameters. The RCRA sampling has provided a full year's worth of RCRA groundwater monitoring parameters for 15 wells.

Groundwater in the 300-Area has been impacted by the intentional discharge of wastewater to the ground via trenches and ponds and onto the ground surface. Leaking pipes have also been documented to have caused groundwater contamination, as have spills. Groundwater mounds have been created as a result of these discharges.

Two major documents regarding groundwater quality at the 300-Area (Lindberg and Bond, 1979; Elderkin, 1986) have indicated the presence of a number of contaminants. Elderkin (1986) has indicated "...the presence of metals, volatile organic chemicals, anions, radionuclides and coliform bacteria" in the groundwater. During the 1985 sampling (RCRA), gross alpha exceeded the NPDWR standard as did some of the metals although none consistently exceeded the NPDWRs. The metals detected most frequently included barium, sodium, potassium, copper, and iron. The volatile organics detected were chloroform (20 parts per billion) and perchloroethylene (15 parts per billion). Perchloroethylene (PCE) has been accidentally discharged to a process trench on two occasions. In November 1982, 120 gallons of PCE was discharged and in July 1984, 12 to 20 gallons was discharged to the trench. The highest PCE concentration measured in a well 100 feet from the trench was 1840 parts per billion 6 days after the 1982 discharge. The maximum PCE concentration was 691 parts per billion in this same well after the 1984 discharge.

Historically, contaminants in the 300-Area have exceeded the NPDWR in some areas. Lindberg amd Bond (1979) developed groundwater iso-concentration contours for the 300-Area for major contaminants. Figures 3-48 through 3-53 are reproduced from that report. These figures exemplify the various impacts that site activities have had on groundwater.

Figure 3-57 shows the groundwater temperatures and hence the major locations of inflow of process wastewater to the aquifer. Figures 3-58, 3-59, 3-60, and 3-61 show iso-concentration contours for fluoride, nitrate, gross beta, and gross alpha. Note that the sources for these constituents appear to vary across the site. It is also worthwhile to note that all these contaminants exceed the NPDWR in at least one area.

Figure 3-62 exhibits groundwater iso-concentration contours for uranium. Compare this to Figure 3-63 which depicts analytical results for uranium from spring and river samples. As can be seen in this comparison (and confirmed by the groundwater flow regime), the 300-Area contaminants in groundwater (in the unconfined aquifer) discharge to the Columbia River.

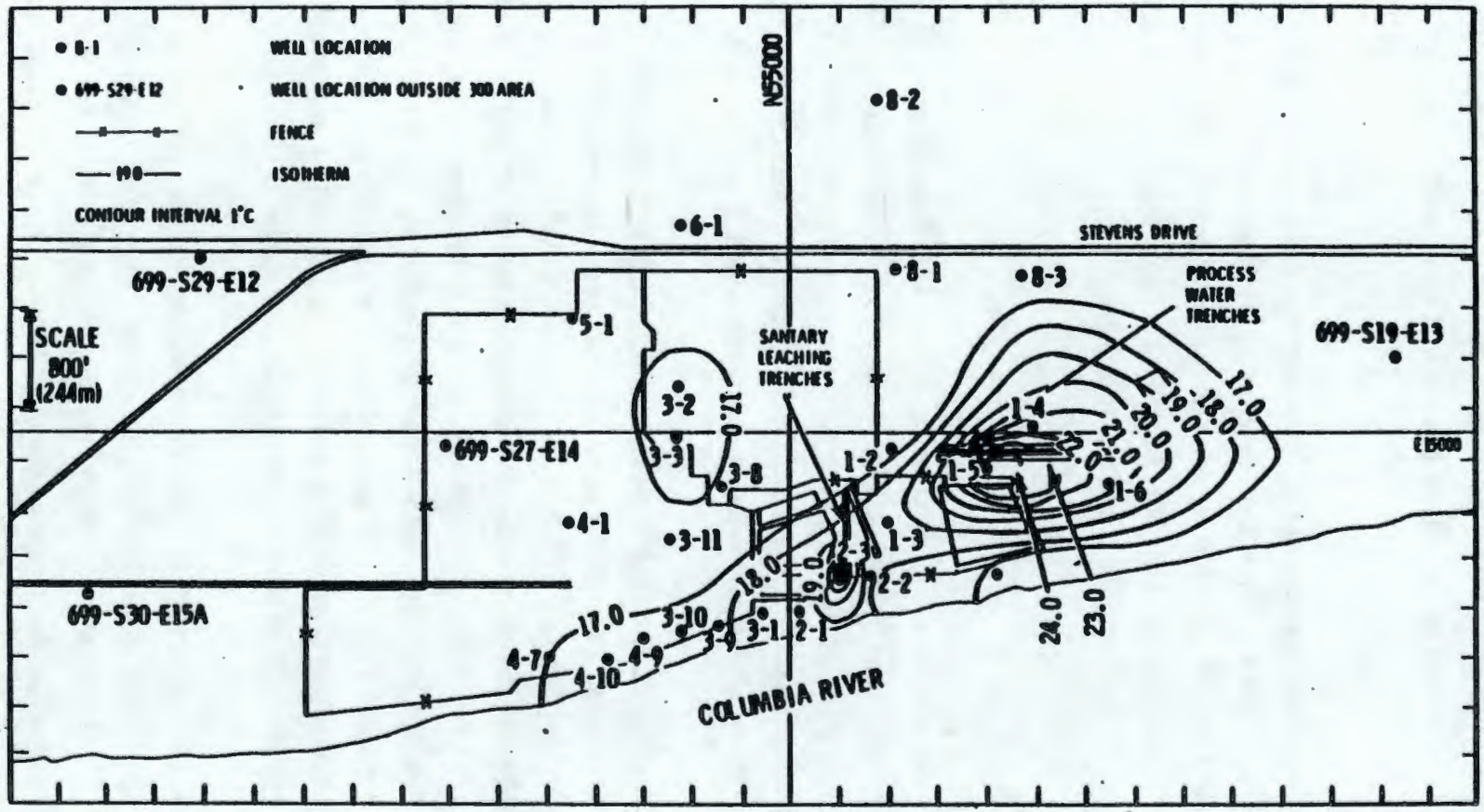
9 2 1 2 1 1 6 3 3

400-Area

A total of 6 wells are used for monitoring at the 400-Area as part of the GWMP. Three of these wells are water supply wells. The HEHF monitors two of these because they are part of the drinking water supply for the 400-Area. Tritium, nitrate, and gamma scans are the analytical parameters monitored in the six wells in the GWMP. Three of the six wells are also monitored for gross beta.

The HEHF monitors for the major metals (inorganics) and secondary chemical and physical contaminants. In 1985, none of the samples collected exceeded the appropriate standard for the HEHF monitored parameters. However, the drinking water wells have consistently exceeded a concentration of 20,000 picocuries per liter for tritium (NPDWR). Historically, all six monitored wells have exceeded 20,000 picocuries per liter for tritium and 50 picocuries per liter for gross beta. Additionally, the maximum tritium concentration in groundwater has been observed at 100,000 picocuries per liter in Well 499-S1-8A in 1985. The maximum gross beta concentration observed in groundwater was 120 picocuries per liter.

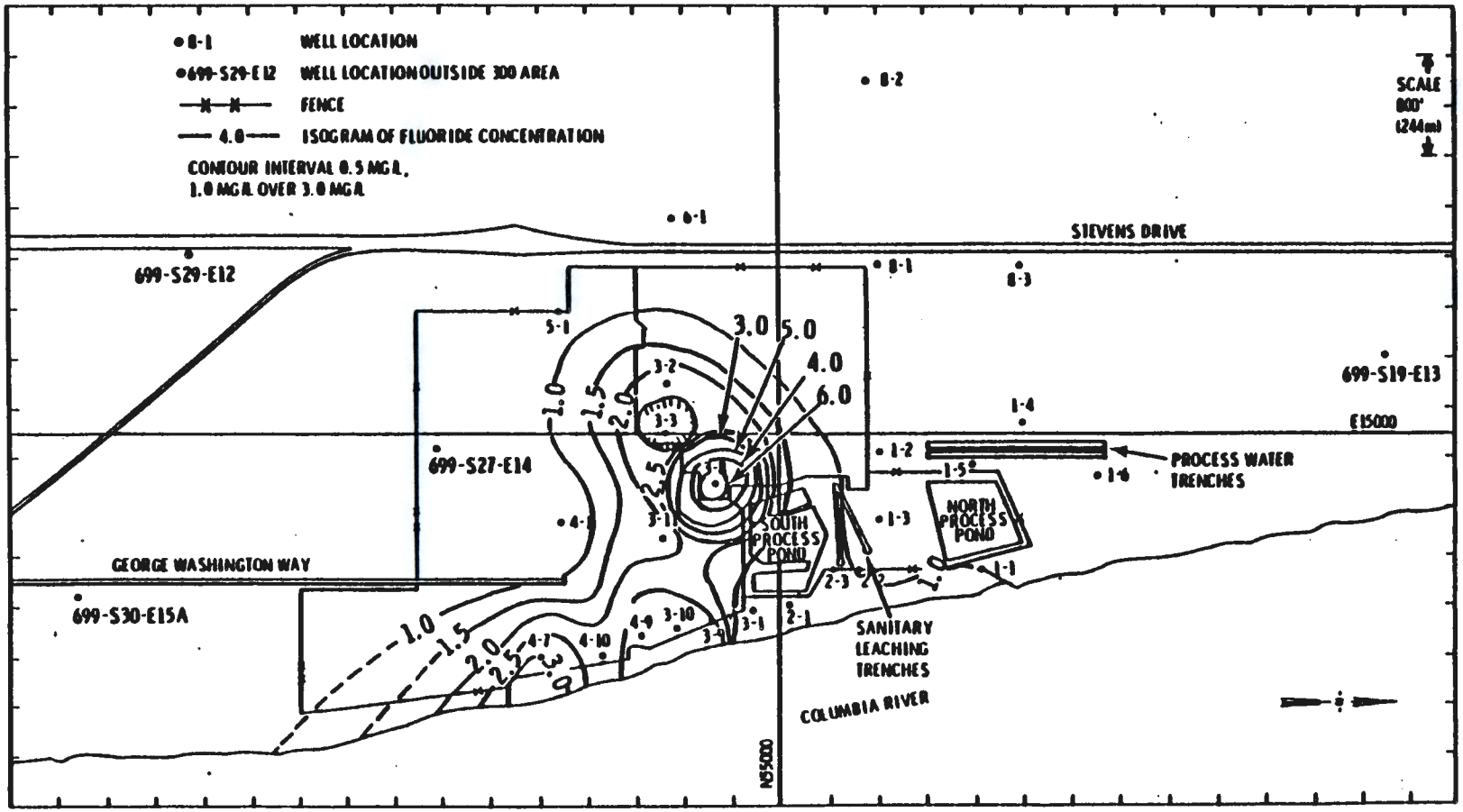
The contaminants occurring in the groundwater at the 400-Area have been attributed to the major groundwater plume that originated in the 200-Area. In 1986 the use of the groundwater from the unconfined aquifer for drinking water purposes ceased due to the contamination. A well in the confined aquifer now supplies drinking water to the 400-Area.



Source: Lindberg and Bond 1979

TEMPERATURES IN THE UNCONFINED AQUIFER UNDER THE 300-AREA, AUGUST 4, 1977

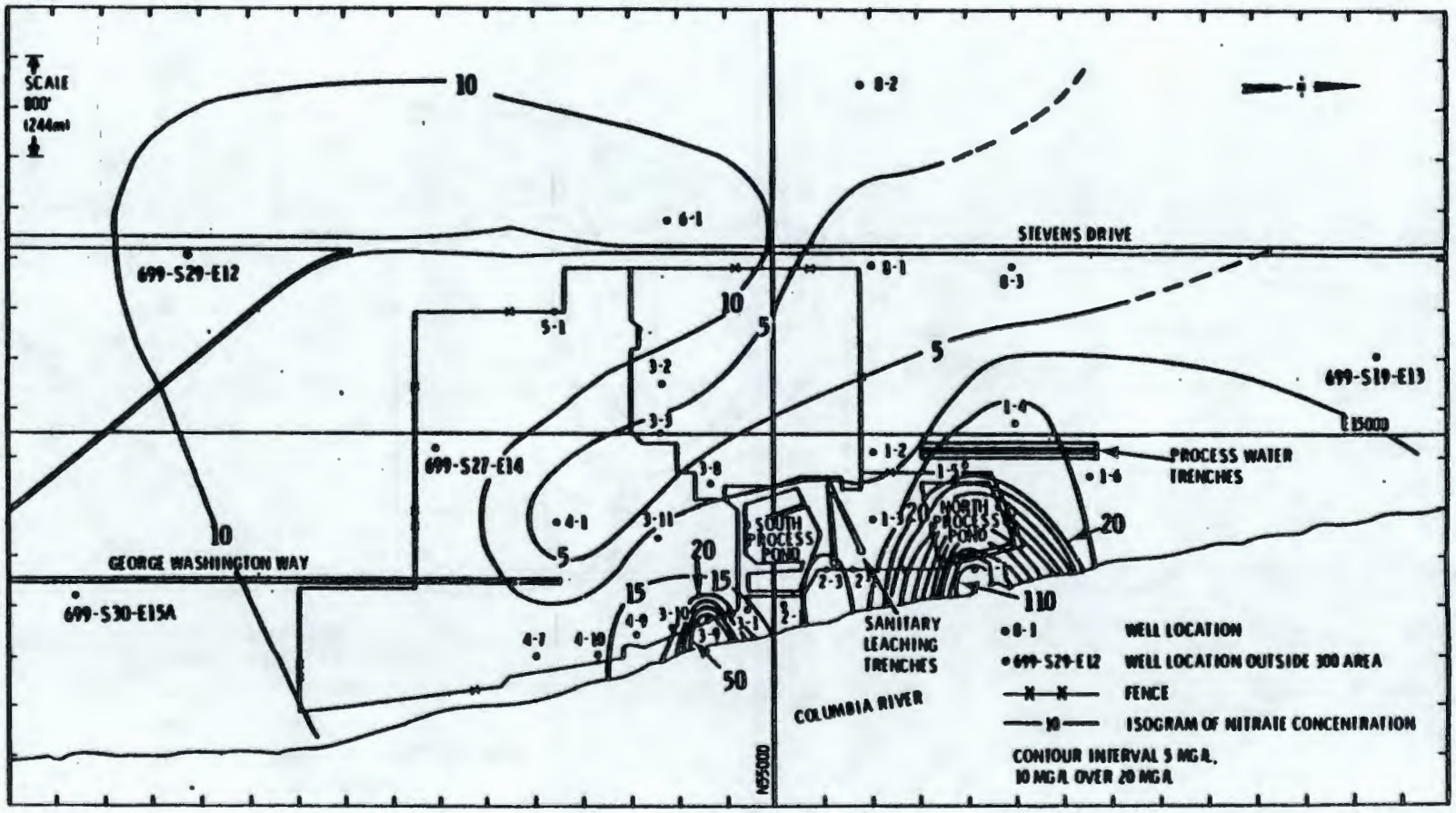
FIGURE 3 - 57



Source: Lindberg and Bond 1979

FLUORIDE CONCENTRATION IN THE UNCONFINED AQUIFER UNDER THE 300-AREA IN FEBRUARY 1977 (BACKGROUND CONCENTRATION LESS THAN 0.1 MG/1)

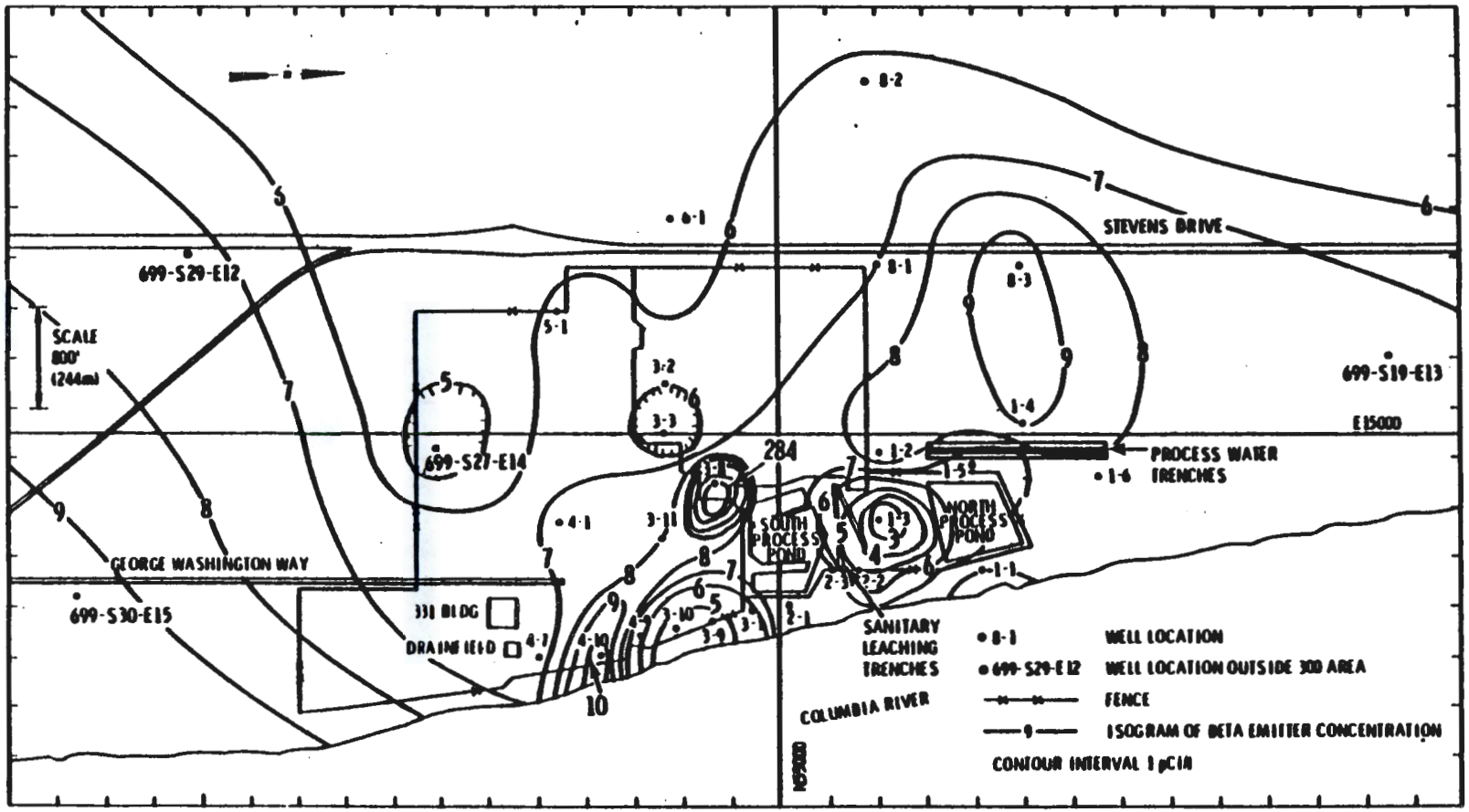
FIGURE 3 - 58



Source: Lindberg and Bond 1979

NITRATE CONCENTRATION IN THE UNCONFINED AQUIFER UNDER THE 300-AREA IN JANUARY 1977 (BACKGROUND CONCENTRATIC^' ^PPROXIMATELY 5.0 TO 10.0 MG/1)

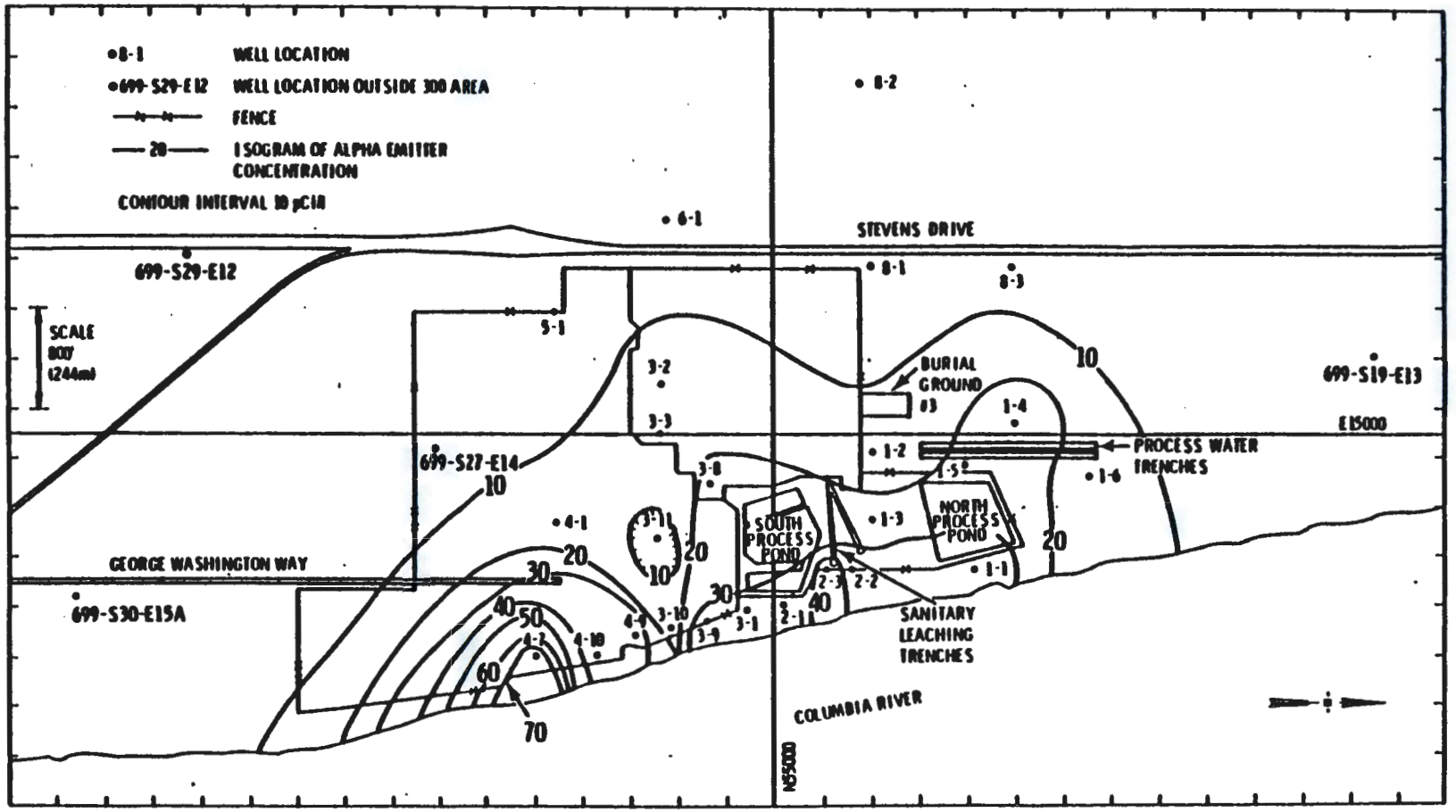
FIGURE 3 - 59



Source: Lindberg and Bond 1979

CONCENTRATION OF BETA EMITTERS IN THE UNCONFINED AQUIFER UNDER THE 300-AREA IN JANUARY 1977 (BACKGROUND CONCENTRATION LESS THAN 6.0 PCI/1)

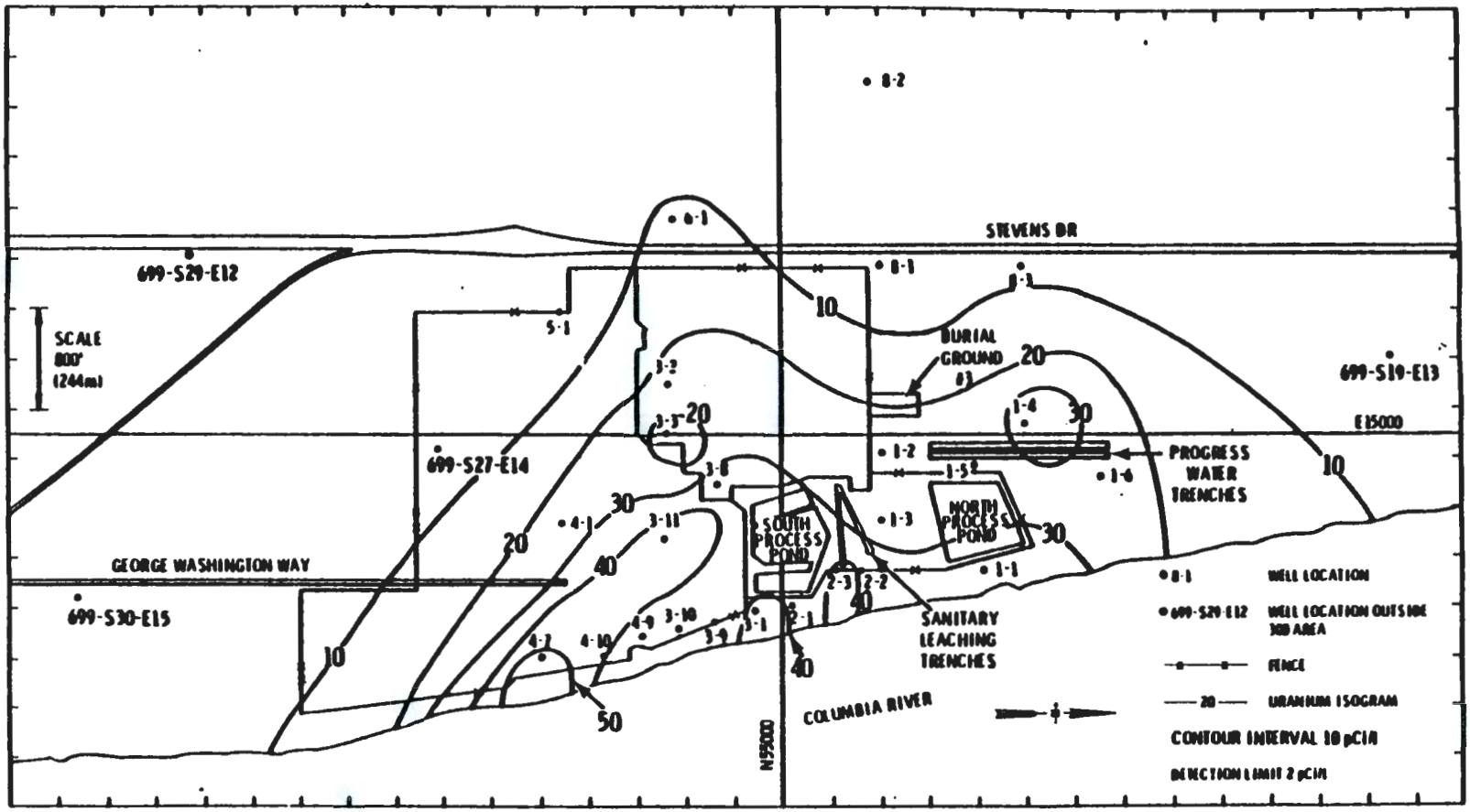
FIGURE 3 - 60



Source: Lindberg and Bond 1979

CONCENTRATION OF ALPHA EMITTERS IN THE UNCONFINED AQUIFER UNDER THE 300-AREA IN JANUARY 1977 (BACKGROUND CONC RATION LESS THAN 0.5 PCI/1)

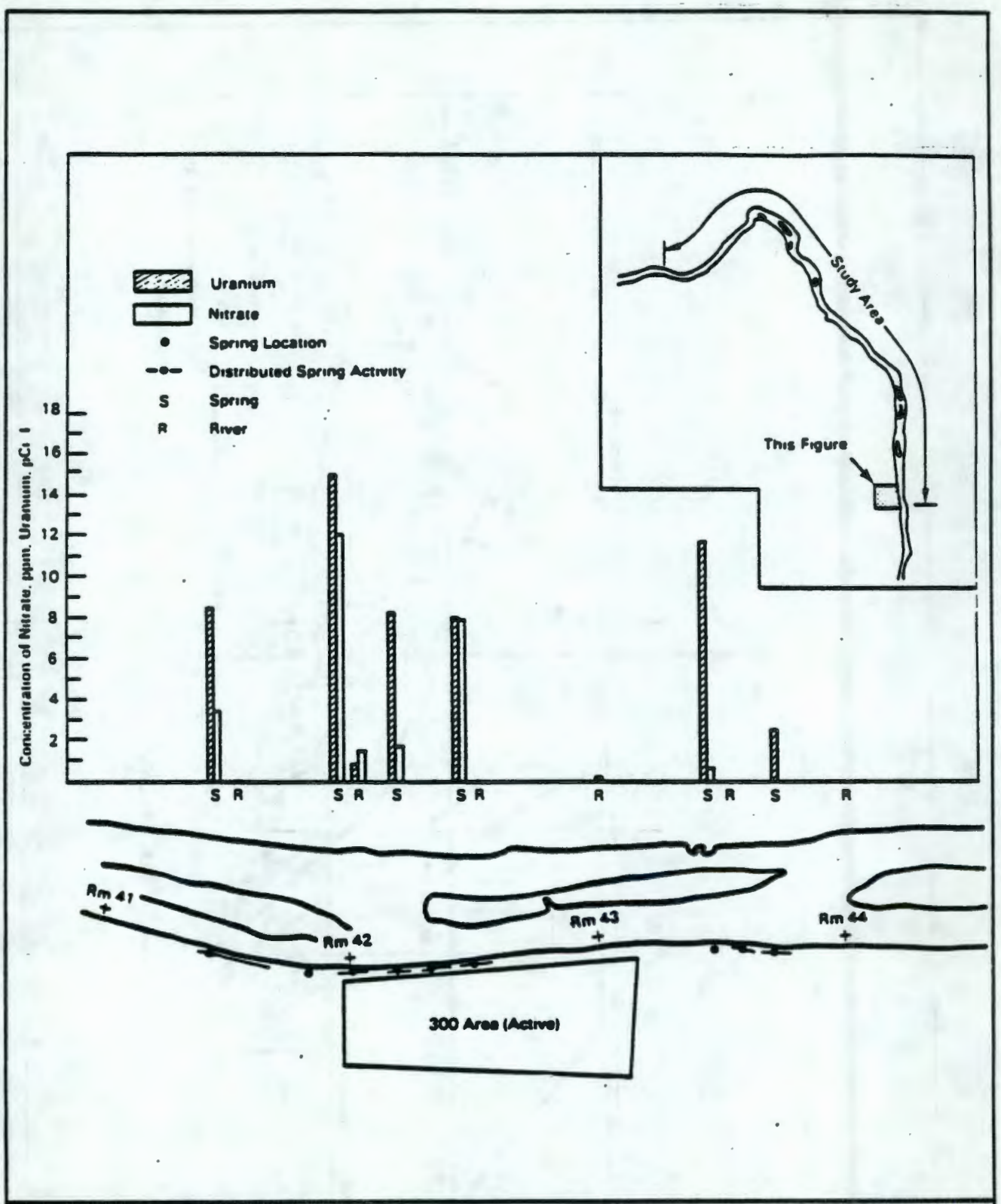
FIGURE 3 - 61



Source: Lindberg and Bond 1979

CONCENTRATION OF URANIUM IN THE UNCONFINED AQUIFER UNDER THE 300-AREA IN JANUARY 1977 (BACKGROUND CONCENTRATION LESS THAN 2.0 PCI/1)

FIGURE 3 - 62



Source: Lindberg and Bond 1979

LOCATIONS AND ANALYTICAL RESULTS FOR SPRING AND RIVER SAMPLES FROM RIVER MILE 41.5 THROUGH RIVER MILE 44

FIGURE 3 - 63

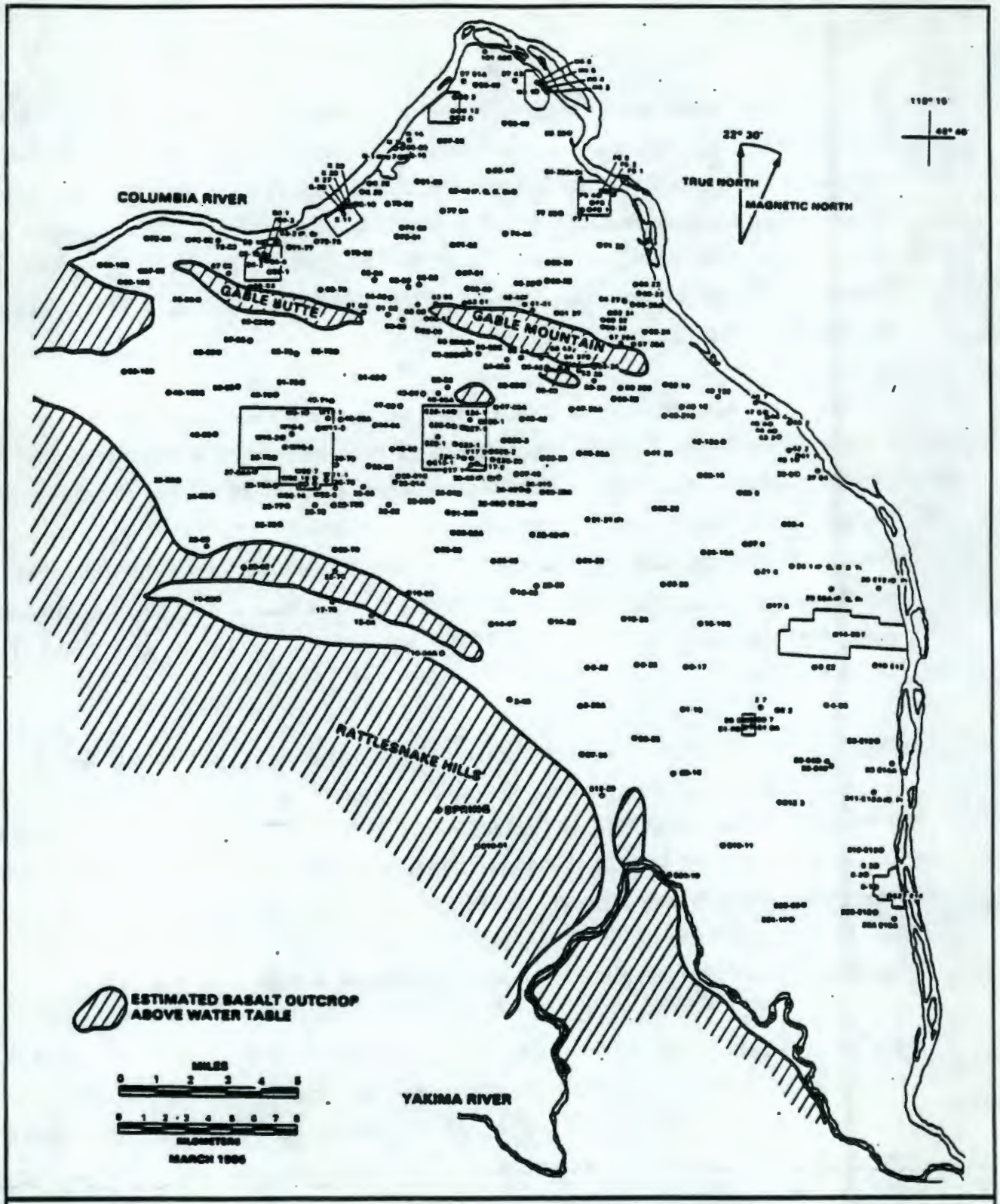
600-Area

A total of 224 wells were sampled in the 600-Area in 1984 as part of the GWMP. The 600-Area encompasses all areas not previously presented in the groundwater section of this report. Of the 224 wells sampled, all but 24 monitor the unconfined aquifer. The 24 wells monitoring the confined aquifer actually include 4 wells that monitor both the confined and unconfined aquifers. Figure 3-64 shows the locations of many of the wells sampled in the 600-Area, although it also shows the locations of wells sampled in other areas.

Monitored parameters in the groundwater of the 600-Area typically include only tritium and nitrate. Gamma scans and gross beta analyses are also performed but at less frequent intervals. Additional analyses as part of special programs may include both nonradiologic inorganics and organics. For example, the U.S. Geological Survey (USGS) analyzed 20 wells in the 600-Area in 1984 for 58 nonradiologic parameters and 7 radiologic parameters. Certain nonradiologic parameters are also a part of the GWMP but are not monitored as frequently as tritium and/or nitrate.

The 600-Area includes a variety of disposal areas that could potentially impact the groundwater. However, these possible impacts are overshadowed by the groundwater impacts created principally by the 200-Areas. The following discussion is limited to both the major impacted areas within the 600-Area and the parameters tritium and nitrate. As in the discussion presented in the 200-Areas, the lack of information on other contaminants is not by virtue of their absence from the groundwater regime but due to the lack of a significant data base.

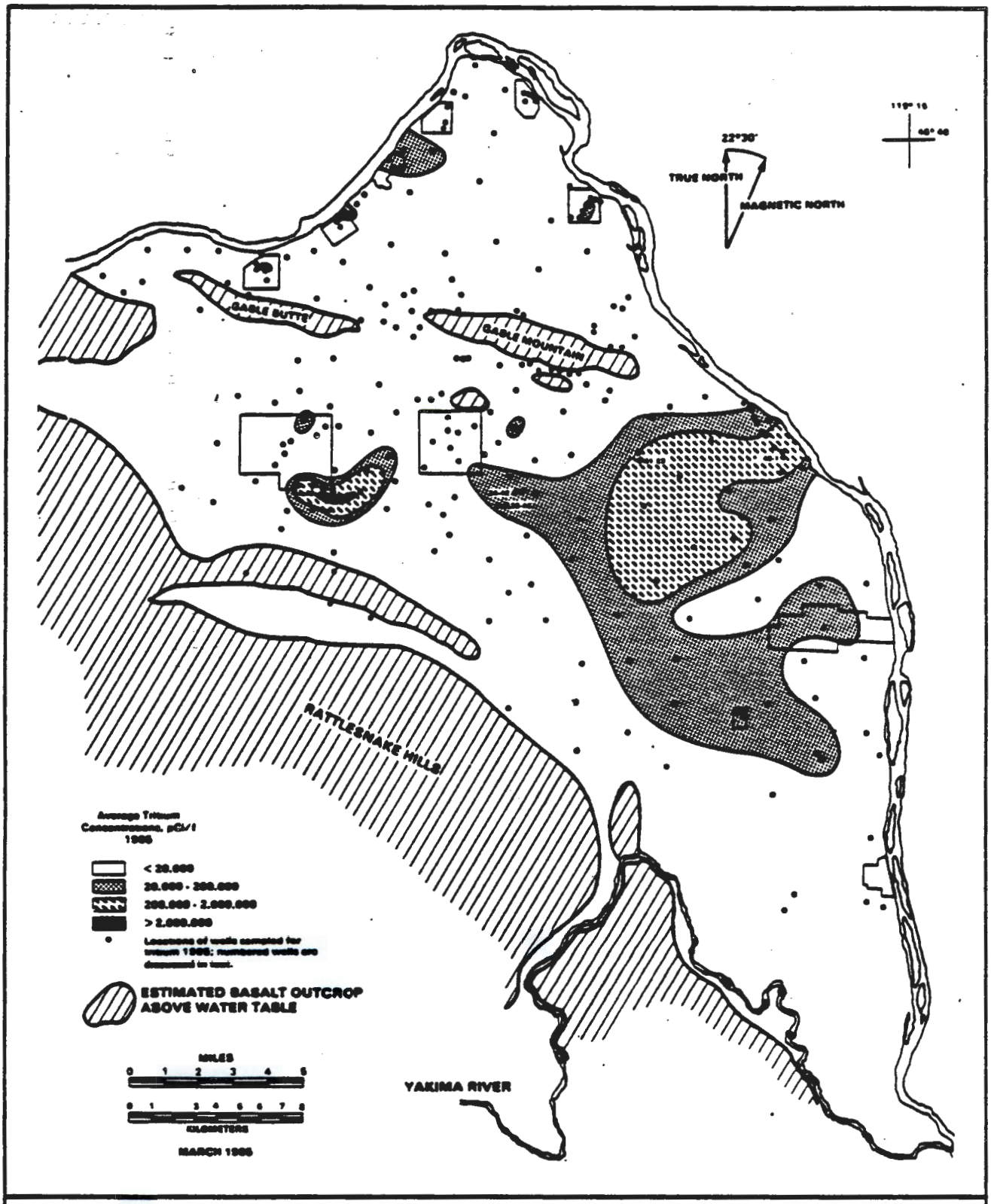
Figure 3-65 depicts the tritium concentrations (plumes) in the unconfined aquifer in 1985 for the entire site. The shaded areas in this figure represent the areas where the tritium concentration exceeded 20,000 picocuries per liter (the NPDWR standard). The largest plume (southeast of the 200E-Area) covers approximately 60 square miles. The major plume is progressing east and southeast and eventually discharging into the Columbia River. The discharge is depicted in Figure 3-66 where spring and river samples show elevated tritium and nitrate concentrations.



Source: Price 1986

LOCATIONS OF SAMPLED WELLS

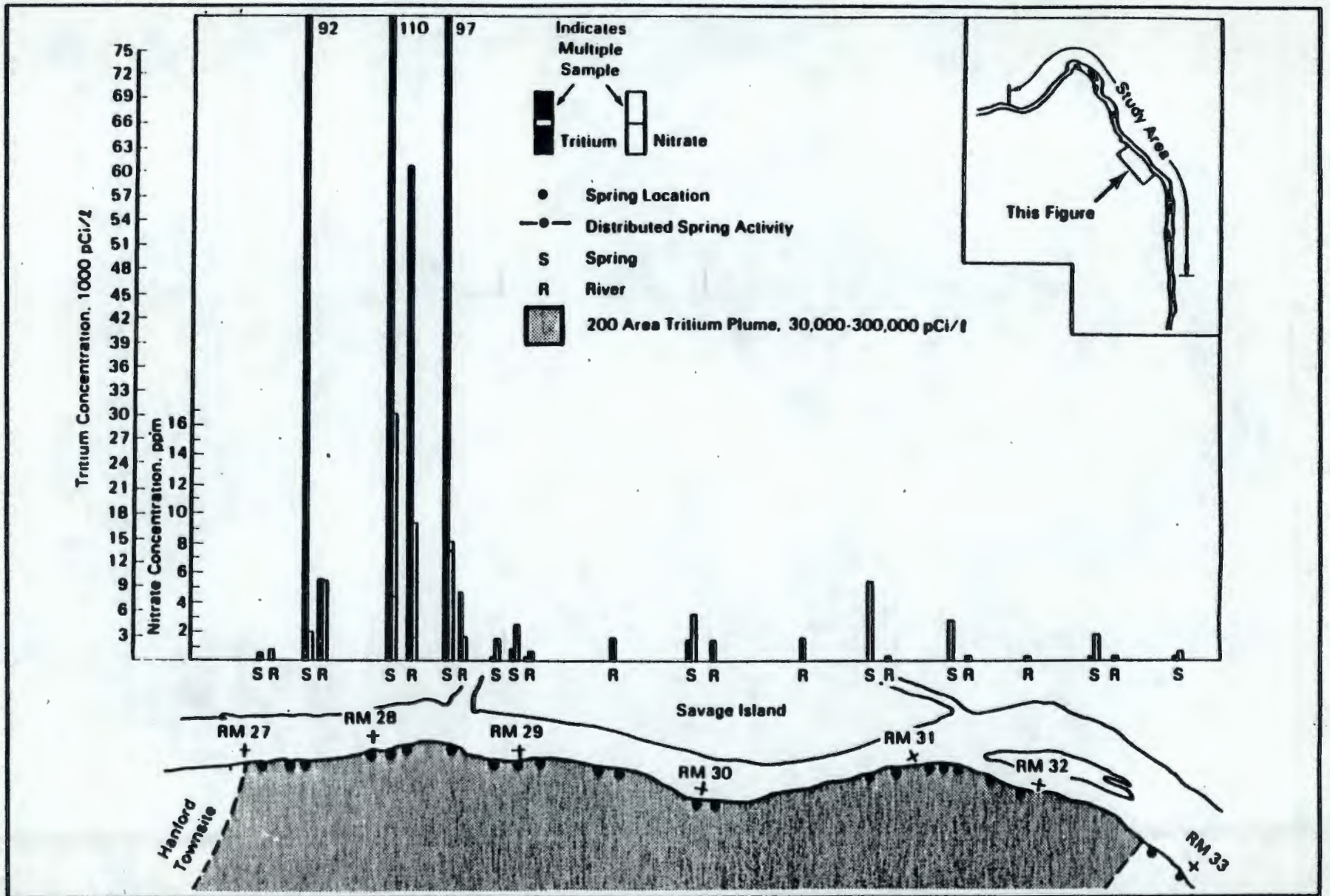
FIGURE 3 - 64



Source: Price 1986.

TRITIUM PLUME FOR 1985

FIGURE 3 - 65



Source: McCormack and Carlile 1984

LOCATIONS AND ANALYTICAL RESULTS FOR SPRING AND RIVER SAMPLES FROM RIVER MILE 27 THROUGH RIVER MILE 33

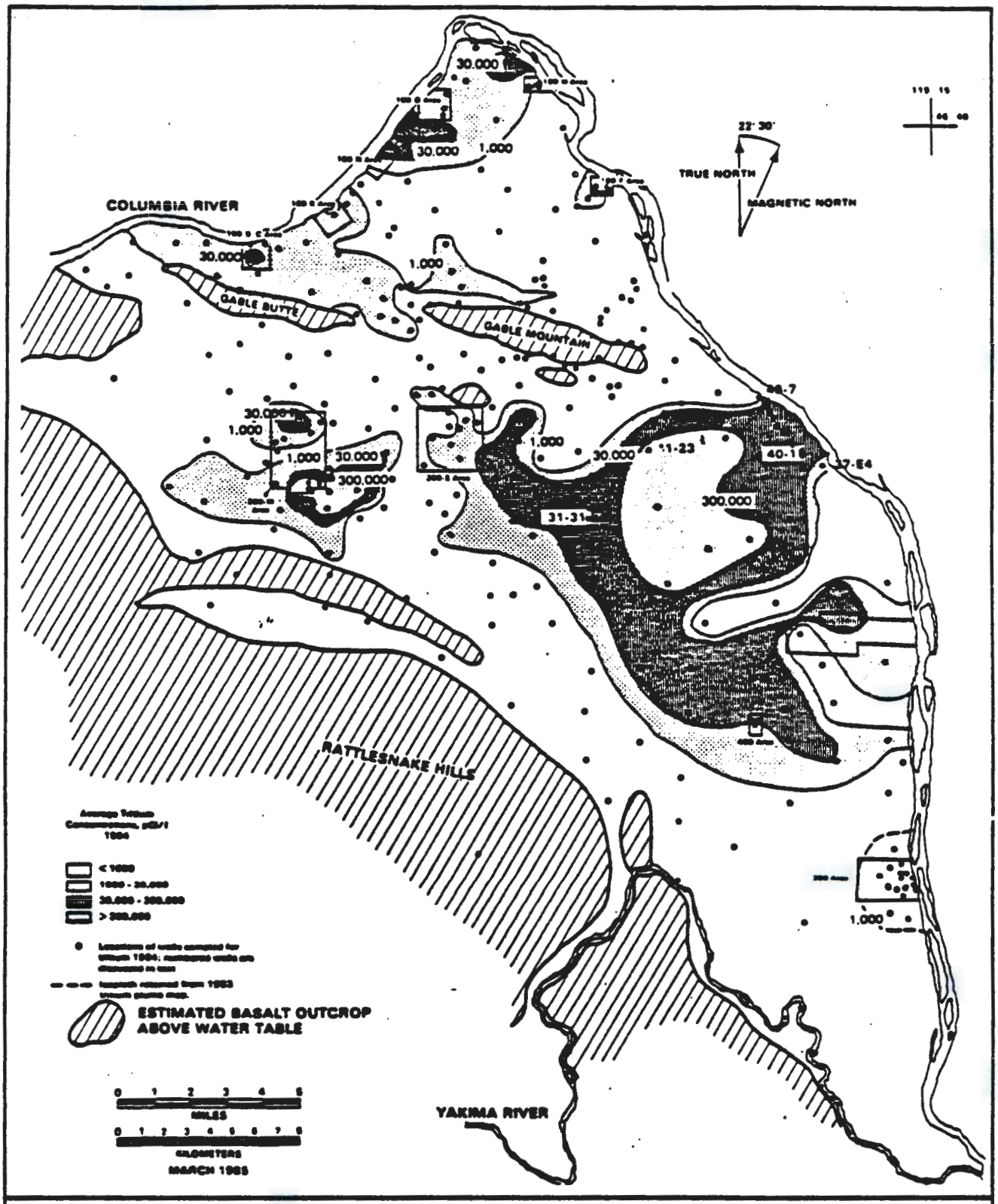
FIGURE 3 - 66

Somewhat more detailed iso-concentration contour maps of tritium can be seen in Figures 3-66 and 3-67. The actual extent of tritium in the unconfined aquifer is basically unchanged between the 1983-1984 time frame and 1985. The difference is that the 1000 picocuries per liter iso-concentration contour is included in Figures 3-67 and 3-68. The result of this contouring is a better definition of the impacted area of the aquifer. The impacts of each of the major areas on groundwater are readily apparent. Note that plumes originate and/or occur in all the 100-Areas, the 200-Areas, and the 300-Area.

Figures 3-69 and 3-70 depict the nitrate iso-concentration contours in the unconfined groundwater for 1983 and 1984. The trends of the nitrate plumes are consistent with those of the tritium plumes. Of significance is the increased areal extent of the 45 milligram-per-liter concentration between 1983 and 1984. Much of the nitrate in the aquifer can be attributed to site activities, however, some of the nitrate may be associated with past or present agricultural activities. According to Cline et al. (1985), other radionuclides such as strontium-90, iodine-129, cesium-137, and plutonium-239/240 have been detected in the unconfined groundwater.

Of additional concern to the Hanford Reservation groundwater regime is the presence of contaminants in the confined aquifer. Although the confined aquifer groundwater typically exhibits contaminant levels substantially lower than those observed in the unconfined aquifer, the confined aquifer has received contaminants from Hanford Site operations. These contaminants have reached the aquifer by one or all of three routes. These routes are: (1) erosional windows where the confining layer is absent such that direct physical connection occurs between the confined and unconfined aquifers; (2) where downward, vertical gradients occur between the two aquifers as a result of groundwater mounding in the unconfined aquifer; and (3) where wells provide communication between the two aquifers.

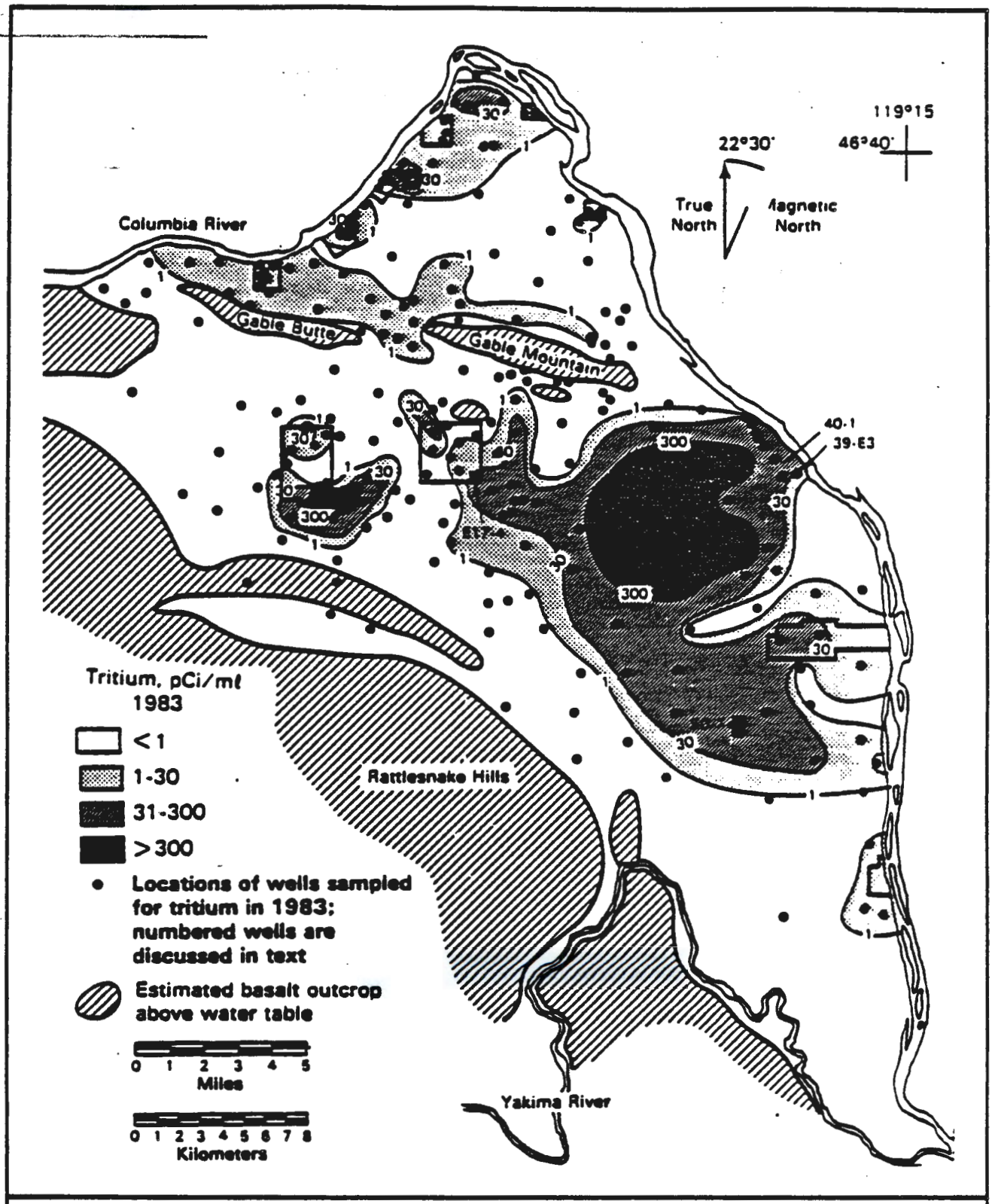
In 1973, the confined aquifer became a concern when it was thought that radioactive contaminants may have been able to move eastward in the confined aquifer beneath the Columbia River to off-site wells tapping the confined aquifer (Richards, 1973). Levels of radioactivity in some of these wells were, in fact, higher than would have been anticipated.



Source: Cline et al., 1985—PNL-5408

AVERAGE TRITIUM DISTRIBUTION IN THE UNCONFINED AQUIFER, 1984

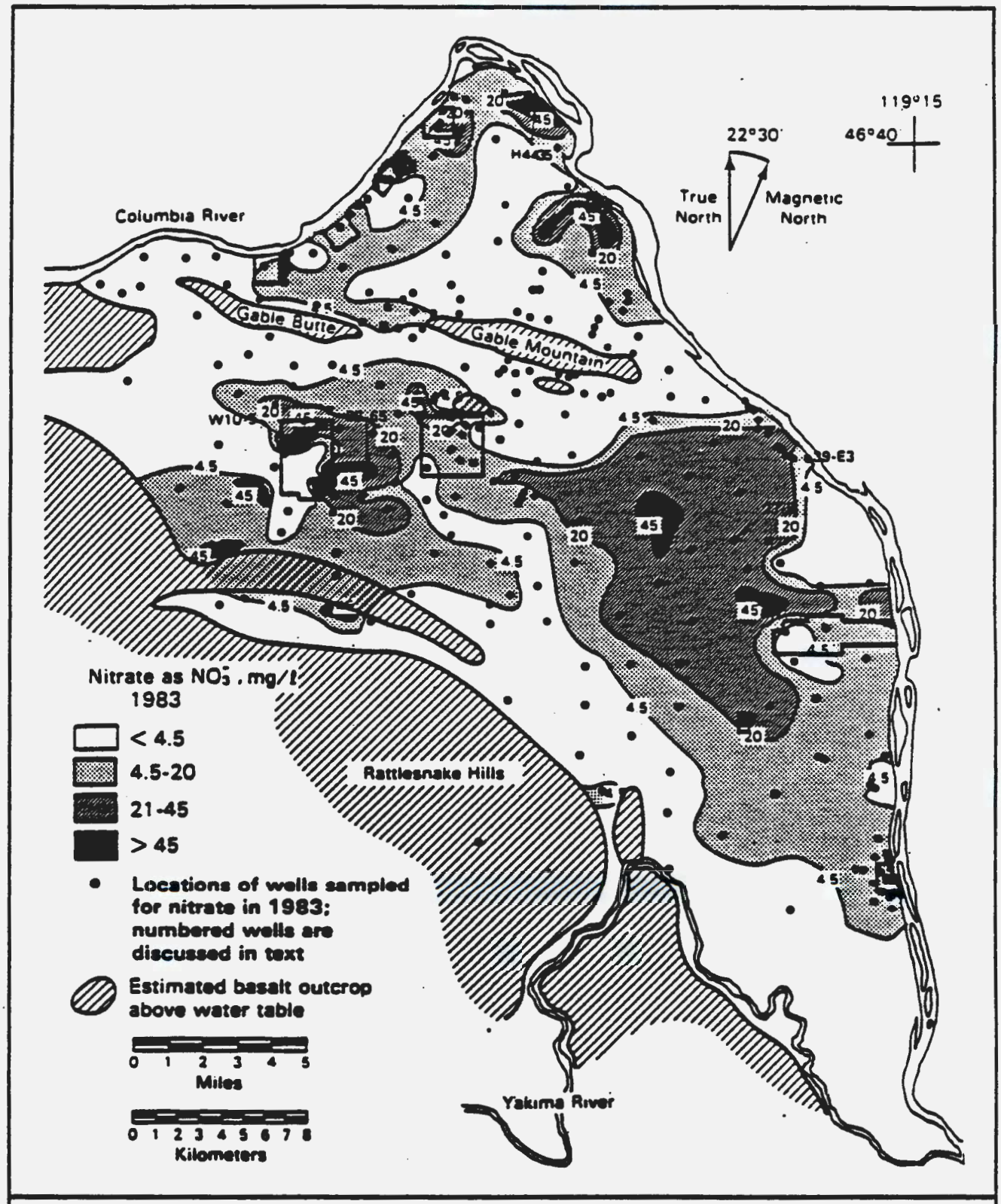
FIGURE 3 - 67



Source: Cline et al., 1985—PNL-5408

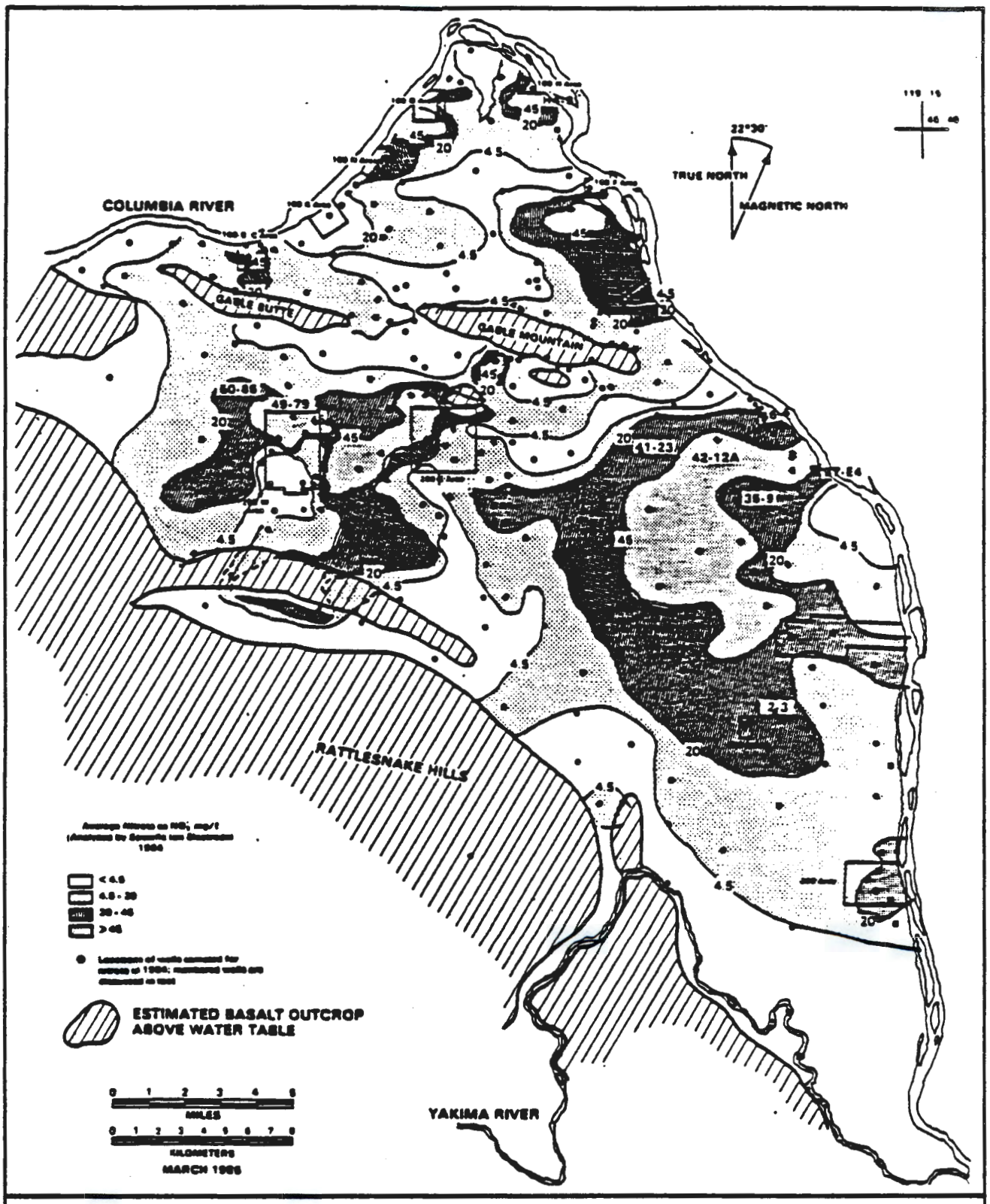
AVERAGE TRITIUM DISTRIBUTION IN THE UNCONFINED AQUIFER, 1983

FIGURE 3 - 68



Source: Cline et al., 1985—PNL-5408

AVERAGE NITROGEN DISTRIBUTION IN THE UNCONFINED AQUIFER, 1983 **FIGURE 3 - 69**



Source: Cline et al., 1985—PNL-5408

AVERAGE NITROGEN DISTRIBUTION IN THE UNCONFINED AQUIFER, 1984

FIGURE 3 - 70

No subsequent routine monitoring of these off-site wells has occurred.

3.4.4 Findings and Observations

Existing and potential problems found at the Hanford Site are presented in this section.

3.4.4.1 Category I

None

3.4.4.2 Category II

1. Potential Groundwater Contamination. Groundwater has the potential to be contaminated in the confined aquifer east of the Hanford Site.

   In 1973, the site (Richards, 1973) became concerned over the potential for movement of radioactive contaminants in the confined aquifer eastward beneath the Columbia River. Water supply wells east of the site provide irrigation and drinking water from the confined aquifer. Levels of radioactivity in the groundwater samples obtained east of the Columbia River during this time were, in fact, higher in some samples than would have been anticipated. No routine monitoring or explanation for the elevated levels has occurred since the mid-1970s.

   The confined aquifer on-site has become contaminated. This has occurred as a result of:

   - Increased piezometric head in the unconfined aquifer
   - "Groundwater windows" from the overlying coarse sediments to the basalt bedrock which lack any confining layers or beds
   - Wells that have allowed for intercommunication between the unconfined and confined aquifer.

The unconfined aquifer, which contains much of the contamination available to the confined aquifer, exhibited tritium levels in excess of 9,000,000 picocuries per liter, gross alpha in excess of 300 picocuries per liter, and gross beta in excess of 500 picocuries per liter in 1985. These levels are one to two orders of magnitude above appropriate drinking water standards (NPDWR).

The confined aquifer appears to have been impacted by contamination to a lesser extent than the unconfined aquifer. However, the data for the confined aquifer are sparse. Only 22 on-site wells were sampled in 1984. Tritium levels were reported to range from 82 to 1800 picocuries per liter in these wells. Iodine-129, however, was reported to range from 2×10^{-5} picocuries per liter to 22 picocuries per liter (Cline et al., 1985). Little additional information is available for the confined aquifer.

2. Lack of Groundwater Data and Monitoring. A major data gap exists in the assessment of chemical constituents in groundwater and as a result of lack of monitoring at some waste sites. The consequence of this data gap is that groundwater contamination could go undetected. Limited data exist on nonradioactive chemical constituents in groundwater. This is particularly true with regard to volatile compounds. Only one set of groundwater analytical data exists for 90 wells for parameters listed in Table 3-33. The RCRA sampling comprises 20 wells that are analyzed for the parameters listed in Table 3-34.

These limited data indicate that nonradioactive constituents have entered the groundwater. For example, Well 699-37-43, which is located within the major site tritium plume, exhibited exceedances of the NPDWR for barium, cadmium, chromium, and radium. Analyses for volatile organics and solvent extractable constituents in three wells in the 600-Area detected 14 constituents (see Table 3-39).

Many waste disposal sites do not have groundwater monitoring systems. This is especially true in the 100-Areas and at solid waste burial grounds. The lack of groundwater monitoring at waste facilities has, in part, resulted from the interpretation of site studies. These site studies indicated that there was

no net recharge to the unconfined aquifer from precipitation and therefore no driving force for contaminants to reach the groundwater from a facility. Ongoing site studies with lysimeters presently indicate that recharge from precipitation does occur.

In addition, the large volumes of water discharged to the ground create additional driving forces that could act to move contaminants downward. The Survey team observed movement of water through the ground from a surface water ditch such that the water discharged into an open radioactive solid waste burial trench.

3.4.4.3 Category III

1. Groundwater Contamination. Groundwater has become contaminated in many areas of the Hanford Site.

   Both the confined and unconfined aquifers have been impacted. The unconfined aquifer has been impacted the most. The contamination has principally resulted from the discharge of large volumes of liquid effluents into and on top of the ground. These discharges have created increases in piezometric head in the unconfined aquifer on the order of 90 feet. The major areas of groundwater contamination are briefly summarized below. It should be noted that the data base on nonradiological parameters is limited and therefore the discussions typically address only tritium, nitrate, and gross alpha and beta.

   - The largest plume (based on tritium concentration) on the Hanford Site covers an area in excess of 60 square miles at a concentration greater than 20,000 picocuries per liter. (The NPDWR is 20,000 picocuries per liter.) This plume, which originated in the 200-Areas, contains nitrate, iodine-129, and other suspected contaminants such as volatile organics and metals. This plume currently discharges to the Columbia River near the Hanford Townsite and to the south (see Figures 3-67 through 3-70).

- 200-Area - Four tritium (and nitrate) plumes exist in the 200-Areas. Two are in the 200-East Area and two are in the 200-West Area (see Figures 3-51 and 3-53). These plumes are defined by tritium greater than 5 milligrams per liter. Six locations in the 200-West Area and two locations in the 200-East Area have gross beta concentrations in groundwater greater than 100 picocuries per liter (see Figure 3-55). Other contaminants suspected to be associated with at least some of these contaminated zones are metals and volatile organics.

- 100-Areas - The reactor areas have been the sources of both historic and continued releases of contamination to groundwater and subsequently the Columbia River. Most of the 100-Areas continue to have an impact on the Columbia River through discharges of contaminated groundwater to the river. Both tritium and gross beta have historically exceeded NPDWRs. The 100N-Area exceeds NPDWRs in the springs that discharge to the river for eight contaminants (see Table 3-39). The 100H-Area contains the RCRA 183H Basins. These basins have leaked and contaminated groundwater. Chromium, mercury, cadmium, nitrate, fluoride, and gross alpha have all exceeded NPDWRs in the groundwater samples. Volatile organics have also been found.

- 300-Area - The 300-Area groundwater has been contaminated by a number of constituents. Elderkin (1986) indicated the presence of metals, volatile organic chemicals, anions, radionucludes, and coliform bacteria in the groundwater. Metals and gross alpha have exceeded the NPDWRs. Contaminant plumes are shown in Figures 3-57 through 3-61.

3.4.4.4 Category IV

1. Contamination of Wells. Wells at the Hanford Site may become contaminated as a result of three separate factors. These are:

- Lack of security - The lack of security at well heads has created some problems in the past and is of concern to the Survey team. Radioactive contamination has occurred by animals falling into a well. Additionally, insects could carry radioactivity into the wells.

- Lack of annular seal - Monitoring results could be affected by well construction (particularly in those wells installed prior to 1980), since many of these wells were only steel-cased with no annular seal. Contaminants could travel along the well casing.

- Spraying of herbicides - In some cases, herbicides are sprayed at monitoring well sites to control plant growth. This practice could result in contamination, especially around older wells, which have no annular seal or surface pads.

2. Erroneous Data. Data quality may be affected by inadequate sampling procedures utilized on-site. Examples are:

- Lack of purging - Some wells on-site are not purged prior to sampling, which could result in erroneous data.

- Cross-contamination - Although well sampling techniques used by PNL were found to be very good, where another contractor was involved the techniques observed were found to be poorly executed. This included the potential for cross-contamination of wells and subsequent potential for erroneous analytical results. Bailers were reported to be rinsed in Columbia River water between wells.

4.0 NON-MEDIA-SPECIFIC SURVEY FINDINGS

4.1 Waste Management

This section discusses findings and observations pertaining to waste management, toxic and chemical materials, radiation, quality assurance, and inactive waste sites and releases. These discussions do not include a background environmental information section because the areas addressed are not necessarily tied to one medium as was the case with the discussions in Section 3.0. These discussions include an environmental monitoring program section, where appropriate and where information was available. The findings for hazardous, radioactive, mixed, and solid waste management are summarized in a section addressing waste management.

4.1.1 General Description of Pollution Sources and Controls

The major sources of radioactive, hazardous, and mixed wastes generated on the Hanford Site are graphically depicted in Figure 4-1. This figure also indicates treatment and disposal options that are currently employed.

4.1.1.1 Hazardous Waste

The Hanford Site operations generate hazardous wastes* at 119 points throughout the site. A breakdown of the number of generating points, by contractor and area, is provided in Table 4-1. A total of 185 tons per year of hazardous waste is generated at the facility (based on calendar year 1985 data); a breakdown of this figure by contractor is provided in Table 4-2.

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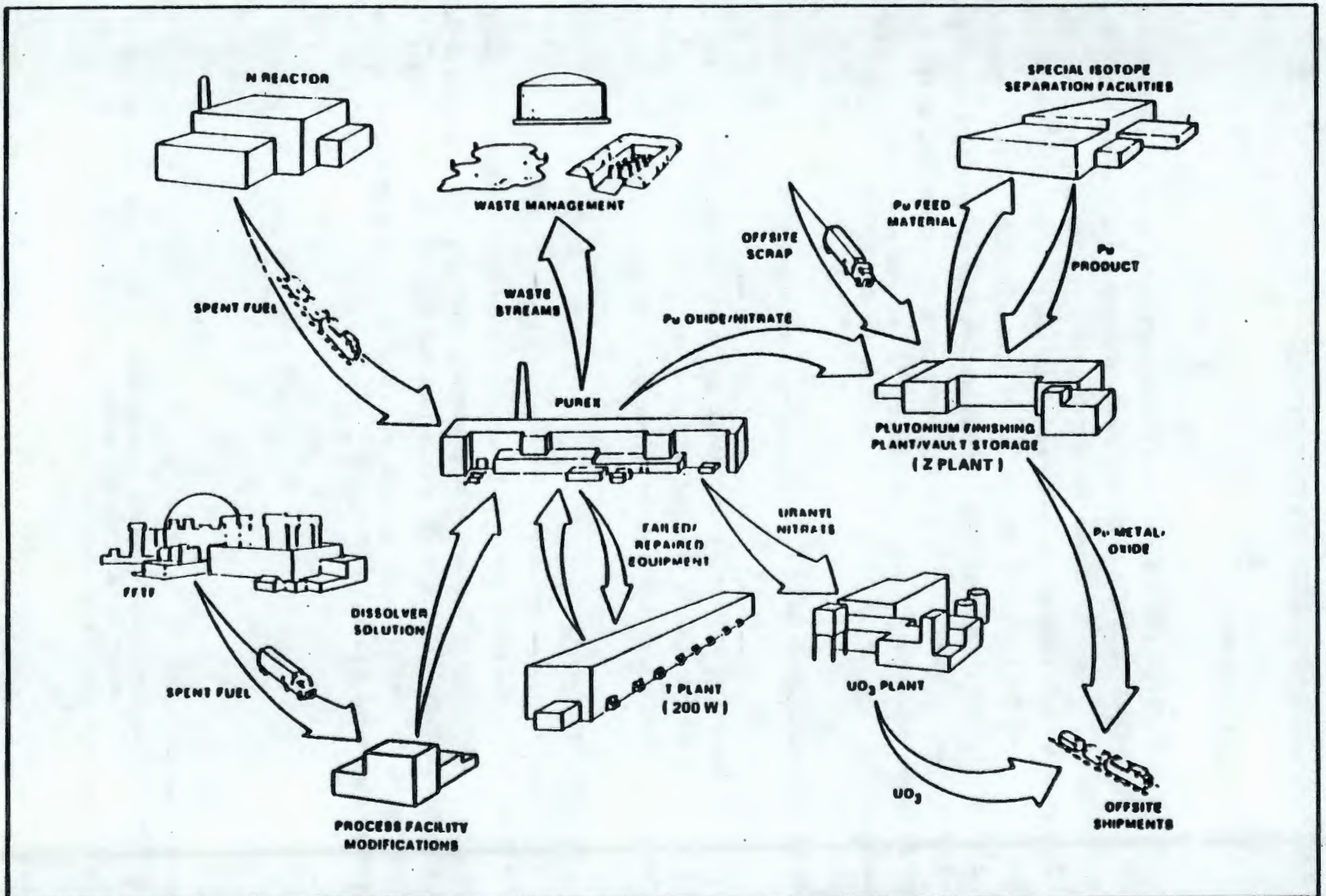
* The term "hazardous waste" is used interchangeably with both the Washington Department of Ecology (WDOE) term "dangerous waste," and DOE's term "non-radioactive dangerous waste" (NRDW).



Source: Handout from Gary Boothe of Rockwell

CHEMICAL PROCESSING OF NUCLEAR FUEL AT HANFORD (B PLANT WILL SEPARATE HLW FROM LLW)

FIGURE 4 - 1

TABLE 4-1

NUMBERS AND LOCATIONS OF HAZARDOUS WASTE GENERATING POINTS AT HANFORD SITE

Management Contractor	Areas at Hanford Site					
	100-Areas	200-East Area	200-West Area	300-Area	400-Area	Misc. Areas*
Hanford Environmental Health Foundation (HEHF)	--	--	--	--	--	1
J. A. Jones Construction Services Company (JAJ)	1	1	1	1	--	6
Kaiser Engineers Hanford (KEH)	1	2	--	--	--	2
Pacific Northwest Laboratory (PNL)	--	--	1	16	--	13
Rockwell Hanford Operations (Rockwell)	--	13	10	--	--	6
UNC Nuclear Industries (UNC)	8	--	--	4	--	--
Westinghouse Hanford Company (WHC)	--	--	1	20	11	--
TOTAL	10	16	13	41	11	28

*Includes 600-, 700-, 1100-, and 3000-Areas

TABLE 4-2

QUANTITIES OF HAZAROUS WASTE GENERATED AT HANFORD SITE IN CY 1985

Management Contractor	Quantity	
	Kg	Lb
Hanford Environmental Health Foundation (HEHF)	466	1,027
J. A. Jones Construction Services Company (JAJ)	5,807	12,799
Kaiser Engineers Hanford (KEH)	206	454
Pacific Northwest Laboratory (PNL)	5,768	12,713
Rockwell Hanford Operations (Rockwell)	18,110	28,896
UNC Nuclear Industries (UNC)	141,789	312,517
Westinghouse Hanford Company (WHC)	1,139	2,510
TOTAL	168,285	370,916 (185 tons)

9 2 1 2 4 5 1 1 6 5 3

The Hanford Resource Conservation and Recovery Act (RCRA) Part B permit application, submitted in November 1985, identifies 12 hazardous waste treatment, storage, and disposal (TSD) units. Table 4-3 lists these, and also identifies the type of unit and its permit status. Of these:

- Three are not permittable under 40 CFR 264 standards, and will therefore be closed in the near future.

- One unit (the 616 Nonradioactive Dangerous Waste or NRDW Storage Facility) is newly constructed and not yet in service.

- One unit (the 300-Area Process Trench) no longer receives hazardous wastes, and accordingly has submitted a closure plan.

- The Part B submittal did not address one unit (the 1324N Neutralization Pond), which was identified in Rockwell's Dangerous Waste Implementation Plan (DWIP).

- Three units (the 437 Maintenance and Storage Facility, the 105DR Sodium Fire Facility and the 221T Test Facility) are currently out of service.

The above factors reduce the number of active, permittable TSD units from 13 to 5. All hazardous wastes (HWs) generated at the Hanford Site are ultimately managed at one or more of these five units. The following paragraphs briefly describe the hazardous waste management (HWM) program by area.

100-Area

The HWs generated in the 100-Area are containerized, stored in various "satellite" areas (i.e., less than 90-day storage), and shipped to the 2727S Storage Facility. Examples of these wastes are solvents, mercury-contaminated demolition wastes, and paints. Sodium hydroxide (NaOH) and sulfuric acid (H_2SO_4) regeneration streams from the 163N Building are discharged to the newly constructed 1324N Neutralization Pond. There the waste is pH-adjusted to fall between 2.0 and 12.5, and is subsequently discharged to cribs.

TABLE 4-3

HAZARDOUS WASTE TREATMENT, STORAGE, AND DISPOSAL (TSD) FACILITIES AT HANFORD SITE

Facility Name	Type	Permit Status (1)
Nonradioactive Dangerous Waste Landfill (2)	Landfill	I/PS
2727-S Storage Facility	Container storage	I/PS
3718-F Treatment/Storage Facility	Thermal treatment, container storage	I/PS
E-8 Borrow Pit	Thermal treatment	I
324 Pilot Plant	Tank treatment	NP/PS
1100-Area Detonation Site (3)	Thermal treatment	I
Ash Disposal Pit	Thermal treatment	I
105-DR Sodium Fire Facility (5)	Container storage, thermal treatment	I/PS
221-T Test Facility (5)	Tank treatment	I/PS
616 NRDW Storage Facility (5)	Container storage	PL/PS
300-Area Process Trench	Surface impoundment	NP/CL
1324-N Neutralization Pond (4)	Surface impoundment	NP
437 Maintenance and Storage Facility (5)	Tank treatment	PL/PS

Notes:

1) I = Interim Status
   PS = Part B permit application submitted
   NP = No permit or interim status
   CL = Closure/Post-Closure Plan submitted and facility no longer accepts hazardous waste
   PL = Planned facility

2) Also called the "NRDW" or "Central" landfill

3) Also called the "Hanford Academy Demolition Site"

4) Not addressed in Part B submittal, but identified in Rockwell's Dangerous Waste Implementation Plan (DWIP)

5) Out of service

9 2 1 2 4 6 1 1 1 6 6 0

200-Area

The HW generated in the 200-Areas (East and West) consists of such materials as solvents, paints, and waste laboratory reagents. These are containerized and stored in various "satellite" drum-storage areas (i.e., less than 90-day storage), and then taken to the 2727S Storage Facility. The 2727S Facility, which has a design capacity of 5000 gallons, receives all containerized HW from the Hanford Site.

From this point, wastes are labeled, segregated as to type, and stored prior to shipment to various commercial disposal facilities approved by the U.S. Environmental Protection Agency (EPA). At present, DOE primarily uses the following facilities for HW treatment/disposal: Chemical Waste Management in Arlington, Oregon; and Crosby and Overton in Kent, Washington.

In the near future, the 2727S Facility will be closed, at which time the new 616 Nonradioactive Dangerous Waste Storage (NRDWS) Facility (with a 40,000-gallon capacity) is expected to be brought on line. Once permitting/groundwater issues have been resolved, the NRDW Landfill will be brought back into service. At that time, some or all of the HW currently being shipped off-site may once again be disposed of on-site.

300-Area

The 300-Area generates and manages a wide variety of hazardous wastes. Some examples of these are waste laboratory reagents, photochemical wastes, acids, caustics, and solvents.

As "landlord" of the area, Westinghouse handles the majority of the HW. Through its facilities and personnel at the 340 Building, all Westinghouse-generated HW is either staged/stored directly, or handled indirectly (i.e., documentation needs). From this area, as well as the numerous "satellite" areas (i.e., less than 90-day storage), containerized HW is shipped to the 200-Area. The other main contractor in the 300-Area, Pacific Northwest Laboratory (PNL), handles its own HW. This is done using point-of-generation satellite areas as well as the 332 Building. At this facility, PNL-generated HW is packaged, labeled, and stored prior to shipment to the 200-Area.

In addition to these activities, certain HWs are treated in the 300-Area in two TSD units: the 3718F Treatment/Storage Facility, and the 324 Pilot Plant. Both units receive alkali metals from points in the 400-Area as well as the 300-Area. The wastes are rendered nonhazardous (or at least nonreactive, depending on the process) by either reacting them with water and/or various alcohols, or by thermal treatment in a "burn pan."

400-Area

The 400-Area generates routine HWs such as paints and solvents, as well as reactive alkali metal waste. These are containerized and stored at two "satellite" areas, then shipped to the 200-Area by way of Building 340.

4.1.1.2 Mixed (Radioactive and Hazardous) Waste

This category of wastes is defined as those wastes which are both hazardous per 40 CFR 261 (or state equivalent), and are combined with low-level radioactive wastes (as defined at 10 CFR 61.2).

The Hanford Site generates radioactive mixed waste (RMW) at 24 points throughout the reservation. A breakdown of the number of generating points, by contractor and area, is provided in Table 4-4. A total of 1771 tons per year* of RMW is generated at the facility (based on calendar year 1985 data); a breakdown of this figure by contractor is provided in Table 4-5.

The Hanford RCRA Part B permit application, submitted in November 1985, identifies 18 RMW TSD units. Table 4-6 lists these, and also identifies the type of unit and its permit status. Of these:

- Seven units are currently out of service.
- Two units no longer receive hazardous wastes, and accordingly have submitted closure plans.
- The Part B submittal did not address one unit (i.e., the 1706KE Laboratory Waste Treatment and Storage Facility), which was identified in the DWIP.

* The rate of generation of RMW is approximately 10 times that of hazardous waste (see Table 4-2).

9 2 1 2 4 6 1 1 6 6 2

TABLE 4-4

NUMBERS AND LOCATIONS OF RADIOACTIVE MIXED WASTE (RMW) GENERATING POINTS AT HANFORD SITE

Management Contractor	Areas at Hanford Reservation					
	100-Areas	200-East Area	200-West Area	300-Area	400-Area	Misc. Areas*
Hanford Environmental Health Foundation (HEHF)	--	--	--	--	--	--
J. A. Jones Construction Services Company (JAJ)	--	--	--	--	--	--
Kaiser Engineers Hanford (KEH)	--	--	--	--	--	--
Pacific Northwest Laboratory (PNL)	--	--	1	5	--	--
Rockwell Hanford Operations (Rockwell)	--	3	4	--	--	--
UNC Nuclear Industries (UNC)	--	--	--	--	--	--
Westinghouse Hanford Company (WHC)	1	--	1	7	2	--
TOTAL	1	3	6	12	2	0

*Includes 600-, 700-, 1100-, and 3000-Areas

TABLE 4-5

QUANTITIES OF RADIOACTIVE MIXED WASTE (RMW) GENERATED AT HANFORD SITE IN CY 1985

Management Contractor	Quantity	
	Kg	Lb
Hanford Environmental Health Foundation (HEHF)	–	–
J. A. Jones Construction Services Company (JAJ)	–	–
Kaiser Engineers Hanford (KEH)	–	–
Pacific Northwest Laboratory (PNL)	30,091	66,200
Rockwell Hanford Operations (Rockwell)	1,101	2,422
UNC Nuclear Industries (UNC)	1,577,735	3,471,017
Westinghouse Hanford Company (WHC)	1,091	2,400
TOTAL	1,610,018	3,542,039 (1,771 tons)

9 2 1 2 4 6 1 1 6 6 4

TABLE 4-6

RADIOACTIVE MIXED WASTE (RMW) TREATMENT, STORAGE, AND DISPOSAL (TSD) FACILITIES AT HANFORD SITE

Facility Name	Type	Permit Status (1)
Solvent Evaporation Unit	Tank treatment	NP/CL
218-W-2A Landfill (6)	Landfill	NP/PS
218-W-6 Landfill (6)	Landfill	PL/PS
218-W-3AE Landfill	Landfill	NP/PS
218-W-3A Landfill	Container storage, landfill	NP/PS
218-W-4C Landfill	Container storage, landfill	NP/PS
218-W-5 Landfill (6)	Landfill	NP/PS
218-E-10 Landfill	Landfill	NP/PS
219-E-10B Landfill (6)	Landfill	PL/PS
218-C-9 Landfill	Landfill	NP/PS
218-E-12B Landfill	Landfill	NP/PS
183-H Basins	Surface impoundments	NP/CL
1706-KE Laboratory Waste Treatment and Storage Facility (4)	Tank treatment, tank storage	NP
221-T Test Facility (5), (6)	Tank treatment	I/PS
3718-F Treatment/Storage Facility (5)	Thermal treatment, container storage	I/PS
105-DR Sodium Fire Facility (5), (6)	Thermal treatment, container storage	I/PS
324 Pilot Plant (5)	Tank treatment	NP/PS
437 Maintenance and Storage Facility (5), (6)	Tank treatment	PL/PS

Notes:
1) I = Interim Status
PS = Part B permit application submitted
NP = No permit or interim status
CL = Closure/Post-Closure Plan submitted and facility not longer accepts hazardous waste
PL = Planned facility
2) Also called the "NRDW" or "Central" landfill
3) Also called the "Hanford Academy Demolition Site"
4) Not addressed in Part B submittal, but identified in Rockwell's Dangerous Waste Implementation Plan (DWIP)
5) Also listed in Table 4-3, since facility manages both HW and RMW
6) Out of service

The above factors reduce the number of active RMW TSD units from 18 to nine. All RMW generated at the Hanford Site is ultimately managed at one or more of these nine units. The following paragraphs briefly describe the RMW management program by area.

In the 100- and 400-Areas, sodium (and sometimes lithium) is used to decontaminate various reactor parts. The resulting radioactive alkali metal waste is containerized and shipped to either the 3718F Treatment/Storage Facility or the 324 Pilot Plant (both located in the 300-Area). The wastes are rendered nonhazardous (or at least nonreactive, depending on the process) by either reacting them with water and/or various alcohols, or by thermal treatment in a "burn pan."

Radioactively contaminated lead shielding is generated in the 100 N-Area on a periodic basis.

Numerous RMWs are generated in the 200-Areas (East and West), chiefly from the B-Plant, the Plutonium-Uranium Extraction (PUREX) Plant, the T-Plant, the Z-Plant, and the various facilities of the Reduction-Oxidation (REDOX) Plant. Examples of these wastes are laboratory reagents, lead shielding, oxidizers, maintenance wastes, caustics, alkali metals, and solvents. The alkali metals are treated in the 300-Area (see above). The remaining 200-Area RMWs are containerized, stored in various "satellite" drum-storage areas (i.e., less than 90-day storage), and disposed of (or retrievably stored) on-site in the six active RMW landfills (see Table 4-6).

The 300-Area generates a wide variety of RMWs; examples are lead shielding, aromatic solvents, laboratory reagents, alkali metals, photographic wastes, and solvents. The alkali metals are treated in one of the two 300-Area TSD units (see above). The remaining 300-Area RMWs are handled by the 340 facilities. From this area, as well as the numerous "satellite" areas, containerized RMW is shipped to the 200-Area for disposal/retrievable storage.

4.1.1.3 Radioactive Waste

Radioactive wastes generated at Hanford Reservation fall into three categories: low-level waste or LLW (as defined at 10 CFR 61.2); high-level waste

or HLW (as defined at 10 CFR 60.2); and transuranic or TRU waste (as defined in DOE Order 5480.2, Items 4k. and 4L).

Low-Level Waste

Liquid LLW is generated at numerous points throughout the site. In the 100-Area, the N-Reactor is the primary generation point for this waste type, which is made up of liquid effluents from the reactor coolant system, spent-fuel storage basin, periphery coolant systems, and various drain systems. The waste is ultimately discharged to the 1325N Crib. Liquid LLW from the 200-Area is routinely discharged to various cribs, ponds, and ditches. Representative sources and disposal sites are listed in Table 4-7. All 300-Area LLW is routed to the 340-Area by way of the Radioactive Liquid Waste (RLW) sewer system; 400-Area LLW is transported to the 340-Area via an 8000-gallon rail tanker. These areas generate approximately 500,000 gallons per year of LLW. The waste is stored in six 8000-gallon tanks and two 15,000-gallon tanks, characterized, and loaded into 20,000-gallon rail tankers for shipment to the 200-Area, where it is land-disposed.

High Level Waste

HLW is generated primarily by the PUREX Plant; representative sources and dispositions are listed in Table 4-8. As illustrated in Figure 4-1, these streams are sent to the double-shell tank/evaporator system. In the PUREX facility, the irradiated fuel from the N reactor is declad and then dissolved with acid so that the plutonium can be separated. The resultant waste acid stream contains the majority of the fission products. While the volume of the corrosive and radioactive components of the wastes are generally well known, few data exist regarding their hazardous chemical composition. Other liquid wastes, which are not discharged to the environment, are also placed in the HLW tanks and managed as HLW.

HLW generated in the PUREX facility is treated with a caustic to a pH in excess of 12 and routed through a double-lined pipe system to underground double-shell tanks. The double-lined pipes consist mainly of pipe-in-pipe; however, some pipe-in-concrete encasements are utilized.

TABLE 4-7

200-AREA LIQUID LLW SOURCES AND DISPOSAL SITES

Effluent Sources	Disposal Sites
242A cooling waste and stream condensate, a farm effluent, AR vault, PUREX cooling water and chemical sewer, B-Plant cooling water, power house	East Area surface ponds, 216-A-25/ 216-B-3
B-Plant chemical sewer	216-B-63
222S Laboratory effluents	216-S-19
242S steam condensate and power house wastewater	216-U-10
AY-AZ steam condensate	216-A-8
PUREX process condensate	216-A-10
PUREX steam condensate	216-A-30 and A-37-Z
PUREX ammonia scrubber condensate	216-A-36B
242A process condensate	216-A-37-1
B-Plant steam condensate	216-B-55
B-Plant process condensate	216-B-62
209E miscellaneous waste	216-C-7
UO_3-Plant process condensate	216-U-12
Laundry wastewater	216-W-LWC
231-Z and 234-5Z waste	216-Z-20

9 2 1 2 4 6 1 1 6 6 8

TABLE 4-8

HLW STREAMS AT HANFORD SITE

Stream Description	Disposition
Aqueous sugar-treated Zirflex acid waste (ZAW)	244-AR vault, then to B-Plant for Sr and Cs recovery or double-shell tanks
10W aqueous waste stream - System 1	Double-shell tanks
20W aqueous waste stream - System 2	Double-shell tanks
Neutralized aqueous decladding waste and rinse	Double-shell tanks
Neutralized aqueous decladding waste and dissolver rinses	Double-shell tanks
Spent metathesis and water rinse	Double-shell tanks

The piping system is laid out such that transfers can be made to and from any tank for treatment process. Any liquid escaping from the primary pipe flows by gravity to a collection tank or diversion box; from there it can be pumped back into the system. The waste is first sent to "aging tanks" where the short-lived fission products decay, wastes cool, and sludge is allowed to settle. Such sludge contains the majority of the fission products. The HLW supernatant is reduced in volume through evaporation, and the evaporator bottoms are returned to the double-shelled tanks. The condensate is presently being disposed of in cribs (leaching fields) as a low-level waste. Supernatant from the older single-shell tanks is sent to the B-plant, where it will be processed to prepare the waste for immobilization in the planned vitrification facility.

Since 1970, HLW has been stored in the double-shelled carbon steel tanks. There are presently 20 of these at Hanford. Each tank can hold one million gallons of waste. While all currently generated HLW at Hanford is stored in double-shelled tanks, not all of the wastes in the 20 double-shelled tanks are by definition HLW. The following is a list of stored wastes:

- o Complexed concentrate from Cs-137 and Sr-90 removal systems
- o Double-shell slurry (mixtures of all types of past waste streams)
- o Cladding removal waste from PUREX plant
- o Facility waste (solvents, caustics, bases, metals, etc....)
- o PUREX first-cycle extraction waste
- o Plutonium Finishing Plant Waste (TRU waste)

Both technical and administrative controls exist at Hanford with regard to HLW. All double-walled pipelines have leak detection systems consisting of encasement alarms, diversion box alarms, material balance discrepancies, radiation monitoring

above grade, and periodic swabbing of encasements. Tanks are controlled or monitored through tank liquid levels, annulus air monitoring, annulus liquid level, and/or leak detection pit monitoring for liquids and air. Hanford employs a computer automated surveillance system (CASS) which makes 5,700 readings/day. All monitoring (other than liquid levels) is for radioactive components in air.

Hanford also has an elaborate process control system where valves, pumps, tank levels, and other items can be monitored from a central area. The system also employs interlocks and fail-safe systems (e.g., shutdown for power failure). Administrative controls involve extensive documentation on material balances, tank inventories, and treatment and tank transfers. Hanford officials indicated that the tank level monitors would provide a first indication of a loss, with readings to the nearest one-half inch amounting to a volume of approximately 1,350 gallons.

For disposal purposes, sludges from the double-shelled tanks will be slurried and sent to a vitrification facility, where the waste will be mixed with a technically controlled boron silica frit, vitrified, poured into a steel cylinder which would be sealed, and then decontaminated before shipment and disposal in a deep geological repository. The Hanford virtrification facility is only in the planning stages and is projected to be completed by the mid-1990's. The majority of the wastes (supernatant and salt cake) in the HLW tanks contain small quantities of carbon (C-14), iodine (I-129), and other residual radionuclides. These would be classified as low-level waste (LLW) and would be mixed with cement, clay, and fly ash to form a grout that will disposed of near the surface on the Hanford Site. Thus, the grout system will treat the LLW, and the vitrification process will eventually treat the HLW.

From 1944-1970, Hanford's high-level liquid wastes were managed in single-shelled tanks. The list below provides an identification of these waste tanks with their important characteristics.

SINGLE-SHELLED WASTE STORAGE TANKS

Tank Farm	Tanks In Farm	Capacity/Tank (gal)		Capacity/Farm (gal)	Year Constructed
T	16	54,500 530,000	(4) (12)	6,578,000	1943-44
U	16	54,500 530,000	(4) (12)	6,578,000	1943-44
B	16	54,500 530,000	(4) (12)	6,578,000	1943-44
C	16	54,500 530,000	(4) (12)	6,578,000	1943-44
BX	12	530,000		6,360,000	1947-48
TX	18	758,000		13,644,000	1947-48
BY	12	758,000		9,096,000	1950-51
S	12	758,000		9,096,000	1950-51
TY	6	758,000		4,548,000	1951-52
SX	15	1,000,000		15,000,000	1953-54
A	6	1,000,000		6,000,000	1954-55
AX	4	1,000,000		4,000,000	1963-64
TOTAL	149			94,056,000	

The single-shelled tanks did not provide the measure of environmental protection necessary for high-level wastes because of the corrosive nature of the waste materials. Over time, the materials of construction in some of the single-shelled tanks failed, causing waste releases to the soil and groundwater.

All of the single-shelled tanks have now been taken out of service, although they are not empty. This means that no new wastes are placed in these tanks; however, existing waste still remain and several of the tanks have been stabilized (all liquids removed). Of the inventory of 149 single-shelled tanks, Hanford has declared 7 to be "assumed leakers", 93 to be "interim stabilized", and 20 to be "sound and deactivated" (Rockwell, 1986d). The list below identifies the quantities of wastes contained in 7 "assumed leakers."

WASTE MATERIALS IN SINGLE-SHELLED TANKS - 1986
(Thousands of Gallons)

Status	Number of Tanks	Supernatant	Sludge	Salt Cake	Interstitial Liquid*
Assumed Leaker	7	43	1,036	1,607	748

* Contained in Sludge and Salt Cake

Source: Rockwell, 1986d

For comparison purposes, the total inventory of wastes in the single-shelled and double-shelled tanks is provided below.

TOTAL HIGH-LEVEL WASTES IN TANKS - 1986
(Thousands of Gallons)

Waste Type	Single-Shell Tanks	Double-Shell Tanks
Sludge	12,330	547
Salt Cake	24,209	812
Interstitial Liquid	6,656*	339*
Supernatant	748	11,816
Double-Shell Slurry	-	2,046

* Contained in Salt Cake and Sludge

Source: Rockwell, 1986d

Transuranic Waste

The TRU wastes currently generated at the Hanford Site are containerized and retrievably stored, stored for future reclamation, or decontaminated (e.g., the Cladding Removal Wastes [CRW]). Six separate waste streams, as presented in Table 4-9, are presently being generated. TRU wastes at Hanford are generated mainly at the PUREX Plant, the Plutonium Finishing Plant (PFP), the FFTF, and the Battelle Laboratory. To date, approximately 525,000 cubic feet of TRU waste, including 804 cubic feet of remote-handled TRU, has been placed at Hanford in retrievable storage. Hanford also has a small quantity of classfied TRU waste in retrievable storage. The rate of generation of TRU waste at Hanford is approximately 12,000 cubic feet per year. Little information is available about the quantity or characterization of stored TRU waste containing hazardous chemicals.

The waste managment system for the handling of TRU waste at Hanford is similar to that for other DOE facilities. To date, only the facilities run by Rockwell which generate the most TRU waste at Hanford have completed the steps necessary to certify TRU waste for the Waste Isolation Pilot Plant (WIPP). The remaining producers of TRU (Westinghouse and Battelle) are moving toward the same status.

Hanford is developing a plan for a WRAP (waste receiving and processing facility) which would process TRU waste as required for certification. After processing and certification, the TRU waste will be sent to the WIPP for disposal.

Prior to 1970, all TRU waste, as well as LLW, were disposed of in shallow land trenches at Hanford. Since 1970, TRU waste has been segregated and placed in retrievable storage. To date, none of the buried TRU waste has been certified for the WIPP. The retrievable storage at Hanford consists of placing the waste in 55-gallon steel drums or steel boxes on an asphalt pad or plywood foundation below grade. Plywood and plastic are placed over the drums, which are then covered with 4 feet of earth. Plastic standpipes are placed into the storage modules to allow for gas sampling.

TABLE 4-9

TRANSURANIC WASTE STREAMS AT HANFORD SITE

Generator	Stream Description	Disposition
UNC	Solid TRU waste from 105KE basin cleanout	Drums/retrievable storage
PUREX	Solid TRU waste	Drums/retrievable storage
PFP*	TRU contaminated solid waste from decontamination and decommissioning maintenance	Drums or steel boxes/retrievable storage
PFP	TRU contaminated liquid organics from Plutonium Reclamation Facility (PRF) and Analytical Facilities	Drums/retrievable storage
WHC	Solid TRU waste	Drums/retrievable storage
WHC	High dose rate TRU waste from cladding, testing, etc.	Drums/retrievable storage

* Plutonium Finishing Plant

Source: DOE Survey Team

U.S. Ecology

U.S. Ecology, Inc., operates a commercial low-level radioactive waste disposal facility on a parcel of land leased by the State of Washington, located southwest of the 200E-Area. The facility has been operating on 100 acres since 1965, and is operated under a license issued by the U.S. Nuclear Regulatory Commission (NRC).

The facility is a potential source of groundwater contamination for radioactive materials as well as hazardous materials. Potentially hazardous waste in the form of organic scintillation vials was disposed of at the site until recently.

Transportation of Liquids

Liquid radioactive waste is transported on the Hanford Site in five railroad cars. One small rail car is used to transport LLW liquids from the 400-Area to the 300-Area. The remaining four cars are used to transport liquids from the 100- and 300-Areas to the 200-Area for disposal. The Survey Team inspected one of the cars and observed that it was in good condition, without any indication of leakage. The cars are maintained by Rockwell with periodic pressure and vacuum testing and are decontaminated after removing the waste in the 200-Area.

A major spill from one of the cars while in transit is unlikely. When filled, the cars can produce high direct radiation levels. However, the cars are not left standing after filling and are emptied soon after reaching the 200-Area.

4.1.1.4 Nonhazardous, Nonradioactive Waste

All the process and nonprocess (e.g., office) areas at the Hanford Site generate nonhazardous, nonradioactive wastes. Examples of these are construction debris, office trash, putrescibles from cafeterias, and packaging materials. Some of the less-commonplace wastes are:

- Filter backwash and sludges from the treatment of riverwater
- Failed/broken equipment and tools
- High-efficiency particulate air (HEPA) filters
- Noncontaminated used gloves and other clothing
- Certain chemical precipitates, such as oxalates.

The quantities of these wastes are not defined. However, they are all disposed of on-site in dedicated nonhazardous cells at the NRDW Landfill operated by Rockwell. The only significant exception to this is the ash generated at both the 200-East and 200-West Power Plants. This waste is simply stockpiled at the respective points of generation.

4.1.2 Environmental Monitoring Program

U.S. Ecology, Inc., operates an environmental monitoring program for its disposal site. The program now includes soil and vegetation sampling and thermoluminescent dosimeter (TLD) measurements at the four corners of the site; one ambient air monitor; and five groundwater monitoring wells. All samples are collected and analyzed on a quarterly basis. U.S. Ecology plans to install an additional nine air samplers to its program in 1987.

Non-media related compliance monitoring/detection systems are not used as part of the Hanford Site's waste management program.

4.1.3 Findings and Observations

4.1.3.1 Category I

None

4.1.3.2 Category II

1. Unidentified Hazardous Constituents in Liquid Effluents. Soil and groundwater contamination by hazardous wastes has potentially occurred at the Hanford Site as a result of the method of disposal of plant waste streams.

   Numerous aqueous process streams are discharged directly to land-based disposal units (e.g., cribs, ponds, drywells) throughout the Hanford Site. Since none of these units are lined, these wastewater streams have seeped into the ground in considerable quantities over an extended time. Accordingly, there exists a high potential for contamination of groundwater. As in the case of the 300-Area Process Trench, the continued discharge of wastewater

(whether technically HW/RMW or not) has the likelihood of forcing hazardous/radioactive constituents into the groundwater, and ultimately into the Columbia River.

4.1.3.3 Category III

1. 300-Area Process Trench Discharges. Contaminated soils from the 300-Area Process Trench have released pollutants to the groundwater and potentially to the Columbia River. Discharges to the 300-Area Process Trench have historically contained radioactive and hazardous constituents, which have the potential to be mobilized by the continued use of the trench for wastewater discharges.

   At the unlined 300-Area Process Trench, HW/RMW has seeped into the ground in considerable quantities over an extended period of time. Accordingly, there exists a high potential for contamination of groundwater. The continued discharge of large quantities of process wastewater to this unit (even though it is said to be no longer either HW or RMW) will probably force hazardous/radioactive constituents into the Columbia River at a significant rate.

2. Hazardous Constituents in Solid Radioactive Waste Disposal Units. Contamination of soil and groundwater by hazardous wastes may have occurred as a result of Hanford's disposal of LLW in landfills.

   Historically, solid or containerized LLW and some TRU wastes were buried in various trenches at Hanford. These trenches or landfills did not contain any liners or impermeable caps and were not designed for containment of hazardous constituents. It is likely that hazardous materials were mixed with LLW, but no records exist to identify the hazardous portion of these wastes. Currently, the site is attempting to separate LLW from mixed waste prior to disposal.

Five of the landfills/retrievable storage units used to manage RMW in the 200-Area are unlined. As a result, unknown hazardous/radioactive constituents can leak out of the units, and readily enter the soil column en route to groundwater. In the absence of a groundwater monitoring system, such an occurrence would go undetected for an extended period of time.

Additional factors aggravating this situation are:

- The nature of the wastes is essentially unknown.
- Impermeable caps are not present.
- No groundwater monitoring systems are in place.

4.1.3.4 Category IV

1. Satellite Storage Areas. Numerous "satellite" drum-storage areas for both HW and RMW throughout the Hanford Reservation have no containment to prevent spills/leaks from contaminating groundwater.

   At least one such area (i.e., the area immediately north of B-Plant) consistently exceeds the 90-day storage limitation. Although there is no regulatory requirement that such areas have secondary containment, the possibility exists for minor spills to enter the groundwater.

2. 2727S Drum Storage Facility. The permitted 2727S drum storage area has no containment to prevent spills/leaks from contaminating groundwater.

   Also, most of the area lacks a cover to prevent exposure of drums to extreme weather conditions. The impact of this situation is relatively minor, since use of this area will be discontinued in the near future (i.e., when the 616 NRDWS Facility is put into service). However, any past soil/groundwater contamination will remain in the form of a continuing release.

3. 1324N Neutralization Pond. This surface impoundment is currently being used to manage RMW (according to both the DWIP and Survey observation). However, it appears that the unit has neither interim nor final status from WDOE to do so. Enforcement action is likely in this case.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollutant Sources and Controls

4.2.1.1 Toxics Management

Rockwell purchases and stores the majority of process and maintenance chemicals for the Hanford Site. The Central Stores Warehouse in the 1100-Area is where the centralized purchasing for the site is performed and many of the chemicals are stored. The other contractors obtain their chemicals through the Rockwell Central Stores, except for small quantities of research and specialty chemicals obtained by direct purchase. Bulk chemicals are shipped directly to various tank farms throughout the Hanford Site, and essential process chemicals are stored in Building 275EA in the 200-East Area. In all cases, the purchasing paperwork is processed through Central Stores.

The Central Stores complex consists of several office and storage buildings. The largest of these buildings is Building 1166, which contains both offices and storage. Very little toxic material is stored in this building (primarily small containers — 1 gallon or less — of insecticide, solvents, paints, laboratory chemicals, etc.). Building 1168 contains gas cylinders used on the site. These cylinders are segregated into several separate bays. The two main buildings for storage of chemicals are Building 1164, Hazardous Material Storage Facility, and Building 1169, Chemical Storage Building. Building 1164 contains highly flammable materials such as solvents and paints. The building is locked, and has containment curbing and a fire detection system. The interior is clean and dry with no evidence of spills or leaking containers. In Building 1169, various chemicals such as acetone, ether, and ethyl alcohol are stored. The building is locked, a containment system is in place, and chemicals are segregated according to compatibility. The spill containment system is piped to several dry pits on the exterior of the building. An emergency shower, eye-wash station, and spill cleanup equipment are located in the building. The building is clean and dry with no evidence of past spills or leaking containers.

Hazardous materials are delivered from the Central Stores in a special shipment once a week to the plant users. Special wooden containers are used to minimize handling, and a Chemical Delivery Truck Manifest identifying the quantity and type of material accompanies all shipments.

Building 275EA contains liquid and dry chemicals in bags, drums, and other containers. The majority of the pesticides used on the site are stored in this facility. The building is clean and dry and no evidence of leaking containers was observed. An inventory of materials is maintained and pesticides can be issued only to approved personnel.

Materials that do not meet specifications (off-spec) and outdated chemicals are disposed of through the Rockwell Solid Waste Processing and Disposal group. If these materials are hazardous, an internal site waste manifest is completed and accompanies the shipment to the Rockwell hazardous material storage facility.

Rockwell has a computer-based inventory system for the warehouse—Warehouse Inventory Management System (WIMS). The WIMS provides data on quantities of materials used, inventory on hand, and reordering points. Part of the material description allows for a notation regarding the hazardous nature of these products. The materials considered hazardous are specified by the Rockwell Industrial Hygiene Department and Material Safety Data Sheets (MSDSs) are available for those materials.

Warehouse personnel are trained in hazardous materials management as part of the Rockwell site-wide training program. Specific employees who handle hazardous materials receive additional training appropriate to their jobs.

Rockwell, in conjunction with the other site contractors, has prepared a list of hazardous materials used on the Hanford Site. This list also identifies the appropriate MSDS reference for further handling information to accomodate the hazardous characteristics of the materials.

Twice a month, the WIMS computer prints out a list of all hazardous material ordered from Central Stores. This list identifies the order number, the quantity and description of the material, the person who requested the material, and the person's location by area and building number. The Rockwell Industrial Hygiene Department staff reviews these printouts to determine unusual or inconsistent usage.

4.2.1.2 Tank Farm Facilities

Toxic and chemical materials are centrally procured and disposed of through Rockwell. However, bulk storage facilities for the large quantities of process and treatment chemicals are located in each of the facility areas where they are to be used. The areas in which the largest quantities of toxic and chemical materials are stored are the 100-, 200-, and 300-Areas.

100-Area

The chemicals used in the 100-area are used by UNC Nuclear Industries (UNC) in a variety of applications for support of the 100N-Reactor and at the 100KE Fuel Storage Facility. Typical chemical consumption for these areas is reported to be as follows:

Material	*Use*	Total Consumed (pounds) 100-KE	100-N
Aluminum sulfate	Flocculant	98,000	390,000
Chlorine	Algicide	8,000	28,000
Polyacrylamide	Filter aid and coagulant	-	650
Sulfuric acid	Cation resin regeneration	-	1,300,000
Hydrazine	Oxygen concentration control	-	19,000
Morpholine	pH control	-	4,600
Sodium hydroxide	Anion resin regeneration	-	980,000
Ammonium hydroxide	pH control	-	64,000 (gallons)

Source: UNC, 1985.

UNC, the responsible 100-Area contractor, has documented its 100-Area toxic and chemical material control procedures in its Environmental Control Manual, UNI-M-31. This manual contains provisions for the preparation and update of Spill Prevention Control and Countermeasure (SPCC) plans, and for conducting and documenting annual inspections of oil and chemical storage facilities (see Figure 4-2). Abridged oil and chemical SPCC plans are also provided in UNI-M-31. UNI has assessed the present deficiencies in spill containment and has proposed improvements to reduce the likelihood or impact of chemical releases. Table 4-10 lists UNC's present and proposed spill containment measures for selected storage units. No implementation schedule for the proposed improvements was provided, however.

200-Area

The largest quantities and variety of toxic and chemical substances are stored in the 200-Areas. These are used predominantly for Rockwell's operation of the 200-Area fuel reprocessing facilities, including the PUREX Plant and B-Plant in 200-East, and the Z-Plant and UO_3 Plant in 200-West.

Table 4-11 lists an inventory of selected process chemicals typically used in the 200-Areas. Although this list was excerpted from a much larger 1975 listing of process chemicals in the Waste Management Operations report for the Hanford Reservation, the process chemicals listed in Table 4-11 are believed to be representative of the types and quantities of chemicals stored in the 200-Areas. Tables 4-12, 4-13, and 4-14 show typical chemical consumption levels at the PUREX Plant, B-Plant, and Z-Plant, respectively.

Due to the volumes and types of chemicals stored, leaks or ruptures of tanks in these areas could result in significant environmental contamination. Rockwell's Environmental Surveillance and Control Manual (RHO-HS-MA-2, part 3) and Environmental Protection Manual (RHO-MA-139, parts E and M) address actions to be taken in the event of spills or contamination incidents, but only in the most general terms.

INSPECTION OF CHEMICAL STORAGE FACILITIES AT 100N-AREA

PERFORMED BY: _____

DATE: _____

An inspection of the chemical storage facilities operated by UNC is required in the UNC Environmental Control Manual (UNI-M-31, Section 5.7). The items below should be inspected for each of the chemical storage facilities listed. Each item should be marked with a check mark or N/A if it is not applicable to a particular chemical storage facility. Any detected problems or any remarks on the general appearance of a chemical storage facility should be discussed in the problems/remarks section at the end of this form.

A copy of the completed inspection should be sent to the Environmental Control Subsection.

Chemical Storage Facility	Check for presence of chemical leakage	Condition of Chemical Storage Facility	Condition of secondary containment (dikes, curbing, etc.)	Condition of hoses, fittings, pumps & other auxiliary equip.
108N Sodium Hydroxide Storage Tank				
108N Sulfuric Acid Storage Tanks				
108N Transfer and Booster Pumps				
163N Sodium Hydroxide Day Tank				
163N Sulfuric Acid Day Tank				
183N Liquid Alum Storage Tanks				
183N Seperan Storage Tanks				
109N Phosphoric Acid Storage Tank				
Phosphoric Acid Transfer Pump				
109N Ammonium Hydroxide Storage Tank				
184N Hydrazine Storage Tank				
184N Morpholine Storage Tank				

Problems/Remarks:

Source: UNC, 1986(b)

FIGURE 4-2

UNI CHEMICAL STORAGE INSPECTION FORM (UNI-M-31)

9 2 1 2 4 6 1 1 6 8 4

TABLE 4-10

100-AREAS MAJOR CHEMICAL STORAGE FACILITIES

Chemical Storage Facility	Spill Containment	Proposed Improvements
INTERNAL DECONTAMINATION SYSTEM		
Phosphoric Acid Tank (one 35,000-gallon above-ground tank)	Retention basin with overflow to ground.	Modify basin to contain 35,000 gallons and seal off drains.
1310N Waste Chemical Storage Tank (One 900,000-gallon partially buried tank)	Earthen retention basin.	Provide leakproof secondary containment.
109N Decontamination Misc. Acid Tank	None.	Provide leakproof secondary containment.
108N CCHEMICAL UNLOADING FACILITY		
Sodium Hydroxide Storage Tank (One 76,300-gallon above-ground tank)	None.	Retention basin to contain one tank volume.
Sulfuric Acid Storage Tanks (Three 10,000-gallon above-ground tanks)	None.	Curbed retention basin to contain one tank volume (10,000 gallons) and reroute overflows.
FILTERED AND DEMINERALIZED WATER PLANTS		
Sulfuric Acid Storage Tank (One 10,000-gallon tank inside 163N)	Retention basin.	Modify retention basin to contain 10,000 gallons; seal off drains and reroute overflow.
Sodium Hydroxide Storage Tank (One 10,000-gallon tank inside 163N)	Retention basin.	Modify retention basin to contain 10,000 gallons; seal off drains and reroute overflow.
Liquid Alum Storage Tanks (Two 8,250-gallon and one 175-gallon tank inside 183N)	Contained with 183N drains.	Isolate area from building floor drain.
Seperan Storage Tanks (Two 880-gallon tanks inside 183N)	Contained within 183N drains.	None proposed.
Chlorine Storage Tanks (Six 2,000-pound cylinders inside 183N)	None.	None proposed.

9 2 1 2 4 1 1 6 8 5

TABLE 4-10 (continued)

Chemical Storage Facility	Spill Containment	Proposed Improvements
WATER QUALITY CONTROL		
Ammonium Hydroxide Storage Tank (One 30,000-gallon above-ground tank)	Retention basin with overflow to ground.	Modify basin to contain one tank volume and seal off drains.
Ammonium Hydroxide and Hydrazine Transfer Pumps (Inside 184N Annex)	Partial retention basin.	Complete retention basin; disable drains to 66-inch RWR line.
Hydrazine Storage Tank (One 1,700-gallon tank inside 184N)	Retention basin.	Disable drains to 66-inch RWR line.
Morpholine Storage Tank (One 900-gallon tank inside 184N)	Retention basin.	Disable drains to 66-inch RWR line.
FUEL STORAGE BASIN RECIRCULATION FACILITY		
Sodium Hydroxide Storage Tank, 107N (One 5,000-gallon aboveground tank)	Retention basin.	None proposed.
Sulfuric Acid Storage Tank, 107N (One 5,000-gallon aboveground tank)	Retention basin.	None proposed.
CHEMICALS AT 100KE-AREA		
Liquid Alum Storage Tank (One 188,000-gallon above-ground tank at 183KE)	None.	None proposed.
Seperan Storage Tank (One 7,500-gallon tank inside 183KE)	Contained within drains in 183KE.	None proposed.
Chlorine Storage Tanks (Six 2,000-pound cylinders)	None.	None proposed.
Sulfuric Acid and Sodium Hydroxide Storage Tanks (Two 3,300-gallon tanks)	None.	Retention basin to contain one tank volume.
CHEMICALS AT 100D-AREA		
Chlorine Storage Tanks (Fourteen 2,000-pound cylinders at 182D)	None.	None proposed.

Source: UNC,1986(b).

TABLE 4-11

TYPICAL INVENTORY OF SELECTED PROCESS CHEMICALS - 200-AREAS

Chemical Compound	How Stored	Typical Inventory
Aluminum Nitrate - Nonahydrate	Bulk Tank	30,000 lb
Ammonium Fluoride-Ammonium Nitrate (AFAN)	Bulk Tank	100,000 lb
Ammonia (Anhydrous)	Bulk Tank	45,000 lb
Carbon Tetrachloride	Drum	20,000 lb
Hydroxyacetic Acid	Bulk Tank	200,000 lb
Liquid Nitrogen	Bulk Tank	150,000 ft^3
Tetra Sodium Ethylene Diamine Tetra Acetate (EDTA)	Bulk Tank	250,000 lb
Trisodium Hydroxyethyl Ethylene Diamine Triacetate (HEDTA)	Bulk Tank	400,000 lb
Normal Paraffin Hydrocarbon	Bulk Tank	200,000 lb
Nitric Acid	Bulk Tank	200,000 lb
Phosphoric Acid	Bulk Tank (polylined) Fiber Drum	15,000 lb
Potassium Hydroxide	Bulk Tank	35,000 lb
Sodium Hydroxide	Bulk Tank	300,000 lb
Sulfuric Acid	Bulk Tank	100,000 lb
Tributyl Phosphate	Bulk Tank 55-gal Drum	25,000 lb
Chlorine	Cylinder	20,000 lb

Source: ERDA, 1975

TABLE 4-12

TYPICAL PUREX PLANT CHEMICAL CONSUMPTION

Chemical	lb/yr[a]
Aluminum Nitrate	275,000
Ammonium Fluoride - Ammonium Nitrate (AFAN)	700,000
Ferric Nitrate	750
Ferrous Sulfamate	20,000
Normal Paraffin Hydrocarbon (NPH)	16,000
Nitric Acid (HNO_3)	900,000
Oxalic Acid	20,000
Potassium Hydroxide (KOH)	160,000
Potassium Permanganate	2,000
Sodium Carbonate (Soda Ash)	10,000
Sodium Hydroxide (Caustic)	650,000
Sodium Nitrite	15,000
Sugar	30,000
Sulfamic Acid	5,000
Sulfuric Acid	25,000
Hydrazine	4,000
Tartaric Acid	6,000
Tributyl Phosphate (TBP)	100,000
Hydroxylamine Nitrate	20,000
Potassium Fluoride	25,000
Cadmium Nitrate	5,000

(a) Assumes 1,000 T/Yr of N-Reactor fuels

Source: ERDA, 1975

9 2 1 2 4 6 1 1 6 8 8

TABLE 4-13

TYPICAL B-PLANT CHEMICAL CONSUMPTION

Chemical	Consumption (lb/yr)	
	PAS + PSS(a)	CAW(b)
Ammonia	600,000	--
Carbon Dioxide	700,000	--
Citric Acid		300,000
Di(2-Ethylhexyl) Phosphoric Acid (D2EHPA)	25,000	10,000
Hydroxyacetic Acid	300,000	250,000
Tetra Sodium Ethylene Diamine Tetra Acetate (EDTA)	1,500,000	--
Tri Sodium Hydroxyethyl Ethylene Diamine Triacetate (HEDTA)	2,000,000	15,000
Normal Paraffin Hydrocarbon (NPH)	85,000	30,000
Nitric Acid	1,500,000	1,000,000
Oxalic Acid	4,000	3,000
Phosphotungstic Acid (PTA)	--	22,000
Sodium Carbonate (Soda Ash)	100,000	650,000
Sodium Glucomate	100,000	70,000
Sodium Hydroxide (Caustic)	1,800,000	1,600,000
Sodium Sulfate	50,000	40,000
Sulfuric Acid	3,000	2,000
Tributyl Phosphate (TBP)	15,000	6,000

(a) SX Operating 70% of time - 200,000 gal sludge per year
(b) SX Operating 50% of time - 250,000 gal CAW per year
(from 1,000 T/Yr N-Reactor fuels)

Source: ERDA, 1975

TABLE 4-14

TYPICAL CHEMICAL CONSUMPTION FOR Pu RECLAMATION AND Pu FINISHING (Z-PLANT)

Chemical	Quantity/Yr
Aluminum Nitrate Nonahydrate[a]	450,000 lb
Carbon Tetrachloride[a]	11,000 gal
Calcium metal [b]	1,500 lb
Magnesium Oxide[b]	2,000 lb
RS-6 Crucible[b]	700 ea
Dibutyl Butyl Phosphonate[a]	3,520 lb
Hydrogen Fluoride[b]	10,000 lb
Hydrogen Peroxide[b]	1,000 lb
Hydroxylamine Sulfate[a]	20,000 lb
Mercuric Nitrate[a]	100 lb
Nitric Acid 57%[a]	350,000 lb
Liquid Nitrogen[a]	(5,500,000 ft^3)
Oxalic Acid[b]	8,000 lb
Potassium Permanganate[b]	300 lb
Soda Ash[a]	200 lb
Caustic[a]	200,000 lb
Sodium Nitrate[a]	8,000 lb
Sodium Nitrite[a]	800 lb
Hydrazine - Scarox[a]	2,500 lb
Tributyl Phosphate[a]	8,000 lb

[a] Pu Reclamation
[b] Pu Finishing

Source: ERDA, 1975

9 2 1 2 4 6 1 1 6 9 0

300-Area

The largest quantities of toxic and chemical materials stored in the 300-Area are associated with the fuels fabrications facilities operated by UNC. The principal chemical substances consumed in the process are as follows:

Material	Use	Total Consumed (pounds)
Hydrofluoric acid	Etching copper and zirconium fuel components; milling and cleaning fuel pieces	79,000
Nitric acid		610,000
Sulfuric acid		150,000
Sodium hydroxide	Neutralization of uranium-bearing and waste acids	490,000
Perchloroethylene	Degreasing	28,000
1,1,1-trichloroethane		330

Source: UNC, 1985

Policies and procedures governing UNI's control of these materials are set forth in the UNC 300-Area Chemical Spill Preventions Control, and Countermeasures Plan (UNI-3879), which is included as part of UNC's Environmental Control Manual (UNI-M-31). As with the 100-Area storage facilities, UNC has undertaken an assessment of existing storage conditions and has proposed improvements to reduce the likelihood of toxic and chemical material releases.

Project H-685 ("Reduced Chemical Discharges to Process Sewers") is designed to both reduce the volume and content of process effluent and to improve spill containment to ensure that chemical spills and leaks do not enter the process sewer. Proposals under Project H-685 include construction of the Process Effluent Treatment Facility (PETF) to treat chemically contaminated liquids from the 303M and 333 Buildings, and provision of spill collection, containment, and (possibly) detection systems for the tank farms and trenches. Table 4-15 summarizes the major chemical storage facilities under UNC jurisdiction in the 300-Area and the proposed improvements for those facilities.

Research and development activities supporting laboratories and test facilities are a major part of the activities in the 300-Area. These research activities may

TABLE 4-15

300-AREA MAJOR CHEMICAL STORAGE FACILITY

Chemical Storage Facility	Spill Containment	Proposed Improvements[a]
311 Tank Farm: Six Large-Volume Tanks (Up to 10,000 gallons each) Containing in separate tanks: Nitric Acid Perchloroethylene Sodium Hydroxide Neutralized Waste Acid	Containment barriers and catch basins	Enlarge basins and barriers to surpass spill containment guidelines
334 Tank Farm: Nitric Acid (Two 6,000-gallon tanks)	Concrete pad, drains to pipe trench connected to Building 333 Process Sewer	Not specified. Catch basin suggested as minimum.
Sulfuric Acid (One 6,000-gallon tank)	Concrete pad, drains to pipe trench connected to Building 333 Process Sewer	Not specified. Catch basin suggested as minimum.
Waste Acid (One 6,000-gallon tank)	Concrete pad, drains to pipe trench connected to Building 333 Process Sewer	Not specified. Catch basin suggested as minimum.
333 Building Process Chemicals: (Most tanks of 200-500-gallon capacity) Nitric Acid-3 Tanks Nitric & Hydrofluoric Acids-6 Tanks Nitric & Sulfuric Acids-1 Tank Chromic & Sulfuric Acids-1 Tank Nitric Acid & Aluminum Nitrate-1 Tank Uranium-Bearing Nitric & Sulfuric Acids-1 Tank (1,770-gallon) Sodium Chloride & Potassium Chloride-1 Tank Potassium Nitrate, Sodium Nitrate, and Sodium Nitrite-1 Tank Perchloroethylene-3 Tanks 1,1,1-Trichloroethane-1 Tank	Drainage trenches connected to Process Sewer	Segregation of selected contaminated waste streams for treatment at PETF, containment structures, and additional diversion control.

a Proposed improvements by UNC

Source: UNC 1986(b).

9 2 1 2 4 6 1 1 6 9 2

involve large quantities of toxic and chemical materials. Measures to be taken in the event of a release are addressed in the following Westinghouse Hanford Company (WHC) documents pertaining to their 300-Area activities:

WHAN-M-11: Industrial Safety
MG-99: Environmental Protection
MG-75: Waste Management Manual.

These documents address emergency measures in general terms, but do not identify any specific storage facilities or preventive or corrective measures that need to be taken.

4.2.1.3 Polychlorinated Biphenyls

Rockwell, Westinghouse, UNC Nuclear, and PNL use PCB equipment in their current operations. J. A. Jones Construction, Hanford Environmental Health Foundation, Boeing Computer Services, and Kaiser Engineers do not own or operate any PCB equipment at the Hanford Site (Rockwell, 1986a).

Rockwell has the lead responsibility at the Hanford Site for maintaining in-service PCB equipment, responding to leaks, transporting PCBs on-site, and storage and disposal of waste PCBs. Westinghouse, UNC Nuclear, and PNL own their PCB equipment and provide in-service inspections, but rely on Rockwell for technical guidance and all repair and maintenance service on PCB equipment. In the case of UNC Nuclear, Rockwell even performs UNC's in-service inspections. Rockwell is also responsible for removing from service any PCB equipment that is no longer useful.

Table 4-16 summarizes the status of PCBs on the Hanford Site during calendar year 1985. The information in this table was derived from the 1985 Hanford Site PCB annual report prepared by Rockwell (Rockwell, 1986b).

The PCB equipment that remains in service is inspected on a monthly basis to determine if any leaks have occurred. Rockwell and Westinghouse inspection logs were reviewed and no serious leaks have been recorded over the past year. All in-service equipment inspected during the Survey had clearly marked PCB signs and

TABLE 4-16

HANFORD PCB STATUS
(CY 1985)

Items	In Service		Storage		Disposal	
	No.	Weight*	No.	Weight*	No.	Weight*
Containers	5	1,498	55	5,448	30	6,602
Transformers	52	133,654	4	4,744	20	8,205
Large HV Capacitors	12	327	30	1,500	0	0
Large LV Capacitors	41	320	0	0	0	0
Other Equipment	0	0	0	0	0	0
Totals	110	135,799	89	11,692	50	14,807

* Weight in Kilograms

Source: Rockwell 1986 b

did not show any evidence of current or past leaks. Many of the Rockwell transformers have been diked for spill containment and are enclosed by chain link fencing.

The PCB Storage Facility, Building 212P, located in the 200-North Area, is operated by Rockwell. This facility is divided into two warehouses, one for radioactively-contaminated PCBs and the other for nonradioactively-contaminated PCBs. The radioactively-contaminated PCBs present a special problem because they cannot be disposed of through commercial operators and are awaiting the availability of a disposal facility within the DOE system. Currently, no disposal system has been identified to handle these wastes. The radioactively-contaminated PCB Storage Facility is diked with a sealed floor, secured, marked with signs, and shows no evidence of current leaks or past spills. This facility contains 24 drums of PCB hydraulic fluid contaminated with plutonium (1024 kilograms PCBs total), which was generated by the Z-Plant. Because of the plutonium content, the packaging of these drums exceeds the standards used for PCB materials only.

The nonradioactively contaminated PCBs are stored in a separate section of the 212P Facility. The drums are properly marked, the floor is sealed and diked, emergency spill equipment is available, and the facility is secured. A printout of the inventory is posted at this facility and a log of additions to the drums is maintained to update the inventory. The facility is clean and dry and there was no evidence of leaking containers or past spills. The inventory in the noncontaminated storage area at the time of the Survey consisted of:

- 1430 kilograms PCB liquids
- 64 kilograms PCB contaminated liquids
- 132 kilograms PCB solids
- 20 kilograms PCB contaminated solids

Rockwell controls PCB transport and storage on the Hanford Site, and its personnel have the training for routine handling and spill response. All used oils, cutting fluids, and hydraulic fluids generated on the Hanford Site are required to be tested for PCBs prior to acceptance by Rockwell for storage and/or disposal. Procedures for PCB handling, transport, and disposal are in place, are technically sound, and are followed by operations personnel.

No disposal of PCBs takes place on the Hanford Site. All disposal is through licensed disposal contractors at off-site locations. The site has used Rollins Incinerator in Deer Park, Texas; U.S. Pollution Control, Inc., in Utah; and U.S. Ecology in Beatty, Nevada, for its disposal contracts. Rockwell representatives have conducted site inspections of several of these operations to verify the disposal procedures and methods. All shipments of PCBs are documented with waste manifests and signed copies are returned from the disposal operator verifying that disposal took place at their site.

All suspect electrical equipment on the Hanford Site has been tested for PCB content using a simplified analytical test to determine gross levels of PCBs. Rockwell is currently in the process of retesting those transformers that were previously identified as having PCB concentrations below 50 parts per million. The effort is being carried out to comply with the State of Washington standard of 1 part per million for PCB contamination. Hydraulic, cutting, and heat transfer fluids are also being sampled and analyzed at this time for PCB content. The sampling program is complete, but the analytical workload has overwhelmed the Hanford Environmental Health Foundation (HEHF) Laboratory, causing a large backlog. The HEHF is taking steps to subcontract PCB analysis to outside laboratories to alleviate this backlog.

Hanford contractors continue to work together to solve PCB issues on the site. Currently, a PCB Transformer Survey Contractor Committee is evaluating the status of PCB transformers at Hanford and the need to replace and/or modify such electrical equipment.

Rockwell maintains excellent records of PCB activities and status. Its computer system allows Rockwell to identify the location of all PCB transformers and the person responsible for maintenance and inspection. An up-to-date inventory of all PCB waste materials is maintained by Rockwell for ready reference.

4.2.1.4 Pesticides

Pesticide usage at the Hanford Site can be grouped into two categories: insecticides and herbicides. Rockwell is primarily responsible for providing pesticide services at Hanford. The other contractors use Rockwell services for the bulk of their pesticide needs, but can handle small applications with their own maintenance staffs.

A Certified Pesticide Applicator licensed by the State of Washington is responsible for Rockwell's program. There are also 19 Certified Pest Operators on the staff licensed by the State of Washington. One of these Certified Pest Operators is responsible for control of insects, rodents, and birds using insecticides, traps, and other control methods. The remainder of the operators are employed in the two road crews applying herbicides to roadsides, railroad rights-of-way, fencelines, burial sites, and tank farms. All the pesticide operators must complete a course of study approved by the State of Washington before they can take the test for certification. Outside contractors are employed to perform the larger insecticide jobs. Benton County Mosquito Control is used to provide insect control for the on-site ponds. An annual contract is awarded to a private corporation on a task order basis for additional smaller scale insecticide problems. Orkin has this contract for 1986.

Herbicide application constitutes, by far, the greatest quantity of pesticides in the outdoor environment. By contrast, most insecticides used on the site are applied indoors in offices and other work locations where insects are a nuisance or threat to the workers. The herbicide applications are accomplished by two crews under separate organizations: (1) Roads and Tracks and (2) Tank Farms. These groups apply chemicals on a year-round basis, weather permitting, timed to coincide with critical growth patterns of vegetation. The Roads and Tracks crew has the job of spraying the shoulders of roads, railroad tracks, and other rights-of-way over the entire site. The Tank Farm crew has responsibility for controlling tumbleweed and other intrusive vegetation on burial sites, tank farms, and other process-related land disposal locations. Because most of these latter types of sites are in the waste management areas of the 200-Area, the Tank Farm crew spends most of its time in this area.

A list of herbicides currently in use at the Hanford Site is provided in Table 4-17. These chemicals are purchased by Rockwell Central Stores and can be released only to authorized pesticide personnel. The chemicals are stored in several locations. Central Stores has a small supply of household-type spray cans for office use. The primary storage facility for herbicides is Building 275EA in the 200-East Area. The chemicals, stored in drums and plastic containers, are kept dry and neatly stacked without any evidence of spillage. This indoor storage area is locked and a posted list of names shows personnel authorized to be issued

TABLE 4-17

HERBICIDES USED AT THE HANFORD SITE

Name	Notes
Arsenal	Used on railroad right-of-ways; application rate 3 lbs/acre; used on roadways
Dicambia	–
Krovar	Nonselective herbicide; application rate 18 lbs/acre
Oust	Replacement for Spike and Round-Up
Round-Up	Used on raodways
Spike	Nonselective herbicide; application rate 5-10 lbs/acre; used on roadways
Telar	Replacement for 2,4-D
2,4-D Amine	Being phased out of program
Nalcotrol	Drift release control
R-11	Surfactant

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containers of herbicides. Once the herbicides are issued to the crews, they are used in the field or stored in one of two sheds that are more convenient for field applications. These sheds are essentially old truck body trailers located near the Wye Barricade and near Building 2713W in the 200-West Area. These sheds are locked and contain only small quantities of chemicals. Evidence of minor spillage during transfer of fluids from storage containers is present in these sheds but it appears that these spills were contained within the sheds without any obvious release to the soil.

Insecticides are stored in Building 201W in flammable materials storage cabinets. This indoor storage location is locked and there is no evidence of spills.

Herbicides are mixed in the field, not at the storage location. All containers and mix tanks are triple-rinsed and the rinsate is reapplied to the working area. Previously, there were two pesticide rinsate dump areas near Building 2713W in the 200-West Area and near Building 275EA in the 200-East Area. These areas have been roped so that access is controlled. These sites are no longer in use and procedures have been changed so that all rinsate is reapplied.

Records of herbicide applications are maintained daily by each crew, specifying the application rate, application area, and weather conditions. Insecticide records are kept on a case-by-case basis correlated to complaints filed by site personnel.

Procedures for herbicide and insecticide application have been developed by Rockwell ("Pesticides and Herbicides" RHO-MA-221) and are being used by its crews and supervisors.

4.2.1.5 Asbestos

Due to the size, nature of operations, and age of the Hanford Site, there is a large quantity of asbestos in the facility. With the decommissioning of retired reactors, and the repair, refurbishment, and maintenance of presently used facilities, large quantities of asbestos waste can be expected to be generated. According to Rockwell records, over 17,000 cubic feet of nonradioactive asbestos was generated for disposal by three of the facility contractors during 1985, and an estimate of over 32,000 cubic feet is scheduled for removal in 1986.

Rockwell has overall responsibility for asbestos management at the Hanford Site. The specialized nature of asbestos handling and the diversity of facility contractor functions has resulted in the actual control of asbestos being divided among three contractors: Rockwell, J. A. Jones, and the HEHF.

Rockwell's asbestos removal requirements are governed by RHO-MA-221 ("Accident Prevention Standard"), Accident Prevention Standard number 13 ("Working With Insulating Materials"), and Accident Prevention Bulletin number 5 ("Airborne Fibrous Materials"). These documents delineate the general responsibilities and procedures to be used when working with asbestos, and include information on safe work practices, training, protective equipment, engineering controls, and disposal methods. Standards for asbestos emissions are set forth in RHO-MA-139 ("Environmental Protection Manual"). Low-level waste containing asbestos is required to be sealed in at least one layer of plastic prior to being placed in a container for disposal (RHO-MA-222, "Hanford Radioactive Solid Waste Packaging, Storage, and Disposal Requirements").

The mechanism by which Rockwell controls asbestos management is through use of a formal Asbestos Disposal Request form (See Figure 4-3). All facility contractors are required to file this form with the Rockwell Industrial Hygiene and Safety Department prior to disposal of asbestos. The form contains a brief summary of asbestos disposal requirements and provides documentation of both the quantity generated and disposal of the asbestos. The actual removal of asbestos during decommissioning and repair projects is generally performed by J. A. Jones. Jones has a large staff of trained and State-certified asbestos workers who are assigned to the asbestos removal or repair projects of the other facility contractors. Computerized records of the workers' certification, training, and physical examination status are maintained and periodically reviewed by the J. A. Jones Safety Department.

The HEHF provides air monitoring during asbestos removal and repair projects with Certified Industrial Hygienists who monitor airborne asbestos levels in accordance with accepted occupational health standard methods. In its capacity as medical monitor for Hanford personnel, HEHF also updates the status (medical fitness) of Jones' certified asbestos workers for asbestos work.

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ASBESTOS DISPOSAL REQUEST

The Industrial Hygiene & Safety Department (IH&S) of Rockwell Hanford Operations has control of asbestos management at Hanford. Accordingly, IH&S has established the following disposal requirements for asbestos at the Central Landfill Asbestos Trench:

1. A radiation release must be obtained for any asbestos emanating from a Radiation Zone.

2. All asbestos material packaged for disposal must be thoroughly wetted to eliminate any airborne asbestos particles during transportation, handling, or burial.

3. All asbestos material must be double plastic bagged or wrapped (6 mil or equivalent) to eliminate any airborne asbestos particles. A seal to preclude environmental or personnel exposure should be provided.

4. An accurate estimate of the asbestos volume must be provided along with the following information:

Generator's Name: _____

Phone Number: _____

Contractor Contracted By: _____

Location: _____ Estimated Volume (ft^3): _____

I have read and accept responsibility for the above outlined requirements for disposal of asbestos material.

Generator Name: _____

Date: _____

The above requirements have been met and the estimated volume appears correct.

Landfill Operator: _____

Date: _____

Source: File Material from Rockwell

FIGURE 4-3

RHO ASBESTOS DISPOSAL REQUEST FORM

Once removed, the asbestos is again placed in Rockwell's control by disposal at the nonradioactive dangerous waste portion of the on-site Central Landfill (radioactive asbestos is disposed of at the radioactive material burial grounds). Several trenches there have been dedicated to asbestos waste disposal.

4.2.2 Environmental Monitoring Program

There is no special environmental monitoring program in existence for toxic chemicals on the Hanford Reservation. Monitoring for these parameters is incorporated into the overall site environmental monitoring programs for air, surface water, groundwater, and soil described previously in Section 3.0.

4.2.3 Findings and Observations

4.2.3.1 Category I

None

4.2.3.2 Category II

1. Potential Spill Release of Hazardous Chemicals to Soils. Potential spills of hazardous chemicals in Building 1169, Chemical Storage Building (1100-Area Central Stores), could be released directly to the soil.

   The present "spill containment" system in the building has drain pipes leading directly to several drywells around the outside perimeter of the building. A spill in the building could discharge directly to the soil and groundwater.

2. Bulk Chemical Storage Tank Spill Containment. Bulk storage facilities for toxic and chemical materials throughout the facility were observed to have deficiencies in either design or operation of spill control measures, thus creating the potential for discharge of chemical contaminants to the soils (and presumably to the surface water or groundwater). Several of the tanks did not have completed dikes or were built on porous materials that would allow spills to soak into the soil and/or groundwater.

Storage tanks in the 100-Area were observed to have several containment deficiencies, such as retention basins lacking impervious bottoms or not having adequate containment capacity. Such deficiencies could result in significant environmental impacts if leaks or releases from the tanks were to occur.

Several tanks in the 200-Area were observed to have containment deficiencies, such as insufficient retention capacity or no containment barriers. For example; a tank farm containing caustics and acid at the B-Plant was observed to lack secondary containment; an aluminum nitrate nonahydrate tank in the Z-Plant was observed to have a concrete barrier around it, but only a gravel bottom within; the T-Plant Tank Farm was found in need of diking and impervious flooring.

Currently, chemical spills and effluents in the 300-Area are released to the 300-Area Process Sewers, and through them to the process trench where they may be released to the environment. Some other examples of inadequate containment observed in the 300-Area included a drain in a pit below the Building 334 Waste Acid Tank where, despite valving, discharges were reported to have occurred; waste acid neutralization facilities in Building 313 were surrounded by curbing with the process sewer within the curb; a caustic storage tank had inadequate capacity to retain the tank contents in the event of tank rupture; and a large, mobile tanker trailer for the storage of nitric acid had no secondary containment measures associated with it.

Information gained during the Environmental Survey indicates that the contractors are aware of the needs for spill prevention and control measures, although there are no clear priorities for such measures. For example, UNC has proposed improvements to spill containment measures at its 100-Area and 300-Area facilities, but has not provided an implementation schedule for those improvements. Also, the various environmental protection manuals used by Rockwell and WHC in the 200-Area and 300-Area, respectively, address spills and contamination in general terms only, and do not identify specific preventive or emergency actions to be taken. Due to the large quantities of hazardous materials stored in some cases, the preparation of much more specific guidance on emergency measures (e.g., site-specific SPCC plans) would be appropriate.

4.2.3.3 Category III

1. Pesticide Rinsate Release Areas. Herbicide rinsate releases to soils and groundwater have occurred in the 200-Area.

Two herbicide rinsate dump sites in the 200-Area have been identified and roped off. These sites are no longer in use, and the types or quantities of herbicide rinsate released to these areas has not been fully characterized, nor have residual concentrations in the soil been identified. The first area is located in the 200-East Area, across 4th Street from Building 275 EA. The second area is in the 200-West Area, near the intersection of Beloit and 20th Streets between 2713-W and 2902-W.

4.2.3.4 Category IV

1. Backlog of Testing of PCB Content in Oils. Concentrations of PCBs in open fluids (i.e., hydraulics, cutting, heat transfer) are not known because of the backlog in analyses at the HEHF Laboratory.

A subcontracting effort is underway to correct this situation, but until the subcontract is in place the samples that have been taken cannot be analyzed.

2. Supervision of Pesticide Applications. The potential exists for contamination of soils and groundwater through misapplication of herbicides.

The Certified Pesticide Applicator for Rockwell does not have direct supervision of the herbicide crews and does not routinely observe field applications. Although field crews are trained and certified, professional oversight by the Certified Pesticide Applicator would provide a necessary safeguard to the environment that does not currently exist. The Certified Pesticide Applicator is administratively assigned to a different organization than the field application crews and, thus, has no direct supervision of these personnel. This organizational status, in addition to the distance separating the locations where these people are assigned, allows potential oversights to occur in monitoring application of herbicides.

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4.3 Direct (External) Radiation

4.3.1 Background Environmental Information

This section presents information on background levels from direct radiation. Direct external radiation is defined as exposure to gamma photons, x-rays, and beta particles coming from radiation sources or radioactive material outside the body. This does not include radiation from ingested or inhaled radioactivity. The effects of radioactive materials in the soil, water, or air have been previously described in Section 3.0 of this report.

Background radiation is considered to be the radiation arising from radioactive material or radiation sources other than the Hanford Site. Background radiation is always present and has two major components, cosmic and terrestrial. The cosmic component is produced by interactions of high energy radiation from outer space with the earth's atmosphere and varies depending upon altitude above sea level. Background radiation levels from the cosmic radiation component vary in the U.S. from 26 mrem/yr* at sea level to 125 mrem/yr in Colorado (NCRP, 1975). Throughout the Hanford area, the contribution of cosmic radiation to the total background radiation is essentially constant at approximately 36 mrem/yr (Oakley, 1972).

The terrestrial radiation component of background radiation is due to over 50 naturally occurring radionuclides, mainly potassium-40 (K-40) and members of the uranium-238 (U-238) and thorium-232 (Th-232) decay series, in the earth's crust. This terrestrial component will vary in intensity, depending upon such factors as local geologic formations and ground moisture.

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* One roentgen (R) or one rad of gamma radiation is equivalent to one rem (which accounts for biological effects), assuming a quality factor of one.

Since World War II, there is a third source of background radiation caused by manmade radionuclides, such as cesium-137 (Cs-137) and strontium-90 (Sr-90), which have been distributed throughout the world as fallout from atmospheric nuclear detonations. This source, which has been decreasing from about 10-15 mrad/yr since above-ground testing stopped in the U.S., is usually included in the terrestrial component and presently constitutes a few mrad/yr. The terrestrial component of background in the U.S. generally varies by region from 15 mrad/yr along the Atlantic and Gulf coastal plains to 140 mrad/yr in the Colorado area (NCRP, 1975).

Within a 65-mile radius of the Hanford Site, the terrestrial background levels vary from town to town from approximately 16 to 29 mR/yr, as evidenced by total background radiation levels of 52 to 65 mR/yr, which are discussed later in the Hanford environmental monitoring program in Section 4.3.3.

According to Oakley (1972), the average total external dose rate from natural sources to an individual in the State of Washington is estimated to be 81.8 millirem per year. This rate includes 36.2 millirem per year from cosmic rays (excluding the neutron component) and 45.6 millirem per year from terrestrial sources. This total compares well with the average estimates of external exposure reported for the Washington Nuclear Plant (WNP-2) which is located on the Hanford Site. The average external dose rate in 1985 according to Washington Public Power Supply System (WPPSS) (1986) was estimated to be 80.3 milliroentgens per year. The NRC also monitors external exposure for WNP-2. In the first quarter of 1986, NRC reported an average external dose rate of about 67 milliroentgens per year for locations 6 to 20 miles from the WNP-2 reactor (Jang, Rabatkin, and Cohen, 1986). The background dose rate reported by the Hanford Site, calculated from the annual average dose rates observed at distant locations, was slightly lower in 1985 than in past years, at 59 millirem per year (Price, 1986). These various estimates of background external exposure Hanford Site are listed in Table 4-18.

4.3.2 General Description of Pollution Sources and Controls

This section describes the facilities (or areas) that are major sources of direct radiation at the Hanford Site, the controls used to reduce radiation at Hanford, and

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TABLE 4-18

COMPARISON OF VARIOUS ESTIMATES OF BACKGROUND EXTERNAL EXPOSURE FOR THE HANFORD SITE OR VICINITY

Source	Dose Rate	Area of Estimate
Oakley (1972)	81.8 mrem/yr	Washington State
WPPSS (1986)	80.3 mR/yr	WNP-2
Jang, Rabatkin, and Cohen (1986)	67 mR/yr	WNP-2 (6-20 miles away)
Price (1986)	59 mrem/yr	Hanford Distant Locations (25-65 miles from center of site)

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the methods used to reduce radiation exposure to members of the public. Most facilities at Hanford conduct operations that involve the production of radiation and/or the processing of radioactive materials. The methods used to control, i.e., reduce, direct radiation exposure are; shielding, distance and time. Hanford places shielding material between the source and the receptor, maintains large distances between the source and the receptor and/or limits the time the receptor stays in the radiation zone. Hanford, like most nuclear facilities, relies mainly on the first two methods to maintain radiation exposures to members of the public below the regulatory limits and as low as reasonably achievable (ALARA).

Since gamma radiation from a point source varies inversely with the square of the distance from the source, high-level facilities (where large quantities of radioactive materials are handled and where external direct radiation is of concern) were located near the center of Hanford (four miles or more from the closest site boundary). In addition, these facilities are normally heavily shielded to protect the workers and the public. After construction, public use of the Columbia River on the Hanford Site was denied, but this changed and the public now has access on the river up to the high-water mark. As a result, the exclusionary distance for the N-Reactor has been changed from approximately 4 miles to 500 feet to the reactor building and only 100 feet to the security fence where the dose rate is 0.4 mrem/hr in one area, or over 3500 mrem/yr for continuous occupancy (which in this particular case cannot occur).

Examples of high-level facilities are the 100-Area production reactors (only N is operating) which are shielded; the 200-Area Fuel Separations Facilities which are heavily shielded; the 200-Area High-Level Radioactive Waste Storage Tanks which are buried to provide shielding; the Radioactive Waste Burial Grounds, also located in the 200-Area; and the Fast Flux Test Reactor in the 400-Area.

The 300-Area, on the Columbia River near the south of the site, is a fuel fabrication area which also has research and development laboratories. There is a small TRIGA research reactor, some multicurie cources and hot cells (shielded cells) for the examination of irradiated fuel, but the facilities are well shielded.

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The 400-Area, north of the 300-Area towards the interior of the site, is the Fast Flux Test Facility (FFTF) which is a shielded sodium cooled reactor. The 1100 Area, near Richland, is a motor pool and warehouse area.

As a result of distance and/or shielding, little, if any, direct radiation from Hanford facilities is measurable at the site boundary. Direct radiation which may be present at the site boundary, would be the result of atmospheric releases of radionuclides, primarily noble gases.

Another source that should be discussed is the 1301N Liquid Waste Disposal Facility (LWDF) which received the liquid effluent from the 100N Reactor until September 19, 1985. This LWDF is a crib and trench in which the radioactive liquid percolates through the ground to the river with the soil column acting as a filter. This facility is not far from the river and the radiation level outside the fence along the road read approximately 1000 μR/hr (1 mR/hr) when monitored on August 19, 1986 by the Survey team. This facility is no longer in use because the soil column lost its ion exchange capacity and radioactive materials showed up in increased concentrations along the shoreline at the N-Springs. Measurements taken along the shoreline in the vicinity of the N-Springs by Survey team personnel indicated dose rates of over 0.2 mR/hr (over 1750 mR/year) where the public has access.

4.3.3 Environmental Monitoring Program

This section discusses environmental monitoring for direct radiation. Some contractors have a separate environmental monitoring program inside the particular facilities and/or areas for which they are responsible (i.e., 100-, 200-, 300-, 400-Area), while Pacific Northwest Laboratory (PNL) monitors the remainder of the site, outside the specified contractor areas, and off-site to provide a unified program. In the case of direct radiation, this is normally performed by placing thermoluminescent dosimeters (TLDs) on fences or stakes approximately 3 feet above the ground at monitoring locations and collecting and reading the TLDs on a specified frequency, usually monthly. The programs are discussed by contractor.

United Nuclear Corporation

United Nuclear Corporation (UNC) does have a separate environmental program for the 100 Area which abuts the Columbia River and includes several retired reactors and the operating N-Reactor. UNC has 36 environmental TLD locations around their facilities at the 100 N-Reactor which, for 1985, ranged from 0.007 mrem/hr to 0.409 mrem/hr. As would be expected, the closer to an operating facility the TLD is located, the higher the recorded dose rate. Of the 8 TLDs that are on fences or stakes on the side of the facility facing the shoreline the range was from 0.009 mrem/hr to 0.409 mrem/hr. (>3500 mrem/yr for continuous occupancy) with a typical value of .02 mrem/hr. (Jacques, 1986). This high measurement was on a fence approximately 100 feet from the shoreline and is attributed to the Emergency Dump Tank which is only a few feet from the TLD location. It should be noted that this area is above the high-water mark and under continuous surveillance by a guard so a member of the public could not be in this area long enough to exceed any limits.

The UNC 1985 Environmental Monitoring report (Jacques, 1986) also showed the results of an annual measurement performed with a micro-R meter from the N-Reactor Outfall to the N-Springs. Levels dropped from a high of approximately 105 μR/hr (0.10 mrem/hr or 876 mrem/yr) to a low of 12 μR/hr at the N-Springs. Measurements along the waters edge were performed with a micro-R meter by Survey personnel and readings of over 200 μR/hr were obtained in August of 1986. It is realized that the measurements taken in both cases were instantaneous readings, whereas the TLD readings were integrated over a year, but the dose rates were a factor of 5 to 10 higher than the annual average and the reactor was shut down at the time. The DOE guideline for the maximum dose to a member of the public was reduced from 500 mrem/yr to 100 mrem/yr in 1985 for prolonged exposures (Vaughan, 1985). Compliance is normally demonstrated at a site boundary by showing that radiation levels (above background) are lower than the guideline. Although the Columbia River is not the site boundary in the vicinity of the N-Reactor, the public does have access at the locations where the radiation measurements were made.

Rockwell Hanford Operations

Rockwell Hanford Operations (RHO) also has a separate environmental program for the 200-Area. Because of the complex of high radiation level facilities in the 200-Area they have established a grid pattern of TLDs to better determine typical radiation levels throughout the area in addition to the use of TLDs on fences, which are normally used to monitor a specific facility. For 1985, the TLDs at surface water sites had a maximum radiation level of 572 mrem/yr, measured at 216-U-10 Pond during the first quarter of 1985. This is a decrease from 3,700 mrem/yr in 1984 and is due to decontamination and decomissioning of U Pond in 1985. PUREX related facilities, including tank farms and active cribs, ranged from 78 to 4,693 mrem/yr at localized areas. The grid sites, which are located outside radiological control areas and represent the general environment, ranged from 63 to 175 mrem/yr. The elevated levels above background at grid sites are attributed by RHO to nearby waste sites and/or low-level contamination in the environment (Elder et al., 1986). Since the 200-Area is in the center of the site, the general public cannot gain access to it and therefore the 200-Area is not a direct radiation problem as relates to the public.

Pacific Northwest Laboratories

PNL has 4 TLDs in the 100 N-Area besides those used by UNC, but they are closer to the shoreline where the public has access. For 1985, they ranged from 0.019 to 0.025 mrem/hr (or 219 mrem/yr). As stated previously, if the new (1985) DOE standards of 100 mrem/yr (above background) are applied here, these values exceed the limit.

In the 300-Area, PNL had 2 TLDs on the perimeter fence, which for 1985, had a maximum dose rate of 0.017 mrem/hr and in the 400-Area there was one TLD with a dose rate of 0.007 mrem/hr. This latter dose rate is at the background level for the Hanford area. The above data is shown in Table 4-19.

The 16 Hanford Site perimeter TLD locations used by PNL ranged from 59 to 71 mrem/yr in 1985. Five nearby communities ranged from 52 to 58 mrem/yr with an average of 55 mrem/yr, while 5 distant communities ranged from 54 to 71 mrem/yr

TABLE 4-19
HANFORD TLD MEASUREMENTS - PUBLICLY ACCESSIBLE ON-SITE LOCATIONS - 1985

Location	Map Location(a)	Average Dose Rate, mrem/h(b)(c)
100N Area Shoreline		
100N Trench Springs	1	0.019 ± 0.014
Below 100N Main Stack	2	0.021 ± 0.008
Upstream Tip 100N Berm	3	0.022 ± 0.008
Downstream 100N Outfall	4	0.025 ± 0.007
300 Area Perimeter Fence		
3777-S Fence	5	0.017 ± 0.004
3705 West Fence	6	0.012 ± 0.003
400 Area (FFTF) Perimeter Fence		
400 East	7	0.007 ± 0.0006

(a) Locations are identified in Appendix F, Figure F-1
(b) Monthly integrated reading in mR were converted to hourly dose equivalent rates
(c) Averages ± 2 times the standard error of the calculated mean
(d) Data from Price, 1986 (Table A.38)

with an average of 59 mrem/yr. All of the above perimeter and off-site measurements fall within the range of background values for the area. The above data is shown in Table 4-20.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

None

4.3.4.3 Category III

1. Maximum Individual Dose Estimate. Direct radiation levels on the shoreline of the Columbia River near the 1301N Crib are substantially elevated above background. These radiation levels (of 175 millirem/per year or above) may be indicators of high radioactivity levels that are being released to the Columbia River.

   The site cannot demonstrate compliance with the maximum individual dose to a member of the public of 100 millirem per year in the vicinity of N-Reactor.

   Measurements were conducted along the shoreline in the same area as the UNC measurements using a micro-R meter on August 21, 1986. Radiation levels increased from 100 microentgens per hour at the N-Reactor Outfall to 240 microentgens per hour at the N-Springs (whereas the UNC survey conducted the previous year ranged from 105 to 12 microentgens per hour from the outfall to the N-Springs). Similar readings in the vicinity of the N-Springs were obtained a few days later with a second instrument.

   If the 240-microentgens-per-hour reading remained constant for a year, the integrated dose over a period of year would be approximately 2100 millirem to a person standing continuously at the high-water mark. Since the river is

TABLE 4-20
HANFORD TLD MEASUREMENTS - PERIMETER AND COMMUNITY LOCATIONS - 1985

Location	Map Location [a]	Average Dose Rate, mrem/yr[b][c]
Perimeter Stations		
Prosser Barricade	1	65 ± 6
ALE	2	65 ± 5
Rattlesnake Springs	3	69 ± 7
Yakima Barricade	4	71 ± 6
Vernita Bridge	5	65 ± 6
Wahluke #2	6	70 ± 7
Berg Ranch	7	71 ± 8
Sagehill	8	64 ± 8
Ringold	9	68 ± 13
Fir Road	10	66 ± 5
Pettett	11	60 ± 10
Sagemoor	12	64 ± 9
Byers Landing	13	68 ± 7
RRC #64	14	62 ± 5
Horn Rapids Rd. Mi. 12	15	62 ± 7
Horn Rapids Rd. Substation	16	59 ± 5
Range of Annual Averages 59-71 mrem/yr		
Nearby Communities		
Benton City	17	52 ± 6
Othello	18	54 ± 5
Connell	19	58 ± 6
Pasco	20	56 ± 7
Richland	21	55 ± 6
Range of Annual Averages 52-58 mrem/yr		
Distant Communities		
Walla Walla	22	57 ± 6
NcNary	23	65 ± 5
Sunnyside	24	59 ± 5
Mose Lake	25	54 ± 4
Washtucna	26	61 ± 4
Range of Annual Averages 54-65 mrem/yr		

(a) Locations are identified in Appendix F, Figure F-2
(b) Monthly integrated readings in mR were converted to annual dose equivalent rates
(c) Averages ± 2 times the standard error of the calculated mean
(d) Date from Price, 1986 (Table A.36)

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currently accessible to the public, the 100-millirems-per-year limit is being applied at the river's edge for the N-Reactor. Currently there are four environmental TLD monitoring points along the N-Reactor shoreline. Based upon a year's worth of TLD data, the dose rate along the shoreline averaged 175 millirem per year (for 1985) (Price, 1986). Based solely on TLD data, the site cannot show that the maximally exposed person would not have received in excess of 100 millirem per year.

During the sampling phase, measurements with a micro-R meter will be performed to verify the radiation levels. If the radiation levels are still similar, a portable multichannel analyzer will be used to characterize the radiation to determine its source. The potential sources are direct radiation from one or more facilities at N-Reactor, radiation from argon-41 in the gaseous plume being released from the stack (especially during inversion conditions), radiation coming from the N-Springs seeps (from the discharge of the Liquid Waste Disposal Facility), or a combination of all three.

2. Long-Term Release of Radioactivity to the Columbia River. Long-term and continuous surface and groundwater releases of radioactive constituents from the Hanford Site may potentially concentrate in the Columbia River sediments. These sediments may be taken up by bottom feeding fish and increase the radiation dose of personnel eating the fish.

Although Hanford Reservation employs an extensive monitoring system for the major emission points, it is known that some discharges, particularly groundwater seeps, are not as closely monitored. The cumulative effect of radiation releases over the lifetime of the Hanford Site may be concentrated in sediments and fish.

A sampling of sediments and fish will be performed to determine if there is a problem.

4.3.4.4 Category IV

None

4.4 Quality Assurance

4.4.1 General Description of Data Handling Procedures

This section of the report discusses the quality assurance (QA) aspects of the Hanford Site environmental field sampling (monitoring) and laboratory analytical programs. Because these programs logically are organized under separate contractors rather than by geographical area or location on the site, they will be discussed in that manner in this section of the report.

4.4.1.1 Rockwell Hanford Operations

Rockwell is responsible for effluent and environmental sampling in the 200-East and West areas. Sampling procedures manuals have been developed and are available to the sampling personnel. Sampling schedules and specific locations are provided in written manuals.

Sample bottles are clearly marked for sample tracking, and chain-of-custody procedures are employed. Sample data sheets are filled out with appropriate identification information and observations.

Sample procedures were appropriate to the media being sampled and procedures were generally followed by the sampling personnel.

The Rockwell 222S Chemical Laboratory is responsible for analyzing process, effluent, waste management, and environmental samples for all Rockwell activities at the Hanford Site. This laboratory handles radioactively contaminated samples, some of which are very highly contaminated. Non-radioactively contaminated or very low-level samples are sent to PNL or U.S. Testing for analysis.

The 222S Laboratory has an extensive QA manual, "Quality Assurance Program Plan-Analytical Laboratories," (RHO-QA-PL-19, Rev. 1) and a QA program in place. The laboratory's QA program is based on meeting NQA-1 standards as established by the American National Standards Institute (ANSI). Audits of QA assurance practice are carried out at several levels of the Rockwell organization. External audits of the 222S Laboratory are performed by Rockwell Hanford

Operations Management. Internally, the laboratory has its own QA organization that performs audits on various aspects of the laboratory's programs. Both types of audits are formal, with written reports and a tracking system to ensure follow-up on audit recommendations.

Laboratory analytical request cards follow each sample through the laboratory. Laboratory notebooks are maintained to record analysts observations and data results. All analytical results are entered from the analytical request cards to a computer system. All data are reviewed and approved by the appropriate laboratory supervisor before being entered in the computer. Computer data are immediately available to the client or data requestor and a follow-up hard copy of the data is sent to the requestor at a later date. Data tapes are archived for future retrieval.

Training for laboratory personnel is extensive and well-documented. Each analyst is trained not only on specific instruments and special analytical procedures, but also on routine or housekeeping procedures (e.g., waste disposal, safety, cleaning equipment). For analytical procedures, the analysts are required to perform a certain number of analyses on a reference or standard sample and their results must fall within specified performance measures before they are approved. A separate notebook is kept on each analyst showing the date of training with a review and approval by the appropriate supervisor. The laboratory has a complete set of procedures manuals that are kept up to date and are available to the analysts for easy reference.

Analytical instruments used in the laboratory have been well maintained and records show the frequency of maintenance. Calibrations are documented in laboratory notebooks and control charts are maintained.

The precision and accuracy of the analytical program are checked with the use of spikes, blanks, duplicates, and reference samples. This QA program has been computerized so that on a monthly basis the results are issued for review by the analyst and supervisor. The program has the ability to track both analyst and equipment performance and any problems are identified and corrective actions taken to remedy the situation.

4.4.1.2 Westinghouse Hanford Company

WHC operates the Hanford Engineering Development Laboratory (HEDL), and much of its analytical laboratory work is in support of the HEDL's research and development activities. The laboratory also performs liquid effluent monitoring from the 300-Area process trench and from the 400-Area wastewater, and airborne radioactive effluent monitoring from the various HEDL facilities. Liquid effluent samples are not analyzed for environmental compliance but are intended primarily for operations checks and process control.

Routine analytical work in the WHC Laboratory is performed in accordance with QA guidelines in its "Analytical Chemistry Laboratory Manual" (HEDL-MG-28). Samples can be tracked internally through the use of sample analysis cards, which follow the samples through the laboratory and contain such information as the type and source of sample, the analytical results, and signatures of analyst and supervisor. Additionally, the WHC laboratories participate in an on-site "round robin" analysis program wherein samples taken in triplicate are analyzed by WHC, Rockwell, and PNL for QA data comparison.

All samples analyzed are individually identified. For routine sampling at repetitive locations, dates are used to distinguish those samples with permanent identification numbers. The radiation counting instrumentation is checked daily, prior to sample analysis, for calibration, and control charts are maintained. Calibration checks outside the normal range of $\pm$ 1 percent are usually recounted, and checks falling outside the $\pm$ 3 percent range indicate the need for instrument shutdown and maintenance, although the instruments are recalibrated only when repairs are required.

As a routine practice prior to counting filter samples, the operator checks the "time-on" and "time-off" information from the data sheet against the previous week's information to make sure the recorded information is not in error. After counting data are obtained for a sample, the results are recorded in notebooks and on the sample card.

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Laboratory operator training is provided on an on-the-job basis under the "Chemistry and Analysis Training Program" manual. Certification of operator skills and knowledge of analytical procedures is determined by the supervisor.

4.4.1.3 UNC Nuclear Industries

UNI performs gamma analysis on effluent and environmental samples, as well as on primary and secondary cooling water for the 100N-Reactor. Weekly pH and chloride analysis is also performed for NPDES discharge monitoring.

The laboratory follows QA guidelines in UNI's "Effluent Radioanalytical Program" (UNI-M-76) which was modeled after EPA's Handbook for Analytical Quality Control in Water and Wastewater (EPA-600/7-77-088). The laboratory also participates in EPA's Interlaboratory Comparison Program on a bimonthly basis. Checks on analytical accuracy, precision, and background are performed weekly, as are instrument calibration checks. If equipment is found to be out of tolerance (± 6 or 7 percent), it is taken out of service until corrected.

Samples are assigned numbers in the laboratory by the lead technician, and then are directed through the laboratory. Sample logbooks are maintained, and they include the sampling schedule, data entries, and copies of the sample labels. Samples to be analyzed for alpha and beta emitters are relabeled and sent to U.S. Testing for analysis.

The monitoring data generated by UNI are stored in a computer data base. The data are checked by an anomalies program to detect any significant variations from the normal range of the samples. The anomalies program performs a statistical analysis of the results and identifies control limits exceeded, unusually high or low results, and any increasing or decreasing trends. Questionable data identified by the anomalies program are reanalyzed. The data generated by UNC are provided to DOE in the form of Environmental Release Summary Data reports and in an annual Effluent Release Report.

4.4.1.4 Pacific Northwest Laboratory

The PNL, which is operated by Battelle Memorial Institute, maintains the Hanford Environmental Surveillance Program (HESP). This program monitors the radionuclide and chemical concentrations in the Hanford Site environment by sampling a variety of environmental media, including air, groundwater, surface water, foodstuffs, wildlife, soil, and vegetation. In general, sampling is performed regularly by PNL personnel, with most analytical work performed by U.S. Testing (see Section 4.4.1.6) under subcontract to PNL.

The overall guidance for QA of the HESP is found in PNL-MA-65, the "Quality Assurance Manual," which was written to address NQA-1. This manual describes general QA protocols, which are implemented by individual QA plans and statements of work for specific monitoring programs within the HESP. Sampling is scheduled annually, and is compiled into the "Environmental Monitoring Master Sampling Schedule." Most sampling is performed at permanent locations to provide comparable data over time. Surface sampling locations are described in PNL-MA-514 and groundwater sampling locations are described in PNL-MA-592. Sampling procedures are described step-by-step in the "Environmental Monitoring Procedures" manual, PNL-MA-580.

Sampling schedules are provided daily through computer-generated trip logs and sample labels identifying the locations to be sampled and parameters to be analyzed. The trip logs serve to identify information pertinent to the sampling effort (dates, times, pump operating times, etc.) as well as provide chain-of-custody documentation. The level of documentation (trip logs) differs depending upon the media sampled and analyses required. The most extensive documentation is used in the Hazardous Materials Monitoring and RCRA Compliance Groundwater Monitoring projects, in which detailed sample labels, chain-of-custody forms, sample analysis requests, and sample log-in forms are prepared for each sample. Late Environmental Sampling Reports, that identify overdue sampling data, also provide additional cross-checks and documentation of sample status.

Sampling activities were observed for air, surface water, and groundwater during the Environmental Survey. All sampling personnel appeared to be familiar with the equipment and procedures used.

The data generated under the HESP are continuously reviewed and compared against historical data, and against other standards and criteria. An anomalous-data program statistically compares data with previous results. The Anomalous-Data Report identifies "failed" data and provides space for documenting instructions and/or actions to be taken. Sign-off spaces are provided to document or comment on the corrective action taken. Quality Assurance protocols also require the occasional submission of blind duplicate and spiked samples to the laboratories, and participation in the EPA Interlaboratory Comparison Program.

4.4.1.5 Hanford Environmental Health Foundation

The HEHF functions as an industrial hygiene resource for the contractors at the Hanford Site, performing ambient, effluent, and workplace sampling as well as providing analytical services. The HEHF does not perform any radionuclide sampling or analysis.

The HEHF conducts periodic (as needed) stack sampling for air pollutants, nitrogen dioxide ambient air monitoring, environmental monitoring at the 108H Basin, drinking water sampling, asbestos sampling, and other special sampling needs upon request (e.g., PCB analyses). Sampling procedures are taken from textbooks and standard industrial references, but there is no site-specific sampling procedures manual.

The HEHF Laboratory performs chemical and medical testing for the Hanford contractors. The HEHF has an extensive medical capability that falls outside the scope of this Survey; only the environmental analytical procedures will be included in this discussion.

The HEHF Laboratory has an operations manual that contains many of the analytical procedures and outlines the QA program ("Environmental Health Sciences Laboratory: Laboratory Operating Procedures" December 1, 1985). Personnel training and qualifications, sample handling, general laboratory operations, analytical procedures, quality control, and instrument operating guides are covered in the procedures manual, although not all analytical procedures are detailed in the manual. For example, several National Institute of Occupational Safety and Health (NIOSH) methods are incorporated by reference.

There is no evidence of internal QA audits at this laboratory, but several external groups perform audits as part of its certification and approval programs. The laboratory is approved by the State of Washington for drinking water analysis and is accredited by the American Industrial Hygiene Association (AIHA) for asbestos work.

Laboratory notebooks are not used by the analysts in the laboratory in favor of recording all data on the analytical worksheet cards. All worksheets are reviewed and approved by the appropriate laboratory supervisor before data are recorded in the record books and the report is issued to the client/requestor. Sample data can be easily checked through the laboratory, and historical analytical results are easily retrievable.

Chain-of-custody-documentation for the analytical samples is maintained in the laboratory and well documented on the record copy of the sample.

Maintenance and calibration records are maintained in notebooks and the type and frequency of calibration appear adequate. Control charts are maintained on analytical procedures to ensure that performance is within control limits.

The HEHF Laboratory utilizes a wide range of analytical reference standards both as part of its certification efforts and for independent interlaboratory comparisons of performance. State of Washington, EPA, and AIHA sources are used for standards. Blanks and duplicate samples are analyzed periodically to check laboratory performance.

4.4.1.6 U.S. Testing Company, Inc.

U.S. Testing (UST) performs over 90 percent of PNL's environmental monitoring analyses under subcontract to PNL. As such, its statement of work (provided to PNL) specifies the type of QA procedures to be used in those analyses. These procedures are documented in UST's Quality Control Manual (UST-RD-QC-9-80) and Quality Assurance Manual (UST-RD-QA-7-80). In addition to the PNL sample analyses, UST also performs low-level radioanalyses (to which their QA procedures also apply) for other facility contractors. UST's analytical procedures are documented in its 2-volume Analytical Procedures Manual (UST-RD-PM-9-80).

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When samples are received by UST, they are checked against the accompanying trip sheets, surveyed for radioactivity, assigned a unique number, and logged into its tracking system. Analytical cards and quality control (QC) vials are assigned and the samples are scheduled for analysis. The laboratory runs blank samples at the rate of 5 percent, and spikes at 10 percent. PNL also submits occasional blind duplicate samples. Additionally, the laboratory participates in the EPA Interlaboratory Comparison Program and uses National Bureau of Standards (NBS)-traceable standards. Data generated by UST are internally reviewed before being approved and submitted to PNL. The remaining samples are retained in storage for later reanalysis, if required after PNL's subsequent review of the data received.

4.4.2 Findings and Observations

4.4.2.1 Category I

None

4.4.2.2 Category II

None

4.4.2.3 Category III

None

4.4.2.4 Category IV

1. Laboratory Analysis of Environmental Data. Environmental monitoring data collected by HEHF may not accurately reflect environmental conditions.

   HEHF does not have a site-specific sampling procedures manual or a sampling location and scheduling guide; thus, samples may not be collected according to the proper technique, and samples could be taken from the wrong locations.

2. Incomplete Analyst Training Records at HEHF. Laboratory data results may be inconsistent because of lack of standardized training of analysts on specific procedures and instruments.

Training of the HEHF Laboratory analysts is largely undocumented and existing records appear to be out of date. No formal records were available showing training in either general and specific laboratory procedures. Training records focused primarily on seminars, academic courses, and outside training.

3. Sample Documentation. Sampling and analysis procedures are not equally documented by all Hanford Site contractors, and records and analytical forms are not always clear in indicating the transfer of samples and when custody was initiated and terminated for each person.

Recently initiated chain-of-custody procedures at the Rockwell 222S Laboratory have not been completely implemented due to multiple entry receipt points for samples into the laboratory. However, laboratory personnel have made modifications to improve this situation.

The WHC Laboratory employs different levels of documentation depending upon the purpose of the analysis and the documentation requirements of the client/requestor. For example, samples from the Basalt Waste Isolation Project (BWIP) will receive a "high" level of documentation due to the decision-making needs of the data. Analytical work for this program is performed in accordance with the "Geologic Repository Quality Assurance Manual" (HEDL-MG-197). On the other hand, routine effluent monitoring samples internal to WHC will receive a "lower" level of documentation, and in some cases where a quick or perhaps qualitative answer is required, no formal QA documentation is provided.

The recorded counting data at the WHC Laboratory are not independently checked to determine if any data transcription errors may have occurred. However, since the samples are from routine processes, any recorded data significantly out of the normal range would be noticeable.

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No formal chain-of-custody documentation is maintained by the UNI laboratories to document the transfer of samples sent to U.S. Testing. However, the frequency and routine nature of the sampling produces a large quantity of data through which sample transfer can be determined indirectly.

3. Environmental Sampling Equipment and Procedures. Sample collection equipment was observed in some locations to have apparently malfunctioned. In several instances, automatic sampling devices for collecting PNL's environmental surveillance samples did not appear to be operating correctly (e.g., water sample collection bottle overflowing; air sampling pump not functioning). Due to the large number and frequency of repeated samplings, these observed instances may have little or no bearing on long-term data trends. Increased emphasis on refresher training for sampling personnel and on instrument maintenance and calibration should serve to improve any negative effects the malfunctions may have on specific sampling results and on the surveillance program in general.

4.5 Inactive Waste Sites and Releases

4.5.1 General Description of Pollution Sources and Controls

The Hanford Site has generated contaminated liquid and solid wastes since its inception in 1943 and has disposed of these wastes in the operational areas known as the 100-, 200-, 300-, and 600-Areas. At the time of the Survey, 337 inactive waste sites had been identified on the Hanford Site. These waste sites were identified as a result of the first phase in the implementation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) program for the DOE Richland Operations Office (RLO) and reported in a document titled Draft Phase I Installation Assessment of Inactive Waste Disposal Sites at Hanford (DOE-RLO, 1986). At the time of the Survey, this document was the most current; however, it did not address sites that closed after November 1980. Also, no inactive sites had been identified in the 400-Area or the 1100-Area. The majority of the 337 sites received radioactively contaminated waste. Chemical contaminants were also present in some of the wastes generated by the Hanford operations, but information on the types and quantities of chemicals is incomplete.

The distribution of the 337 sites by each major operational area is depicted in Figure 4-4. As shown in this figure, 216 sites (or 64 percent) are located in the 200 East and West Areas used for chemical separations and processing. The information in the Phase I document (DOE-RLO, 1986) indicates that approximately 300 billion gallons of liquid wastes have been placed in land-based disposal sites at the 200 Area. In comparison, 90 inactive waste sites (or 27 percent) have been identified in the 100 Area, where the eight inactive reactors are located, along with the 100N reactor. The volume of liquid waste disposed of in the 100 Area is estimated to be approximately 80 billion gallons. Three sites are located in the 300 Area used for fuel fabrication, with an estimated waste volume of 5.6 million gallons. The remaining inactive waste sites are located in the 200 North Area and the 600 Area. The available information is insufficient to quantify the total amount of solid or dry waste placed in the inactive waste sites at Hanford.

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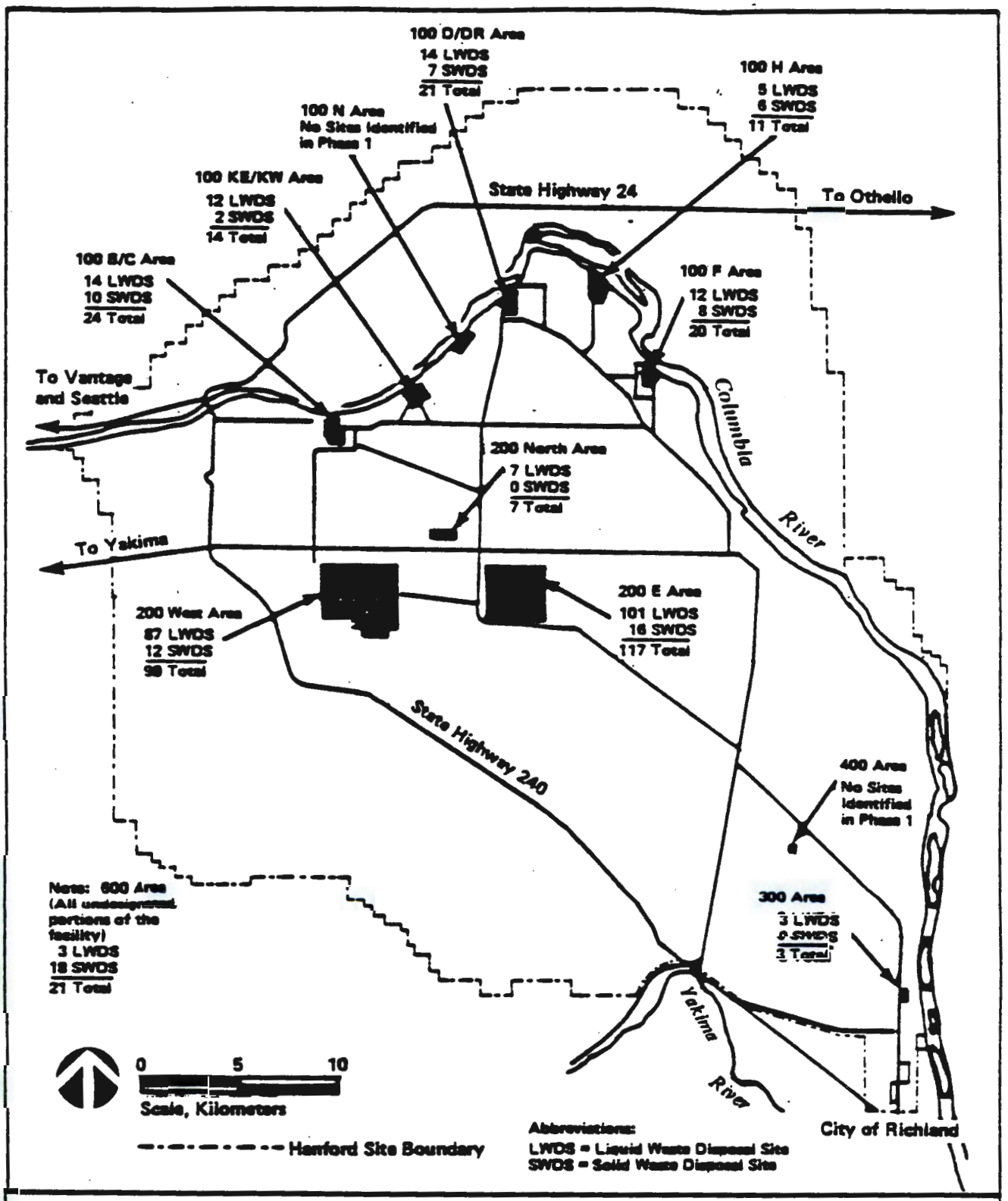

Source: DOE-RLO, 1986.

DISTRIBUTION OF INACTIVE WASTE SITES IN EACH OPERATIONAL AREA OF THE HANFORD SITE

FIGURE 4 - 4

4.5.1.1 Description of Waste Disposal Methods

At the Hanford Site, 15 basic methods of waste disposal have been used during its 44 year period of operation. As an overview of the types of inactive waste disposal sites existing at Hanford, the 15 disposal methods are described below. The disposal methods are grouped according to those used for liquid wastes and those used for solid or dry wastes. Table 4-21 provides a breakdown of the number of inactive waste sites by disposal method for each area of the Hanford Site.

Process liquid wastes have traditionally been disposed of on land using eight different disposal methods: cribs, tile fields, french drains, trenches, ditches, ponds, reverse wells, and dry wells. A brief explanation of each of these disposal technologies is presented below.

- Cribs are below-grade, soil-covered facilities that are typically constructed of wooden or concrete side supports with an open bottom, and have a liquid distribution line extending through a bed of highly permeable material, such as gravel or crushed stone. Cribs range in depth from 2 to 35 feet with most falling in the 10-25 foot range. Their areal dimensions are based on the volume and dispersion capacity of the distribution system. One of the smallest cribs covers a 16 sqaure foot area while one of the largest cribs occupies 44,000 square feet. Cribs received both radioactively and chemically contaminated liquids (DOE-RLO, 1986). In some cases, cribs were designed on the basis of the radionuclide retention capacity of the unsaturated soil column beneath the crib. Cribs are sometimes built in conjunction with a tile field that disperses the liquid over a larger surface area. Figure 4-5 depicts a typical box-like crib structure with a connecting tile field. Sufficient backfill material is placed over the crib to prevent surface contamination and to reduce the direct radiation hazard (Harmon, 1975 and English, 1984).

- French drains function similarly to cribs in dispersing liquids to the subsurface soil. The primary difference is that a french drain is designed to receive a smaller quantity of wastes (Harmon, 1975). French drains range from 2 to 10 feet in diameter and 3 to 44 feet in depth. Both radioactively and chemically contaminated wastes were placed in french drains (DOE-RLO, 1986).

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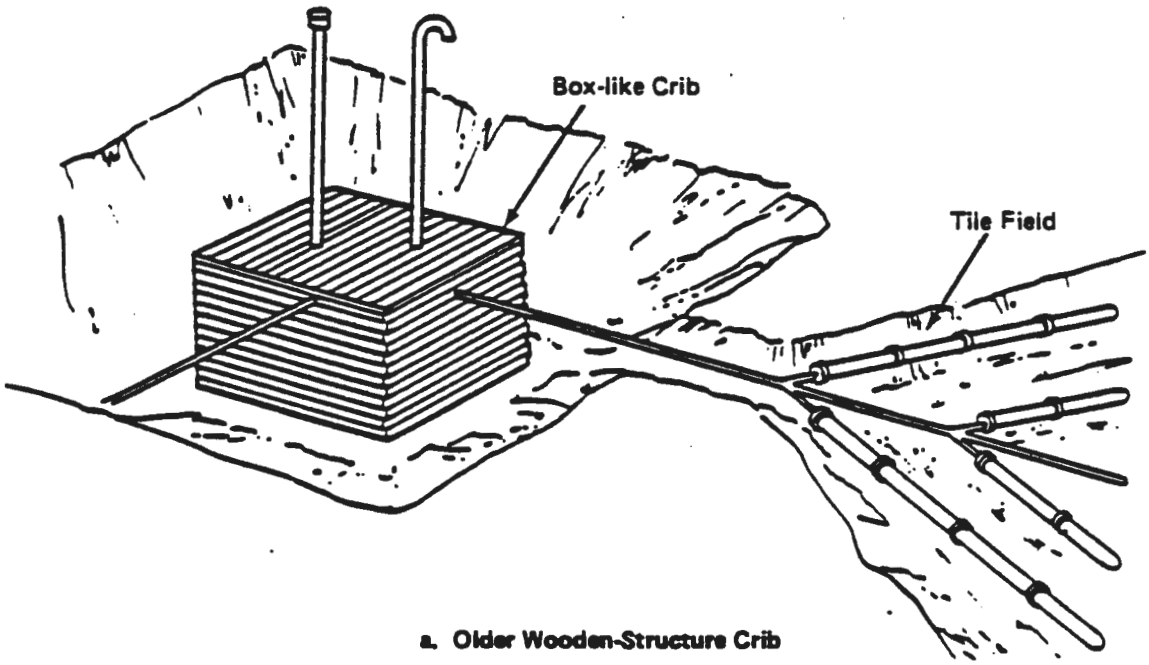
TABLE 4-21

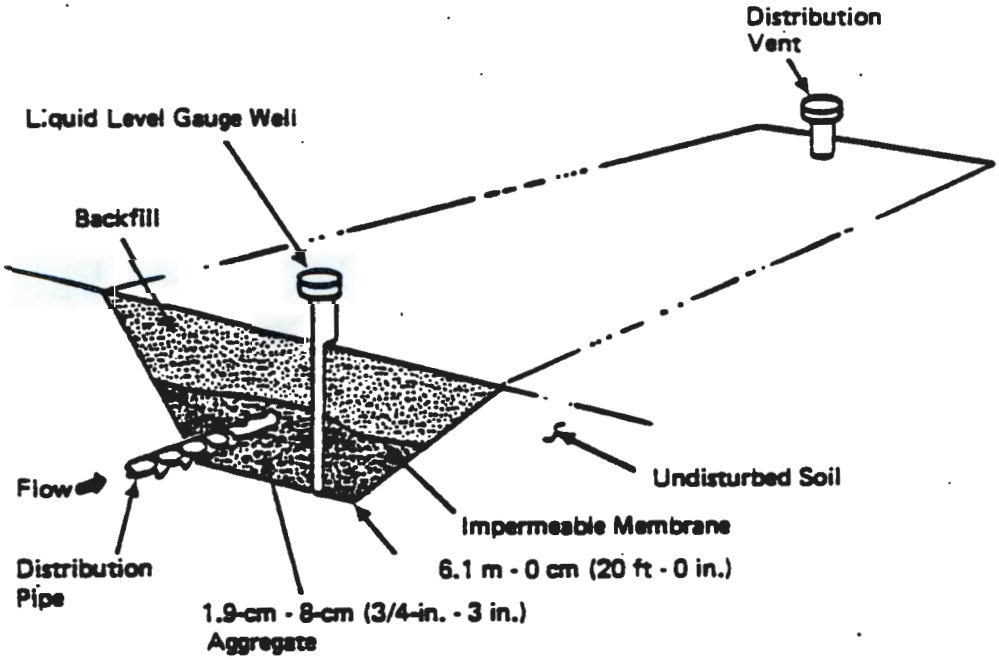
BREAKDOWN OF INACTIVE WASTE SITES BY DISPOSAL METHOD FOR EACH AREA OF THE HANFORD SITE AS IDENTIFIED IN THE PHASE I INSTALLATION ASSESSMENT REPORT

Hanford Area Designation	Liquid Waste Disposal Sites (LWDS)									Solid Waste Disposal Sites (SWDS)					Total LWDS & SWDS
	Ponds	Cribs	Trenches	Ditches	French Drains	Reverse Wells	Dry Wells	Tile Fields	Total LWDS By Area	Landfills	Burial Grounds	Burning Pits	Burial Vaults	Total SWDS By Area	
100 B/C	--	8	3	--	2	--	1	--	14	--	8	1	1	10	24
100 KE/KW	--	4	2	--	4	--	2	--	12	--	1	1	--	2	14
100 N	--	--	--	--	--	--	--	--	0	--	--	--	--	0	0
100 D/DR	--	5	6	--	3	--	--	--	14	--	6	1	--	7	21
100 H	--	2	2	--	1	--	--	--	5	--	5	1	--	6	11
100 F	--	2	5	--	5	--	--	--	12	--	6	1	1	8	20
200-East	--	46	29	5	17	4	--	--	101	--	12	1	3	16	117
200-West	5	34	28	7	8	4	--	1	87	--	8	2	2	12	99
200-North	3	4	--	--	--	--	--	--	7	--	--	--	--	0	7
300-Area	2	1	1	--	--	--	--	--	3	--	--	--	--	0	4
400-Area	--	--	--	--	--	--	--	--	0	--	--	--	--	0	0
600-Area	--	2	--	--	--	--	--	--	3	4	14	--	--	18	20
Total No. of Sites by Disposal Method	10	108	76	12	40	8	3	1	258	4	60	8	7	79	337

Source: DOE-RLO, 1986



a. Older Wooden-Structure Crib



b. Side-View of Typical Rock-Filled Crib

Source: Harmon, 1975 and DOE-RLO, 1986.

SCHEMATIC OF A TYPICAL CRIB
HANFORD SITE

FIGURE 4 - 5

- Trenches and ditches are usually unlined, long and narrow excavations that can be either covered or uncovered. The distinction between the two is that trenches are used for liquid disposal through percolation while ditches are constructed to convey the waste stream. Mixed waste has been placed in both types of structures, however trenches received higher activity waste streams (Harmon, 1975). The degree of sideslope varies among these structures but usually the sidewalls are formed by the existing soils rather than being reinforced by wood or concrete. Trenches range in depth from 3 to 25 feet and in length from 10 to 4,000 feet. The ditches at Hanford are usually shallower, with depths ranging from 2 to 8 feet. Their lengths vary from 850 to 4,150 feet (DOE-RLO, 1986).

- Ponds are bodies of water enclosed in a natural or diked surface depression used for the disposal of large quantities of liquid effluents through percolation and evaporation. The inactive ponds at Hanford range from 1.5 to 31 acres in size (DOE-RLO, 1986). Maintenance of a pond's efficiency for liquid disposal is achieved through periodic dredging of the settled solids on the pond bottom. In the more recently designed pond extensions, series of trenches were excavated in the pond bottom to increase percolation, since the liquid waste could move more readily through the sides of the trenches than through the pond bottom where the solids settled. Pond configurations differ, with some being a continuous open body of water and others being a series of smaller basins connected by pipes or an overflow outlet.

- Reverse wells are cased boreholes, usually drilled only into the unsaturated zone, with screens or perforations set at various depths to allow liquids to disperse into the subsurface material. The construction details and depths of the reverse wells used at the Hanford Site vary considerably but the concept of waste disposal is the same. Well diameters range from 3 to 8 inches at the screened interval. Most reverse wells have a total depth of 75 to 150 feet. There are two wells however that are noteably deeper. One well is set at a depth of 206 feet, which is approximately 40 feet above the groundwater table. The other well has a total depth of 302 feet and is about 20 feet below the water table (DOE-RLO, 1986). This method of waste disposal is no longer used at the Hanford Site.

- Dry wells are essentially sumps with open bottoms, ranging in size from 4 foot cubes to cylinders that are 3 feet in diameter with a total depth of 7 feet. Wooden or steel covers are used to limit access. Both liquid and sludge waste have been disposed of in dry wells (DOE-RLO, 1986).

Storage of highly radioactive liquid wastes exists at the Hanford Site using underground steel-lined concrete tanks. Originally the tanks contained a single carbon-steel liner; these are now being replaced by double-lined tanks. Because of the expense and limited volume of waste tanks, the Hanford Site initiated a program to minimize the volume of wastes by evaporating water from tanked wastes, allowing wastes to settle, and decanting the supernatant. The contents of most tanks, therefore, consist of sludge, salt cake, and bound interstitial water (English, 1984).

Solid wastes were disposed of in the following:

- Burial grounds for radioactively contaminated solid wastes exist in each operational area on the Hanford Site. Beginning in 1968, solid wastes generated in the 300-Area were shipped to the 200-Area for disposal (Harmon, 1975). This practice began for the 100-Area in 1973 (Dorian, 1978). The majority of solid waste has been disposed of at the Hanford Site through landfilling, commonly using the trench method. Depths of excavation range from 6 to 25 feet and the sizes range from less than 1 acre to 15 acres (DOE-RLO, 1986). Associated with some of the burial grounds on the Hanford Site are structures called caissons. Caissons are varied sizes of metal pipe buried vertically and used for disposal of small items (Harmon, 1975).

  Segregation of contaminated solid waste was based on combustion properties, the level of radioactive contamination, and the size of the article to be buried, with the larger, more cumbersome articles being placed together. In the early years of operation, minimal controls were placed on waste packaging prior to disposal and most of these controls were selected based on safety considerations for the workers handling the waste.

- Construction pits were also used for solid waste disposal. Typically, an old borrow pit was used for disposal of material such as concrete and wooden construction debris, scrap metal, and plasterboard. Construction pits may have also received asbestos and paint wastes. Radioactive wastes were not disposed of in these pits. As an example of the size of these pits, one in the 200 Area is reportedly 1,500 ft x 50 ft x 20 ft (DOE-RLO, 1986). Once filled, these pits were covered with soil.

- Vaults, silos, and tunnels are secure structures used to dispose of radioactively contaminated solid wastes that are usually underground. By design, these structures allow for retrieval of wastes and could possibly be classed as waste storage areas. Vaults are used to dispose of small quantities of highly radioactive solid waste, such as laboratory samples (English, 1984). Their dimensions range from 16 ft x 8 ft x 8 ft to 16 ft x 16 ft x 28 ft. One vault is located above-ground and is 427 ft x 100 ft x 5 ft in size (DOE-RLO, 1986). Silos are similar, but are larger structures used to dispose of highly radioactive reactor hardware. Tunnels are used to dispose of large pieces of highly contaminated equipment on flatbed rail cars. One tunnel at the PUREX facility is 358 feet long, 22.5 feet high and 19 feet wide containing contaminated equipment stored on 8 railroad cars (DOE-RLO, 1986). The other tunnel at PUREX, which is considered active, is almost five times longer than the inactive one (McLaughlin, T.J., 1986).

- Burning grounds were used in each operational area for nonradioactive combustible solid waste disposal. The frequency of use and the types of waste disposed of by open burning have not been well documented. Reportedly, paint wastes and solvents may have been disposed of in these pits. The 100-Area burning grounds were reportedly 100 ft x 100 ft and 10 ft deep (English, 1984 and DOE-RLO, 1986).

- Ash pits are also present in the Hanford Site areas. These pits are earthen excavations primarily used for the disposal of fly-ash and bottom ash from coal-fired boilers that generate process steam. The dimensions of the ash pits were not available in the background documentation.

4.5.1.2 Area Description and Waste Information

The review of inactive waste sites and past releases included a visual inspection of the 100-, 200-, and 300- and 600-Areas on the Hanford Site. This subsection provides a basic overview of each area and tabulations of waste types and quantities for the inactive waste sites.

4.5.1.2.1 100-Area

The 100-Area is the location of eight inactive nuclear reactors and the 100 N Reactor. The reactors are situated in six discrete locations along the Columbia River. Their order, from upstream to downstream, is as follows:

100B/C (two reactors colocated)
100KE/KW (two reactors colocated)
100N
100D/DR (two reactors colocated)
100H
100F

Chemicals and radioactive wastes have been disposed of at all of the reactor locations. A summary of the types and quantities of chemical wastes placed in the inactive sites at the eight inactive reactor locations is provided in Table 4-22. Sites at the 100N Reactor, however, were considered by Hanford contractors as being either active or closed after November 1980. Therefore, specific waste inventory information was not available for these waste sites. Table 4-23 provides a summary of the number of curies (decayed through April 1, 1986) for selected radionuclides disposed of in the 100 Area inactive waste sites. A summary of the volume of waste disposed of in these inactive waste sites is given in Table 4-24.

As shown by these tables, for the 100 Area reactors the largest volume of liquid wastes has been disposed of in the 100KE/KW-Area. Similarly, the largest quantities of sodium dichromate, sodium hydroxide, sulfuric acid, copper sulfate, cadmium and mercury have been disposed of in the 100KE/KW-Area. The number of curies of tritium, cesium-137, and plutonium-239 are noteably higher in the

TABLE 4-22

TYPE AND QUANTITY OF CHEMICALS DISPOSED OF IN THE 100-AREA INACTIVE WASTE SITES

	100-Area Reactors				
	B/C	KE/KW	D/DR	H	F
Chemical/Compound (Units in kg)					
Sodium Dichromate	1,760	300,040	1,782	3,690	2,164
Sodium Oxalate	2,200	–	2,000	2,000	2,000
Sodium Sulfamate	7,200	–	2,000	2,000	2,000
Sulfamic Acid	–	10,000	–	–	4,000
Sodium Hydroxide	–	100,000	–	–	–
Sulfuric Acid	–	100,000	–	–	–
Copper Sulfate	–	500	–	–	–
Potassium Borate	–	–	3,000	–	–
Ammonium	–	–	–	–	1,000
Metallic Waste (Units in kg)					
Aluminum	129,815	201,031	117,206	43,181	59,783
Lead	214,366	82,965	296,012	93,983	112,762
Cadmium	7,438	17,145	7,438	3,175	3,900
Graphite	582	146	108	43	70.7
Desiccant	28	33	28	16	16
Boron	1,724	1,360	1,632	725	816
Mercury	0.9	1,500	–	–	–

Source: DOE, 1986

9 2 1 2 4 1 1 7 3 5

TABLE 4-23
NUMBER OF CURIES* FOR SELECTED RADIONUCLIDES DISPOSED OF IN THE 100-AREA INACTIVE WASTE SITES HANFORD SITE

Radionuclide	100 B/C-Area		100 KE/KW-Area		100 D/DR-Area	
	Liquid Waste	Solid Waste	Liquid Waste	Solid Waste	Liquid Waste	Solid Waste
Tritium (H-3)	190.77905	14808.50000	154.52800	7.00000	2.10900	7.00000
Cobalt-60 (Co-60)	190.39759	1542.00000	67.93101	2289.00000	2.37678	1443.00000
Strontium-90 (Sr-90)	5.42484	2.80000	11.71722	7.60000	0.94884	2.63000
Iodine-129 (I-129)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Cesium-137 (Cs-137)	14.72361	2.80000	167.86564	7.60000	28.06670	2.63000
Plutonium Isotopes						
Pu-238	0.11331	0.00000	0.19110	0.00000	0.00000	0.00000
Pu-239	0.24247	0.00000	4.64300	0.21600	0.14436	0.00000
Pu-240	0.03412	0.00000	0.51590	0.01380	0.01604	0.00000
Pu-241	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Uranium Isotopes						
U-233	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
U-235	0.00046	0.00000	0.00280	0.00000	0.00053	0.00000
U-238	0.17438	0.00000	0.31919	0.00000	0.06184	0.00000
Beta	0.00000	0.00000	0.97400	0.00000	0.26460	0.00000
Gamma	0.00000	0.00000	0.00000	0.00000	0.00200	0.00000
Alpha	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

* Values Decayed Through April 1, 1986.

Source: DOE-RLO, 1986

TABLE 4-23
NUMBER OF CURIES* FOR SELECTED RADIONUCLIDES
DISPOSED OF IN THE 100-AREA INACTIVE WASTE SITES
HANFORD SITE
PAGE TWO

Radionuclide	100 H-Area		100 F-Area		All of the 100-Area	
	Liquid Waste	Solid Waste	Liquid Waste	Solid Waste	Liquid Waste	Solid Waste
Tritium (H-3)	0.24578	3.50000	2.07660	4.30000	349.73843	14830.30000
Cobalt-60 (Co-60)	0.92584	614.00000	1.55634	766.30000	263.18756	6654.30000
Strontium-90 (Sr-90)	1.24414	1.00000	3.31346	11.70000	22.64850	25.73000
Iodine-129 (I-129)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Cesium-137 (Cs-137)	4.09910	0.00000	3.88474	1.30000	218.63979	14.33000
Plutonium Isotopes						
Pu-238	0.00309	0.00000	0.00053	0.00000	0.30803	0.00000
Pu-239	0.06418	0.00000	0.06634	0.00000	5.16035	0.21600
Pu-240	0.00673	0.00000	0.00736	0.00000	0.58015	0.01380
Pu-241	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Uranium Isotopes						
U-233	0.00000	0.00000	0.00016	0.00000	0.00016	0.00000
U-235	0.00144	0.00000	0.01901	0.00000	0.02424	0.00000
U-238	0.16494	0.00000	0.02435	0.00000	0.74470	0.00000
Beta	0.00000	0.00000	0.00000	0.00000	1.23860	0.00000
Gamma	0.00000	0.00000	0.00000	0.00000	0.00200	0.00000
Alpha	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

* Values Decayed Through April 1, 1986.

Source: DOE-RLO, 1986

TABLE 4-24

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 100-AREA INACTIVE WASTE SITES HANFORD SITE

100-Area Reactors	Volume of Waste Disposed*	
	Liquid Sites (gallons)	Solid Sites (cubic feet)
B/C	1.2×10^{8}	8.9×10^{5}
KE/KW	7.9×10^{10}	3.5×10^{5}
D/DR	2.6×10^{7}	1.4×10^{6}
H	1.8×10^{8}	4.6×10^{5}
F	3.6×10^{8}	1.8×10^{6}
Total	7.9×10^{10}	4.9×10^{6}

* NOTES:

Volumes given are the best available estimates to date, but it should be recognized that the database is incomplete.

Source: DOE-RLO, 1986

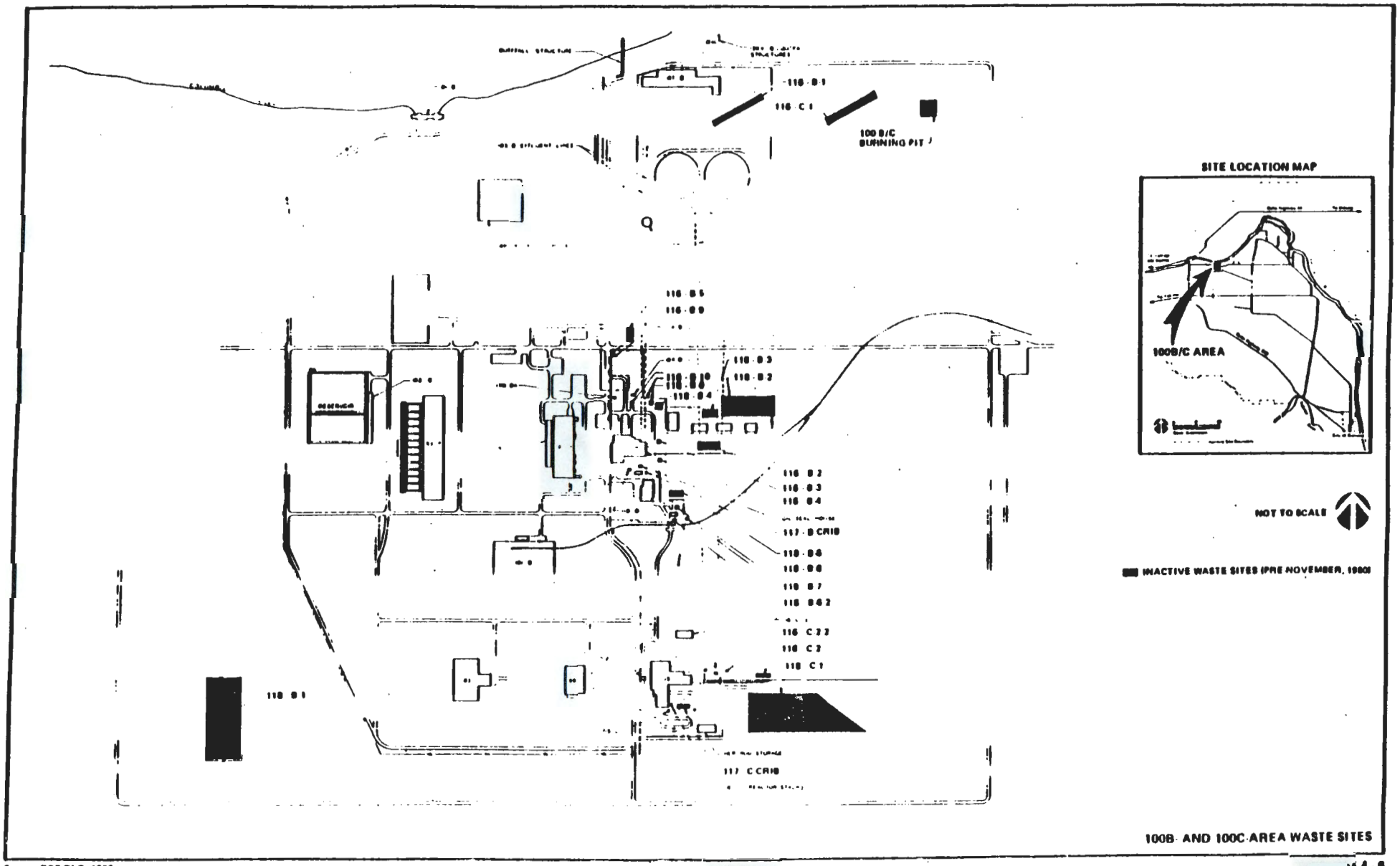
liquid waste sites at the 100KE/KW inactive waste sites, along with cobalt-60 in the solid waste sites. The number of curies of tritium (for both liquid and solid waste sites) and cobalt-60 (for the liquid waste sites) at the 100B/C-Area are also noteably higher than the values reported for the other reactor inactive sites. The values for strontium-90 are highest in the 100F-Area inactive waste sites, while the 100D/DR-Area inactive waste sites contain the largest quantity of lead.

The following paragraphs provide information specific to each reactor location, presented in the order that they are situated along the Columbia River.

100B/C-Area

Twenty four inactive waste sites have been identified in the 100B/C-Area, as shown in Figure 4-6. Signs with the site identification number are present at most site locations. Some of the sites were marked with radiation signs (designating surface or subsurface contamination) and rope barriers as needed. Generally, herbicide applications to the land surface have eliminated vegetation on top of the covered sites. Signs of wind or water erosion of surface soils were not apparent. Table 4-25 provides the number of sites in the 100B/C-Area grouped by disposal method and the estimated total volume of waste received in each type of disposal structure. A review of available data indicates that wastes have been disposed of to a maximum depth of 25 feet, which is about 15 feet above the water table. Only six groundwater monitoring wells are located in the 100 B/C-Area; therefore groundwater contamination problems potentially associated with the 24 individual inactive waste sites cannot be identified. Also, several of the liquid waste disposal sites are located within 200 feet of the Columbia River.

In addition to the sites identified by the Phase I effort, there are two inactive retention basins, once used to temporarily hold the reactor cooling water, in the 100B/C-Area, along with areas where sludge was removed from the basins and disposed of on the land adjacent to these structures. The basins are currently dry and the remaining sludge has been covered by available soils. The associated underground pipe systems also exist and their location is marked by radiation signs. Based on information provided by UNC, these retention basins and the ancillary structures have leaked large quantities of liquid into the subsurface material.



100B- AND 100C-AREA WASTE SITES

Source: DOE-RLO, 1990.

TABLE 4-25

REPORTED VOLUME OF WASTE DISPOSED OF IN THE
100B/C-AREA INACTIVE WASTE SITES
HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	7	4.6×10^6	-
Trenches	3	1.2×10^8	-
French Drain	1	8.9×10^4	-
Drywell	1	1.3×10^6	-
Burial Grounds	10	-	8.9×10^5
Burial Vault	1	-	NA
Burning Pit	1	-	NA
Total	24	1.2×10^8	8.9×10^5
Date of Last Use		1969	1973

NOTES:

Maximum Reported Depth of Waste Disposal = 25 ft.

Depth to Water Table at Above Site = 41 ft.

NA: Not Available

Source: DOE-RLO, 1986

Radionuclides were the primary contaminant reported in the cooling water. These basins are on the bank of the Columbia River and groundwater is approximately 40 feet below the land surface. The residual contamination (chemical and radioactive) in the buried sludges and the potential for gradual release to the river via groundwater have not been documented.

Future plans for the B-Reactor include the possibility of opening portions of the plant to the public as a museum because it was the first operating production reactor of its type in the United States.

100KE/KW-Area

There are 14 inactive sites in the 100KE/KW-Area, as shown in Figure 4-7. During the Survey, eight inactive sites were visually inspected. Table 4-26 provides a summary of the volume of waste placed in the 100K-Area sites. Waste volumes are based on available data, which are not well documented for each site. Refer to Table 4-22 for a summary of chemicals disposed of in the inactive sites and to Table 4-23 for the inventory of selected radionuclides.

Two major releases at the 116KE, KW-1 (107 Retention Basins) and the 116-KE-2 (105KE Fuel Storage Basin) were identified during the Survey. The 107 Retention Basins leaked water contaminated with radionuclides at a rate of 10,000 to 20,000 gallons per minute between 1955 and 1971. The 105KE Fuel Storage Basin leaked radioactively contaminated water at a rate of 450 gallons per hour for an unknown period until repaired in 1979 (Diediker, L.P., 1985). No chemical releases were identified by the Survey team, since recordkeeping for nonradioactive contaminants did not exist until recently.

100N-Area

One inactive waste site, the 1301N crib and trench, was identified during the Survey in the 100N-Area. The Phase I effort did not include this site as one of the 337 because it closed after November 1980. Also, the 100N-Area was the only location identified that utilized silos, one of the disposal methods described in Section 4.5.1.1. Further, available information on releases in the 100N-Area was reviewed.

TABLE 4-26

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 100KE/KW-AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	4	1.2×10^7	-
Trenches	2	7.9×10^{10}	-
French Drains	4	NA	-
Dry Wells	2	NA	-
Burial Ground	1	-	3.5×10^5
Burning Pit	1	-	NA
Total	14	7.9×10^{10}	3.5×10^5
Date of Last Use		1971	1975

NOTES:

Maximum Reported Depth of Waste Disposal = 39 ft.

Water Table Elevation for the Above Site = 68 ft.

NA: Not Available

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 4 4

In September 1985, the 1301N crib and trench was retired. This structure received approximately 2000 gallons per minute of radioactive liquid waste from the 100N-Reactor. The 1301N disposal site depended upon the influent percolating downward through native substrata, which was anticipated to remove contaminants by adsorption and ion exchange. The radioactive liquid was generated from the reactor coolant system, spent fuel storage basin, periphery coolant systems, and various radioactive drain systems.

The 1301N structure is located approximately 850 ft from the Columbia River. The crib itself is a 125 ft by 290 ft and 5 ft deep rectangular basin filled with 3 ft of large stones. On the north side of the crib a trench extends 1,600 ft long by 50 ft wide and 12 ft deep (McLaughlin, T.J., 1986). The 1301N structure is completely enclosed by a fence because of the radiation hazard by entering the site. The waste disposal site has not been stabilized by covering with clean soil and grading.

In the 1303N facility at the 100N-Reactor, there are three silos utilized for the storage of dummy fuel spacers. The silos have a diameter of 17 feet and are 35 feet deep with an earthen bottom. They are constructed of concrete and have a dome-shaped concrete cover. The dummy fuel spacers, which are used to maintain the proper distance between the fuel rods in the reactor, are radioactive. The spacers are removed from the reactor during normal refueling and placed in a water-filled cooling receptacle. After cooling the spacers are removed by converyor to the silos. The spacers are removed from the silos every 4 to 6 months by an electromagnetic crane and placed on railroad cars for disposal in the 200-Area. The area immediately around the silos is roped off because of the radiation hazard in the area.

During the Survey, some information on spills and releases in the 100N-Area was obtained. Approximately 1 million gallons of radioactive water was released accidentally between 1972 and 1985 (Diediker, L.P., 1985). There is no information on chemical contamination caused by these releases. Also, there are three documented releases of diesel oil. The worst leak occurred in 1966 when 80,000 gallons of No. 4 diesel leaked from a 4 inch supply line. There were several small releases of No. 6 fuel oil to the ground which were contained and removed for disposal (Jacques, L.D., 1985). One chemical release of 10 to 15 gallons of

trichloroethane has been identified which was ultimately discharged to the 1301N crib and trench (DOE, 1979).

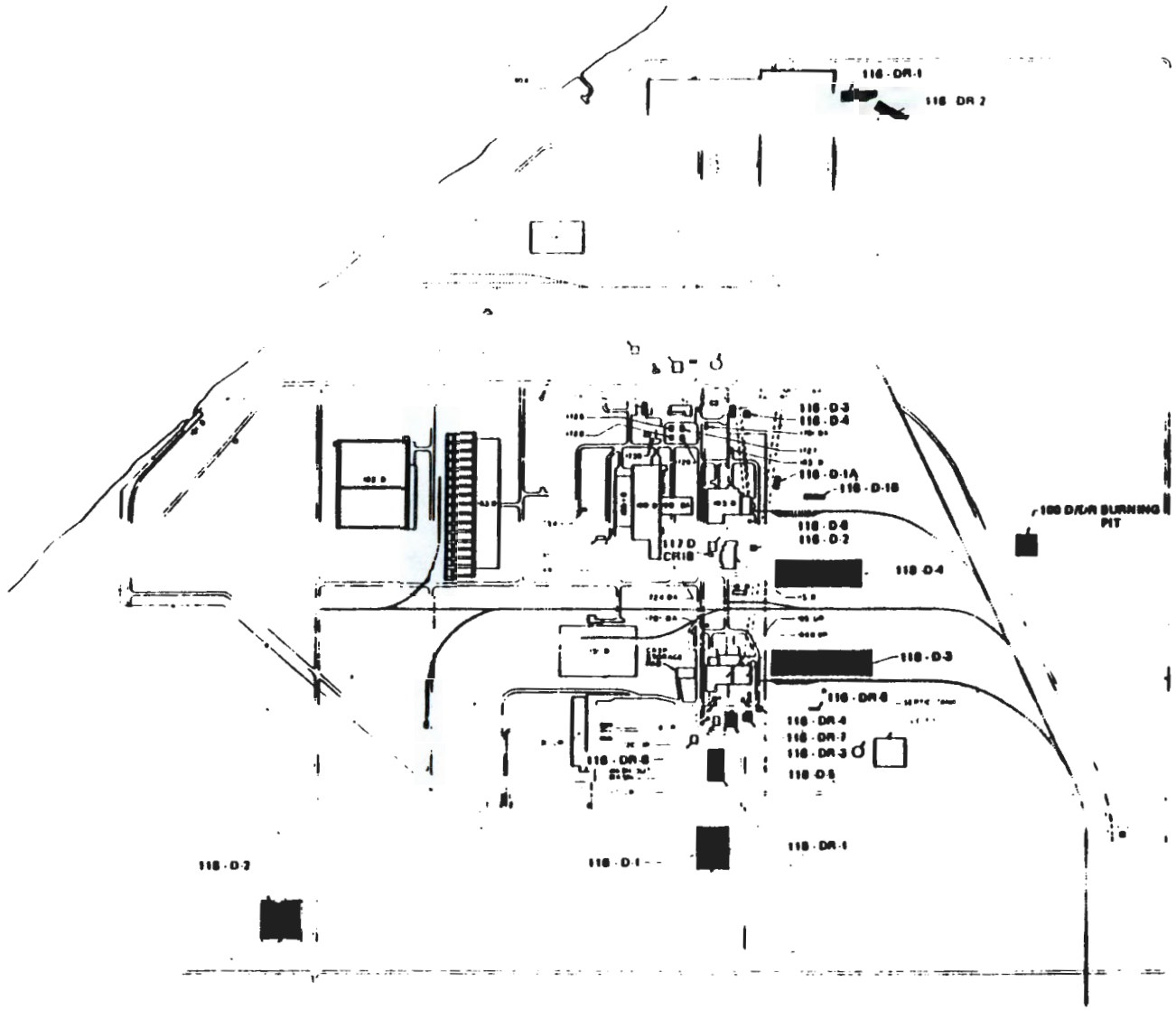
100D/DR-Area

There are 21 inactive waste sites that were identified in the Phase I effort located in the 100D/DR-Area, as shown in Figure 4-8. Generally, the locations are fairly well defined and covered with native soils. The maximum depth of waste disposal was 20 feet. The water table at this same location was reported to be 56 feet below the land surface. Similar to the other reactor locations, the existing groundwater monitoring network is insufficient to identify potential contamination problems associated with the 21 individual inactive waste sites. The total estimated volume of waste placed in the various inactive disposal sites identified is summarized in Table 4-27. These quantities are based on available information and should not be considered all-inclusive. Refer to Table 4-22 for a summary of chemicals disposed of in the inactive sites and to Table 4-23 for the inventory of selected radionuclides.

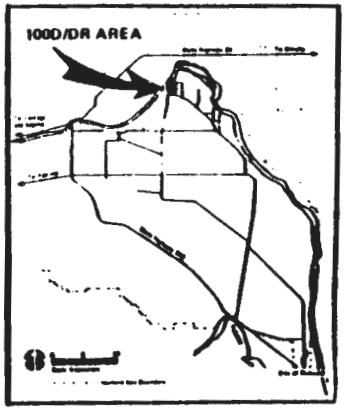
100H-Area

There are 11 inactive waste sites located in the 100H-Area as shown in Figure 4-9. Waste quantity information for the 100H-Area is summarized in Table 4-28. All the sites have been stabilized and, based on visual observations, they do not appear to be causing any immediate problems. New groundwater monitoring wells are being installed to monitor a RCRA regulated facility (183H Solar Evaporation Ponds), which is currently under remedial construction efforts. The number of groundwater monitoring wells around the inactive sites is very limited so groundwater problems cannot be documented. Refer to Table 4-22 for a summary of chemicals disposed of in the inactive sites and to Table 4-23 for the inventory of selected radionuclides.

No documentation was found to confirm spills or releases. The 107H retention basin, like other reactor retention basins at the Hanford Site, leaked radioactive primary cooling water into the substrata in the area when they were in use in the past.



SITE LOCATION MAP



NOT TO SCALE

INACTIVE WASTE SITES (PRE-NOVEMBER, 1989)

100D- AND 100DR-AREA WASTE SITE

Source: DOE-RLO, 1990.

FIGURE

4-93

TABLE 4-27

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 100D/DR-AREA INACTIVE WASTE SITES HANFORD SITE

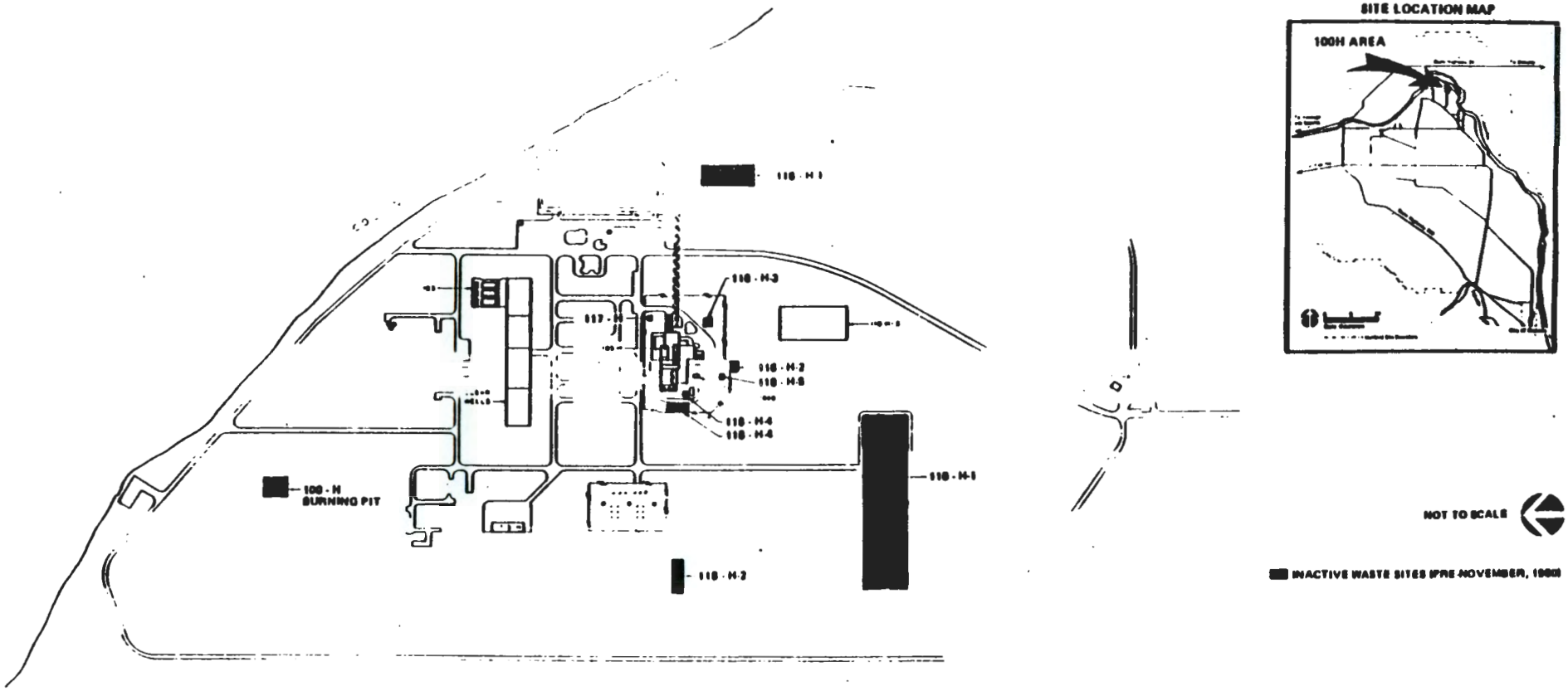
Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	5	1.8×10^5	-
Trenches	6	2.6×10^7	-
French Drains	3	4.2×10^4	-
Burial Grounds	6	-	1.4×10^6
Burning Pit	1	-	3.5×10^4
Total	21	2.6×10^7	1.4×10^6
Date of Last Use		1967	1973

NOTES:

Maximum Reported Depth of Waste Disposal = 20 ft.

Depth to Water Table at Above Site = 56 ft.

Source: DOE-RLO, 1986



100H AREA WASTE SITES

Source: DOE-RLO, 1989.

FIGURE 4-9

TABLE 4-28

REPORTED VOLUME OF WASTE DISPOSED OF IN THE
100H-AREA INACTIVE WASTE SITES
HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	2	7.9×10^4	-
Trenches	2	1.8×10^8	-
French Drains	1	1.1×10^5	-
Burial Grounds	5	5	4.6×10^5
Burning Pit	1	-	NA
Total	11	1.8×10^8	4.6×10^5
Date of Last Use		1965	1965

NOTES:

Maximum Reported Depth of Waste Disposal = 20 ft.

Water Table Elevation for the Above Site = 42 ft.

NA: Not Available

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 5 0

100F-Area

There are 20 inactive waste sites located in the 100F-Area, as shown in Figure 4-10. Available information for the 100F-Area on waste quantities disposed of in these sites is summarized in Table 4-29. All of the sites have been stabilized and from surface observations do not appear to be causing any immediate problems. There is a lack of groundwater monitoring wells in the area so groundwater problems cannot be documented. Refer to Table 4-22 for a summary of chemicals disposed of in the inactive sites and to Table 4-23 for the inventory of selected radionuclides.

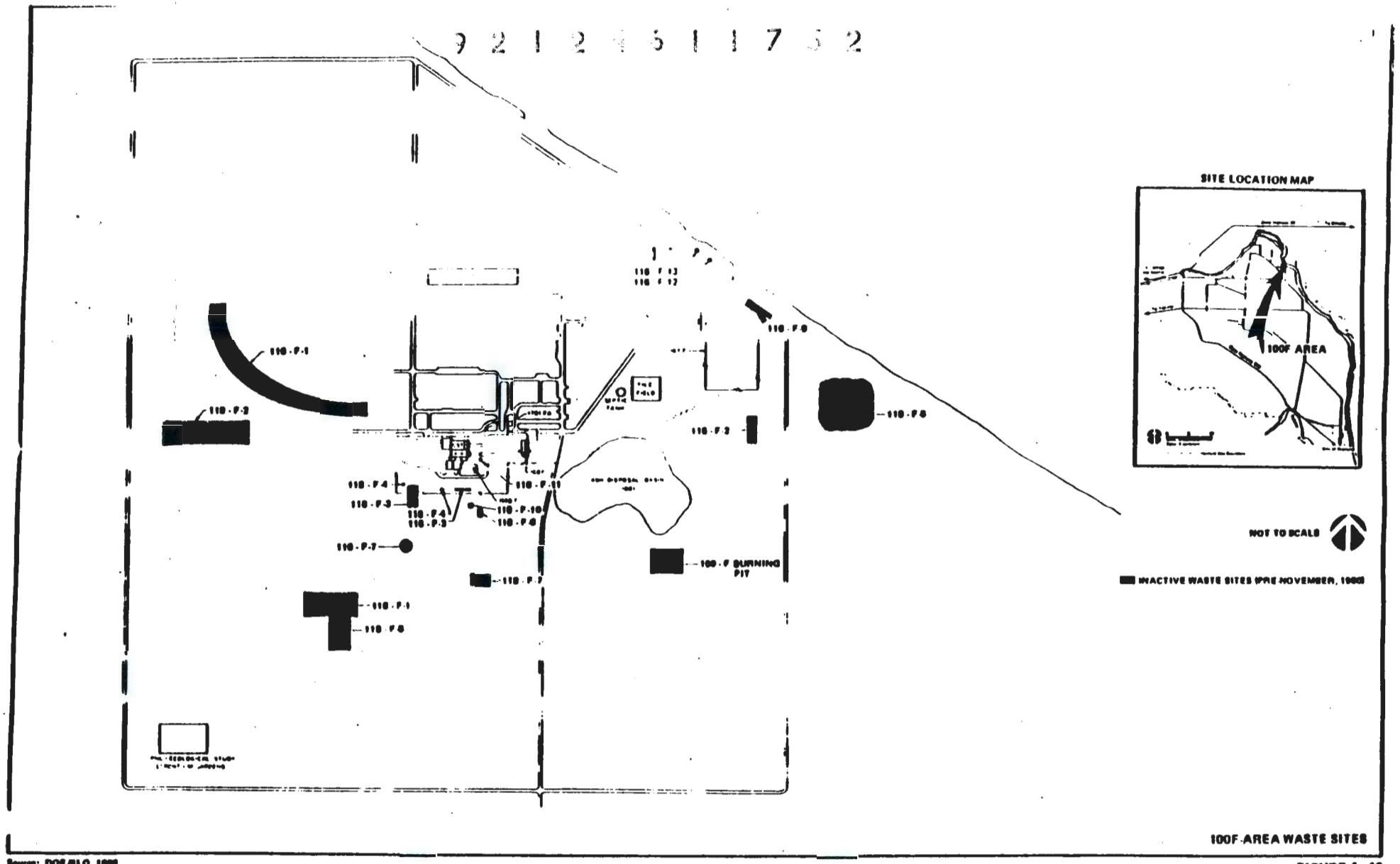
4.5.1.2.2 200-Area

In the 200 East-, 200 West- and 200 North-Areas, 223 inactive waste sites have been identified, 195 of which are liquid waste sites. Approximately 300 billion gallons of liquid waste have been disposed of on this plateau at the Hanford Site (DOE-RLO, 1986). Little or no treatment of the radioactively and/or chemically contaminated liquid effluents occurred prior to disposal. Traditionally, the Hanford Site has disposed of the liquid effluents based on their radioactive constituents; consequently, much less is known about the chemicals potentially in the waste streams. The principal philosophy at Hanford has been that the cation exchange capacity of the soils in the unsaturated zone would prevent radioactive contaminants from reaching groundwater, provided that this calculated capacity was not exceeded by overuse of the waste disposal structure (i.e., crib, trench). However, the groundwater beneath the 200-Area is contaminated with tritium and nitrates as discussed in Section 3.4, Hydrogeology.

The liquid effluents generated in the 200-Area were grouped into five categories in the Phase I effort (DOE-RLO, 1986). These categories are as follows:

Steam Condensate & Cooling Water;
Process Condensate;
Miscellaneous Liquid Waste;
Process Waste; and
Tank & Scavenged Wastes.

9 2 1 2 4 5 1 1 7 5 2



100F-AREA WASTE SITES

Source: DOE/RLO, 1988.

FIGURE 4 - 10

TABLE 4-29

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 100F-AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	2	1.8×10^3	-
Trenches	5	3.6×10^8	-
French Drains	5	2.4×10^5	-
Burial Grounds	6	-	1.8×10^6
Burial Vault	1	-	NA
Burning Pit	1	-	NA
Total	20	3.6×10^8	1.8×10^6
Date of Last Use		1976	1975

NOTES:

Maximum Reported Depth of Waste Disposal = 20ft.

Water Table Elevation for the Above Site = 18ft.

NA: Not Available

Source: DOE-RLO, 1986

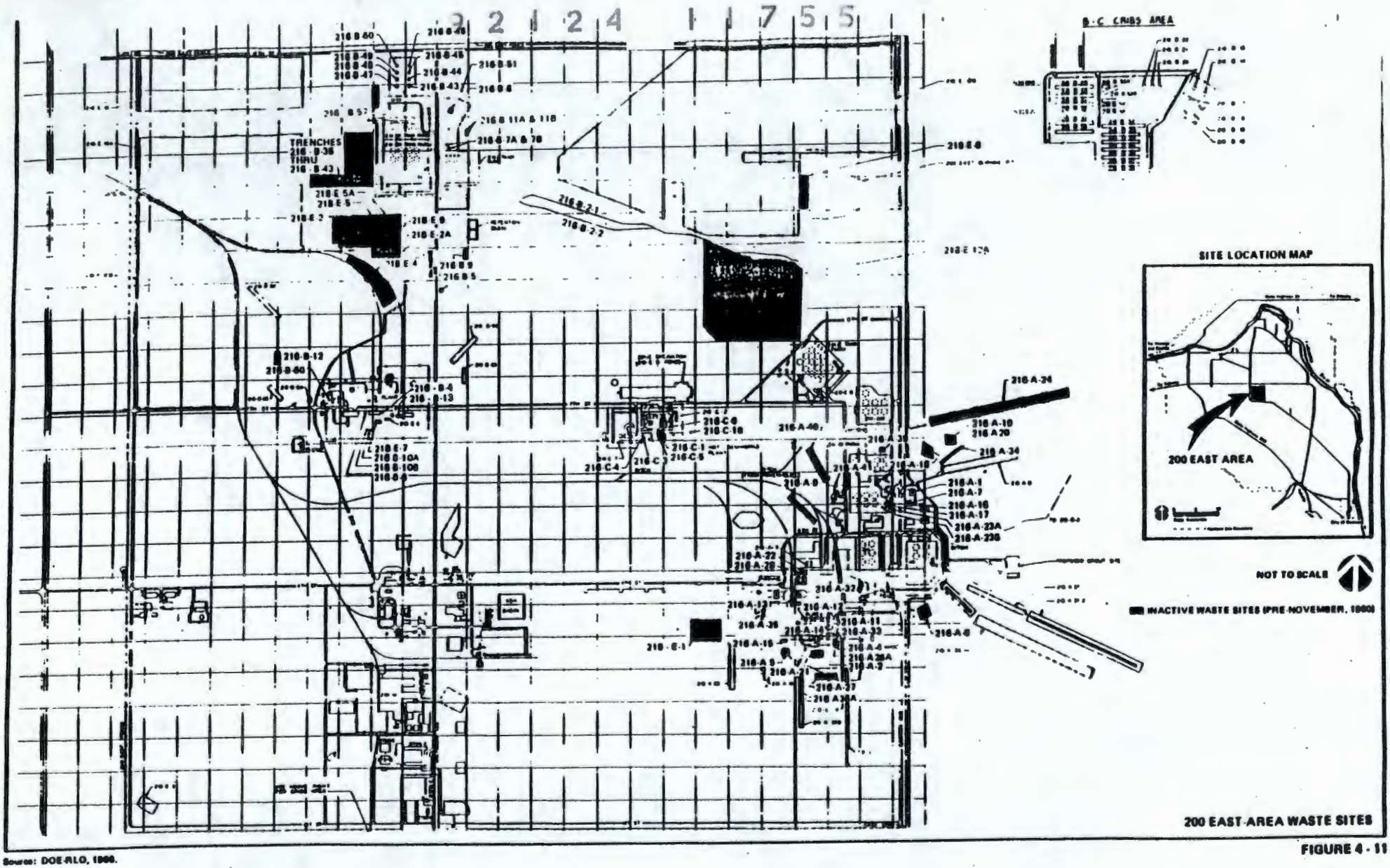
Generally, the steam condensate and cooling water waste stream classification has been considered as the least hazardous. Although this waste stream is significant due to the volume, the levels of chemical and radioactive contamination that have occurred through accidental releases are expected to be relatively low. The four other categories of waste streams are mixed chemical and radionuclide wastes, with the tank and scavenged waste reported as the most highly concentrated effluent that has been disposed of on the facility. Tank waste includes condensate from boiling tank waste and tank supernate, which contained a high concentration of salt and usually was basic, and likely contained highly mobile radionuclides due to the presence of other compounds. Scavenged waste was generated when tank waste from the bismuth phosphate extraction process was scavenged to recover uranium (DOE-RLO, 1986).

Overall, the sites associated with the B-Plant, followed by the T-Plant, probably received the highest concentration of hazardous substances disposed of on land in the 200-Area. Much of the liquid waste generated in the PUREX and REDOX Plants is highly radioactive and placed in tank farms for storage; therefore, the volume of waste placed in land disposal structures was less than either the B or T Plants. In addition, some sites associated with the 200-Area plants are contaminated with transuranic radionuclides (DOE-RLO, 1986).

The following paragraphs provide more specific information on the waste types and quantities disposed of in the 200-Area.

<u>200 East-Area</u>

The PUREX Plant, B-Plant, and the Semiworks and Critical Mass Laboratory, which comprise the 200 East-Area major processing facilities, have a total of 117 inactive waste sites associated with their past operations, as shown in Figure 4-11. Table 4-30 provides a list of the types and quantities of chemicals and compounds placed in the disposal areas for the three plants in the 200 East-Area. Table 4-31 provides the number of curies (decayed through April 1, 1986) for selected radionuclides disposed of in the 200 East-Area inactive waste sites. Table 4-32 presents the total volume of waste placed in the 200 East-Area inactive sites, grouped according to the disposal methods used.



Source: DOE-RLO, 1990.

FIGURE 4-11

TABLE 4-30

CHEMICALS DISPOSED OF IN THE
200 EAST-AREA INACTIVE WASTE SITES
HANFORD SITE

Chemical/Compound (units in kg)	PUREX Plant	B-Plant	Semiworks & Critical Mass Lab
Nitrate	1,345,837	36,455,801	11,350
Sodium	21,000	17,800,580	3,000
Nitric Acid	1	12,002	15,600
Sodium Dichromate	610	200	--
Ammonium Carbonate	200,000	21,100	--
Ammonium Nitrate	730,000	197,000	--
Sulfate	29,000	2,380,311	--
Tributyl Phosphate	172,900	--	14,000
Paraffin Hydrocarbon	335,200	--	24,000
Butyl Phosphates	90,000	--	--
Phosphate	--	2,834,008	--
Ferrocyanide	--	83,900	--
Oxalate	--	79,000	--
Fluoride	--	388,600	--
Sodium Silicate	--	147,500	--
Sodium Hydroxide	--	73,500	--
Sodium Aluminate	--	358,000	--
Nitrite	--	283,000	--
Potassium	--	520,000	--
Sulfuric Acid	--	10,000	--

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 5 6

TABLE 4-31

NUMBER OF CURIES* PER SELECTED RADIONUCLIDES DISPOSED OF IN THE 200 EAST-AREA INACTIVE WASTE SITES HANFORD SITE

Radionuclide	Liquid Waste Disposal Sites				Solid Waste Sites
	Purex Plant	B-Plant	Semiworks & Critical Mass Laboratory	Total for 200 East	Total for 200 East
Tritium (H-3)	18,400.00000	2,949.00000	70.00000	21,419.00000	0.00000
Cobalt-60 (Co-60)	5.07611	3.66259	0.02076	8.75946	0.00000
Strontium-90 (Sr-90)	1,248.96640	14,248.96688	189.64000	15,682.57328	2,672.12800
Iodine-129 (I-129)	0.00000	0.00000	0.00000	0.00000	0.00000
Cesium-137 (Cs-137)	1,571.4236	10,811.45517	0.3354	12,383.21417	2,861.2915
Plutonium Isotopes					
Pu-238	0.00000	0.00000	0.00000	0.00000	0.00000
Pu-239	40.70144	544.24797	0.64257	585.59198	723.06810
Pu-240	10.97616	146.49590	0.17305	157.64511	57.42740
Pu-421	0.00000	0.00000	0.00000	0.00000	0.00000
Uranium Isotopes					
U-233	0.00000	0.00000	0.00000	0.00000	0.00000
U-235	0.00000	0.00000	0.00000	0.00000	0.00000
U-238	14.37612	10.33976	0.13346	24.84934	138.31980
Beta	5,600.88000	49,337.41217	382.93000	55,321.2217	5,923.73598
Gamma	0.00000	0.00000	0.00000	0.00000	0.00000
Alpha	0.00000	0.00000	0.00000	0.00000	0.00000

* Values Decayed through April 1, 1986.

Source: DOE-RLO, 1986

TABLE 4-32

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 200 EAST-AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Cribs	46	42.1×10^{9}	-
Trenches	29	2.6×10^{7}	-
Ditches	5	2.0×10^{11}	-
French Drains	17	2.9×10^{6}	-
Reverse Wells	4	9.8×10^{6}	-
Burial Grounds	12	-	1.9×10^{5}*
Burial Vaults	1	-	2.5×10^{3}
Burning Pit	3	-	NA
Total	117	2.0×10^{11}	1.9×10^{5}

NOTES:

Maximum Reported Depth of Waste Disposal = 302 ft.

Water Table Elevation for the Above Site = 283 ft.

NA: Not Available

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 5 8

As indicated in these tables, wastes from the B-Plant have been major sources of chemicals, including nitrates, sodium, sulfate, phosphate, ferrocyanide, oxalate, and fluoride. Of the three plants in 200 East-Area, the B-Plant liquid wastes sites also contain the largest inventories of strontium-90, cesium-137, plutonium-239, plutonium-240, and other unidentified beta emitters. The majority of the inactive waste sites associated with the B-Plant received tank and scavenged waste streams that are considered to contain some of the highest concentrations of chemicals and radionuclides compared to all other identified Hanford inactive sites. These sites are located in the immediate vicinity of the B-Plant, as well as in an area known as the BC Crib and Trench Area which is located south of the fenced portion of the 200 East-Area.

Liquid wastes from the PUREX Plant have contained large quantities of tributyl phosphate, paraffin hydrocarbons and butyl phosphates in comparison with the other two plants. The inactive liquid waste sites for the PUREX Plant also have received considerably more tritium than sites used by the other plants. A discussion of the tritium contaminated groundwater plume associated with the 200 Area is provided in Section 3.4, Hydrogeology. Much of the waste generated by the PUREX processes is high-level radioactive waste. This waste is not disposed of on the Hanford Site, but is stored in underground tanks. Historically, some of the 149 single-shell tanks have leaked; therefore, Hanford is phasing out use of these tanks.

The Semiworks and Critical Mass Laboratory, known as C-Plant, was undergoing decontamination and decommissioning at the time of the Survey. C-Plant was originally a pilot plant for the demonstration of the PUREX and REDOX processes. It then was used for seven years to produce strontium. Less quantities of contaminants are associated with the C-Plant as a result of these smaller-scale operations. Other than nitric acid, C-Plant inactive wast sites received smaller quantities of chemicals and radionuclides than the B-Plant or PUREX Plant waste sites.

The inactive waste sites are generally well marked in the 200 East-Area. Cover material has been placed over the sites, and vegetation control is practiced where deemed appropriate. Some of the older, wooden crib structures that have a surface soil cover are deteriorating and in a few cases, have shown signs of collapsing. Four reverse wells were constructed in the 200 East-Area, one of which was set at a depth approximately 20 feet below the water table.

200 West-Area

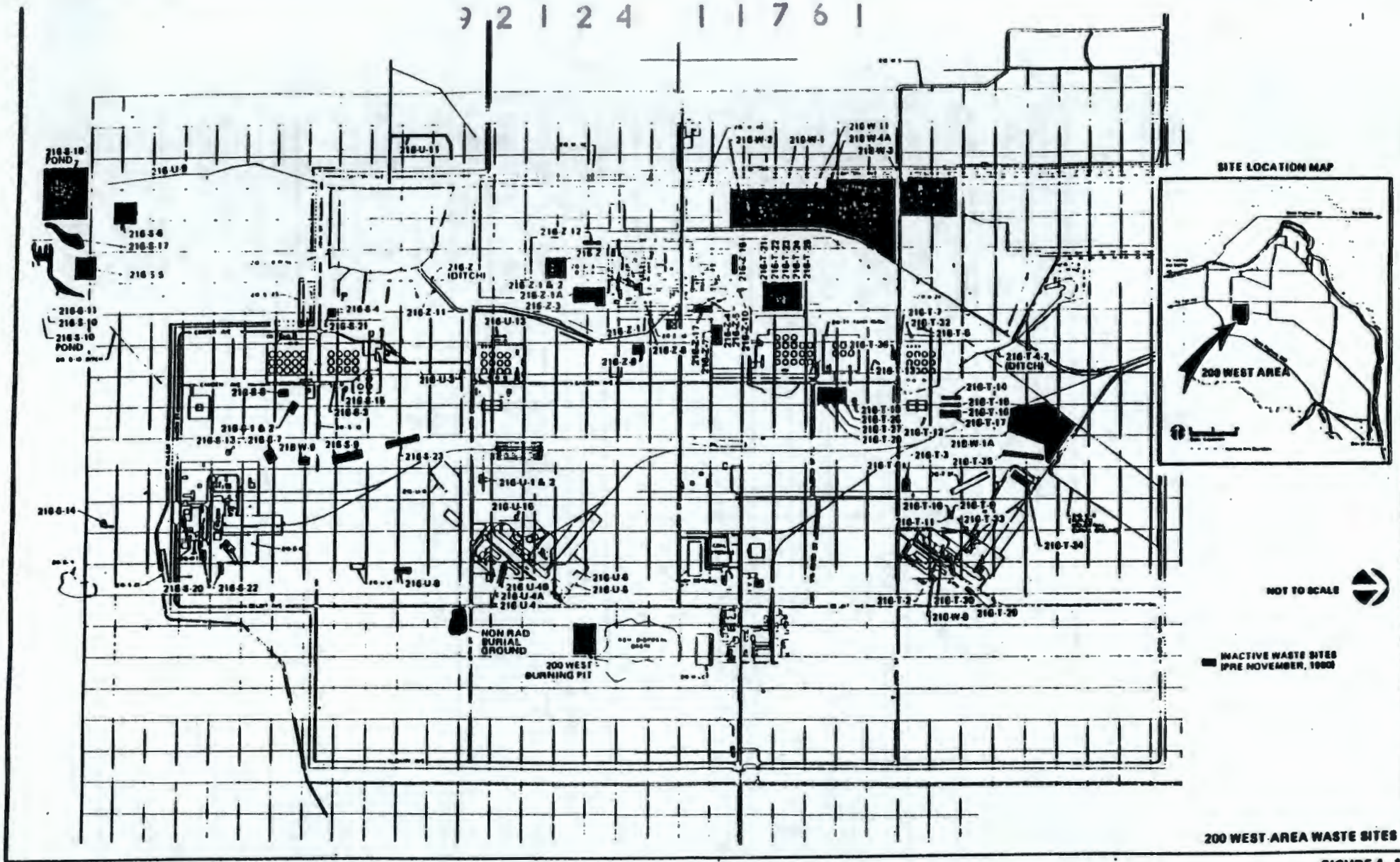
The REDOX Plant, the T-Plant, the U-Plant and the Z-Plant comprise the 200 West-Area major processing facilities. There are 99 inactive waste sites associated with these plants as shown in Figure 4-12. Of the 99 sites, 12 are solid waste sites and 87 are liquid waste sites. Table 4-33 provides the types and quantities of chemicals disposed of in these sites. Table 4-34 provides the number of curies (decayed through April 1, 1986) for selected radionuclides disposed of in the 200 West-Area inactive waste sites. Table 4-35 provides waste volume information for these sites based on available information.

Comparison of the inactive waste site inventories for the four plants shows that the T-Plant generated a variety of chemical waste and the largest quantity of substances such as nitrates, sodium, sulfate and phosphate. In addition, the sites associated with the T-Plant contain the highest number of curies of cesium-137 and other unidentified beta emitters.

The Z-Plant waste sites also contain a variety of chemicals, several of which are unique to this plant. In addition to several nitrate compounds, the Z-Plant is reportedly the only process in the 200-Area that disposed of carbon tetrachloride. The Z-Plant liquid waste sites have the largest inventory of plutonium-239 and plutonium-240 compared to all of the other 200-Area plants. The Z-Plant and the U-Plant waste sites have received tributyl phosphate; however, the combined total quantity is almost five times less than that disposed of in the sites associated with the PUREX Plant in the 200 East-Area.

The decayed number of curies of tritium is the largest for inactive sites that received waste from the U-Plant. The total number of curies of tritium in the 200 West-Area is double the number reported for the 200 East-Area.

Of the four plants in the 200 West-Area, the REDOX Plant inactive waste sites are reported to have the largest number of curies of strontium-90. Also, the wastes from this plant included methyl isobutyl ketone which was not reported to be in any of the other 200-Area inactive waste sites.



200 WEST AREA WASTE SITES

Source: DOE-RLO, 1990.

FIGURE 4 - 12

TABLE 4-33
CHEMICALS DISPOSED OF IN THE 200 WEST-AREA INACTIVE LIQUID WASTE SITES
HANFORD SITE

Chemical/Compound (Units in kg)	Redox Plant	T-Plant	U-Plant	Z-Plant	Total
Nitrate	209,101	5,198,004	1,201,789	2,223,240	8,832,134
Methyl Isobutyl Ketone	10,000	–	–	–	10,000
Aluminum Nitrate	100,000	–	–	360,000	460,000
Nitric Acid	380,300	15,000	200,000	76,000	671,300
Sodium	21,135	5,588,000	500.400	3,805.320	9,914,855
Sodium Dichromate	10,002	210	–	–	10,212
Sodium Hydroxide	2	299,010	–	1,000	300,012
Sodium Aluminate	3	311,000	–	–	311,003
Ammonium Nitrate	1,400	200,600	–	–	202,000
Sulfuric Acid	–	11,000	–	–	11,000
Potassium	–	310,000	–	–	310,000
Sodium Silicate	–	129,800	–	–	129,800
Sodium Oxalate	–	95,000	–	–	95,000
Fluoride	–	497,200	–	490,900	988,100
Sulfate	–	250,800	100,000	20,000	370,800
Phosphate	–	1,450,000	70,030	–	1,520,030
Tributyl Phosphate	–	–	13,000	22,000	35,000
Paraffin Hydrocarbon	–	–	40,000	–	40,000
Aluminum Fluoride Nitrate	–	–	–	410,000	410,000
Carbon Tetrachloride	–	–	–	260,000	260,000
Calcium Nitrate	–	–	–	260,000	260,000
Dibutyl Butyl Phosphate	–	–	–	15,000	15,000
Magnesium Nitrate	–	–	–	350,000	350,000
Ferric Nitrate	–	–	–	77,000	77,000

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 6 2

TABLE 4-34
NUMBER OF CURIES* PER SELECTED RADIONUCLIDES DISPOSED OF IN THE 200-WEST AREA INACTIVE WASTE SITES HANFORD SITE

Radionuclide	Liquid Waste Disposal Sites					Solid Waste Sites
	REDOX Plant	T-Plant	U-Plant	Z-Plant	Total for 200-West	Total for 200-West
Tritium (H-3)	13,000.95080	15.44600	30,000.00000	0.00000	43,016.39680	0.00000
Colbalt-60 (Co-60)	4.09861	1.88673	0.01050	0.10578	6.10162	0.00000
Strontium-90 (Sr-90)	3,398.79940	1,021.28000	2.71631	225.32880	4,648.12451	1,114.58000
Iodine-129 (I-129)	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Cesium-137 (Cs-137)	1,909.31100	9,269.66800	5.83290	228.43170	11,413.24360	1,192.35000
Plutonium Isotopes						
Pu-238	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Pu-239	187.25626	537.30880	24.25642	9355.25285	10,104.07433	18,574.05710
Pu-240	51.06672	144.82146	6.36312	2522.30521	2,724.55651	5,015.81542
Pu-241	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Uranium Isotopes						
U-233	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
U-235	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
U-238	3.06515	0.30365	9.64391	0.03220	13.04491	156.29663
Beta	11,480.31000	18,019.71	16.96660	972.99200	30,489.97860	2,119.11000
Gamma	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
Alpha	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000

* Values Decayed Through April 1, 1986.

Source: DOE-RLO, 1986

TABLE 4-35

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 200 WEST-AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed	
		Liquid Sites (gallons)	Solid Sites (cubic feet)
Ponds	5	1.4×10^{10}	-
Cribs	34	2.9×10^{9}	-
Trenches	28	*3.4×10^{7}	-
Ditches	7	*1.1×10^{8}	-
French Drain	8	1.7×10^{8}	-
Reverse Wells	4	4.8×10^{6}	-
Tile Fields	1	4.8×10^{6}	-
Burial Grounds	8	-	NA
Burial Vaults	2	-	NA
Burning Pits	2	-	NA
Total	99	1.7×10^{10}	8.9×10^{5}

NOTES:

Maximum Reported Depth of Waste Disposal = 206 ft. (3 million gallons)

Water Table Elevation for the Above Site = 249 ft.

* = Incomplete Information
NA: Not Available

Source: DOE-RLO, 1986

9 2 1 2 4 6 1 1 7 6 4

200 North-Area

Historically, the 200 North-Area was used for irradiated fuel storage from the 100-Area reactors. There are seven inactive liquid waste disposal sites that received radioactive liquids, sludges, and solids from the storage basins. These disposal sites were retired in 1952. The only active operations at the 200 North-Area involve PCB management activities.

There is no information available on the nature of the chemical constituents in the wastes disposed of in the 200 North-Area. Table 4-36 provides waste volume information. Table 4-37 provides the number of curies (decayed through April 1, 1986) of selected radionuclides for these seven inactive waste sites. In comparison to the other 200-Areas, the waste volumes and radionuclide inventory are small.

4.5.1.2.3 300-Area

Two large ponds, named the North and South Process Ponds, constitute the major inactive liquid waste sites in the 300-Area. The location of these disposal sites is shown on Figure 4-13, and the types and quantity of chemicals and compounds disposed of in the 300-Area are provided on Table 4-38. The available records indicate that the only radionuclide disposed of in these ponds was cobalt-60, and the number of curies (decayed through April 1, 1986) is 0.002. According to contractor personnel, a major flood occurred in 1948 and caused the contents of the South Process Pond to be released into the Columbia River. No further documentation was available regarding this release. The ponds are now dry, with the exception of a portion of the South Process Pond, and the bottom sediments remain uncovered. The ponds are located about 150 feet from the bank of the Columbia River and the water table is reportedly 24 feet beneath the bottom of the ponds. These inactive waste ponds had a service period of about 30 years. One trench is located in the 300-Area that also received a large volume of liquid waste. This trench is now covered. The estimated total volume of liquid waste disposed of in the 300-Area sites is given in Table 4-39 (DOE-RLO, 1986).

There are two inactive solid waste disposal sites in the 300-Area. These sites are designated as 600-Area sites in the Phase I Report. One site (618-6), located in the vicinity of Buildings 325, 308, and 324, was excavated and the contents were placed

TABLE 4-36

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 200-NORTH AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method	Number of Sites	Volume of Waste Disposed
		Liquid Sites (gallons)
Ponds	3	7.5×10^8
Cribs	4	8×10^6
Total	7	7.6×10^8
Date of Last Use		1952

Notes:

Maximum Reported Depth of Waste Disposal = 7 ft.

Water Table Elevation for the Above Site = 173 ft.

Source: DOE-RLO, 1986

TABLE 4-37

NUMBER OF CURIES* PER SELECTED RADIONUCLIDES DISPOSED OF IN THE 200 NORTH-AREA INACTIVE WASTE SITES HANFORD SITE

Radionuclide	200 North Area
	Liquid Wastes
Tritium (H-3)	0.00000
Cobalt-60 (Co-60)	0.00000
Strontium-90 (Sr-90)	0.48760
Iodine-129 (I-129)	0.00000
Cesium-137 (Cs-137)	0.55080
Plutonium Isotopes	
Pu-238	0.00000
Pu-239	0.11420
Pu-240	0.02860
Pu-241	0.00000
Uranium Isotopes	
U-233	0.00000
U-235	0.00000
U-238	0.00304
Beta	2.026
Gamma	0.00000
Alpha	0.00000

* Values Decayed Through April 1, 1986.

Source: DOE-RLO, 1986

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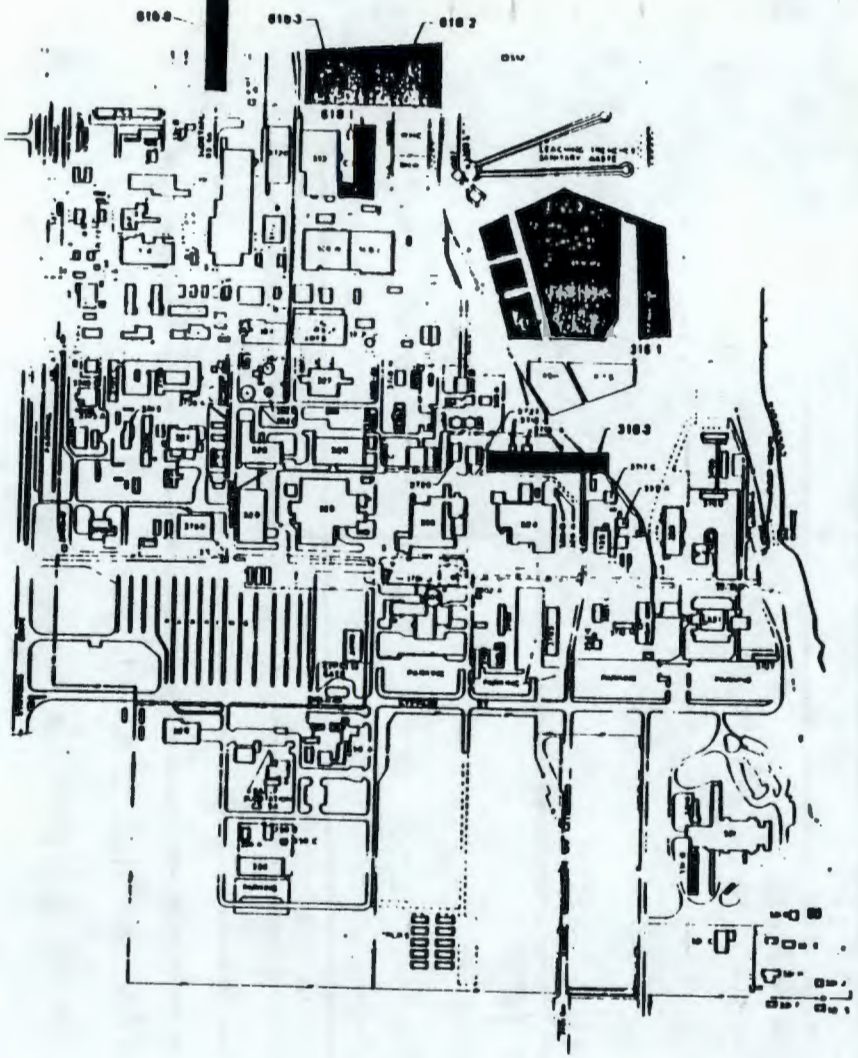

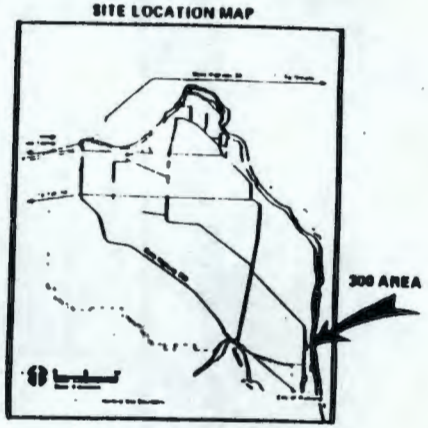

NOT TO SCALE

INACTIVE WASTE SITES (PRE-NOVEMBER, 1990)

Source: DOE-RLO, 1990.

300-AREA WASTE SITES

FIGURE 4 - 13

TABLE 4-38

CHEMICALS DISPOSED OF IN THE
300-AREA INACTIVE PROCESS PONDS
HANFORD SITE

Chemical/Compound	Quantity (kg)	Chemical/Compound	Quantity (kg)
Sodium	3×10^6	Cadmium (II)	1.4×10^2
Sodium Hydroxide	1.8×10^6	Silver (I)	1.9×10^3
Sodium Aluminate	4×10^6	Lead (II)	6.0×10^3
Sodium Silicate	1.9×10^5	Beryllium	7.0×10^1
Nitrate	1.8×10^6	Fluoride	1.2×10^4
Nitrite	1.6×10^6	Copper (II)	1.1×10^5
Mercury	1.0×10^2	Trichloroethylene	2.0×10^6
Nickel (II)	1.8×10^4	Uranium	7.0×10^4
Chromium (VI)	8.0×10^3	Nitric Acid	1.9×10^6
Zinc (II)	8.0×10^3		

Source: DOE-RLO, 1986

TABLE 4-39

REPORTED VOLUME OF WASTE DISPOSED OF IN THE 300-AREA INACTIVE WASTE SITES HANFORD SITE

Disposal Method*	Number of Sites	Volume of Waste Disposed
		Liquid Sites (gallons)
Pond	2	5.3×10^9
Trench	1	2.6×10^8
Total	4	5.6×10^9
Date of Last Use		1975

NOTES:

Maximum Reported Depth of Waste Disposal = 20 ft.

Depth to Water Table at Above Site = 43 ft.

*The crib designated as 316-4 is not grouped with the 300-Area sites because it is not proximate to the 300 Area. Crib 316-4 is actually in the 600-Area, adjacent to the 618-10 Burial Ground.

Source: DOE-RLO, 1986

in another 600-Area burial ground close to the 400-Area. The other solid waste site (618-1) is marked by flush monuments and is beneath and in the vicinity of Building 334A (DOE-RLO, 1986).

A former burning pit is also located in the 300-Area, based on information obtained during the Survey. The pit was reportedly located near the corner of the fence close to the equipment storage yards. Information on the service period and types of waste disposed of in this burning pit was not documented.

4.5.1.2.4 600-Area

There are 20 inactive waste sites located in the 600-Area, as shown in Figure 4-14. Eighteen of the 20 sites are classified as solid or dry waste disposal sites. The two liquid waste sites, which were classified as cribs, have been exhumed. A third crib is actually located in the 600-Area but is usually grouped with the 300-Area sites due to its site identification number. This crib (316-4) is located next to the burial ground (618-10) just south of the Fast Flux Test Facility (FFTF). Although fences have been placed around some of the 600-Area sites, the boundaries and exact locations are not well defined. One site has been stabilized; the others are covered but have no vegetation control. One pesticide-contaminated site (USBR 2,4-D) is located on the eastern side of the Columbia River. For the majority of the 600-Area sites, the volume and characteristics of the waste disposed of are not documented.

4.5.1.3 Sites Planned for Further Study

For the 337 inactive waste sites identified at the Hanford Site, 62 were recommended for more specific site characterization under Phase II of the DOE-RLO CERCLA program. The flow of the Phase I process is shown in Figure 4-15, which indicates that three possible recommendations for a site resulted from the Phase I work. They are: (1) No Further Action Required; (2) Further Action Pending; and (3) Characterize under Phase II. Figure 4-15 also provides the numerical breakdown of sites for each progressive step in the ranking process. Table 4-40 provides the site identification number of the sites recommended for Phase II characterization, all of which are liquid waste sites. Figures 4-16 and 4-17 depict the Phase I Assessment for the 100-Area and 200-Area, respectively, giving more specific information on the rating of the types of effluents.

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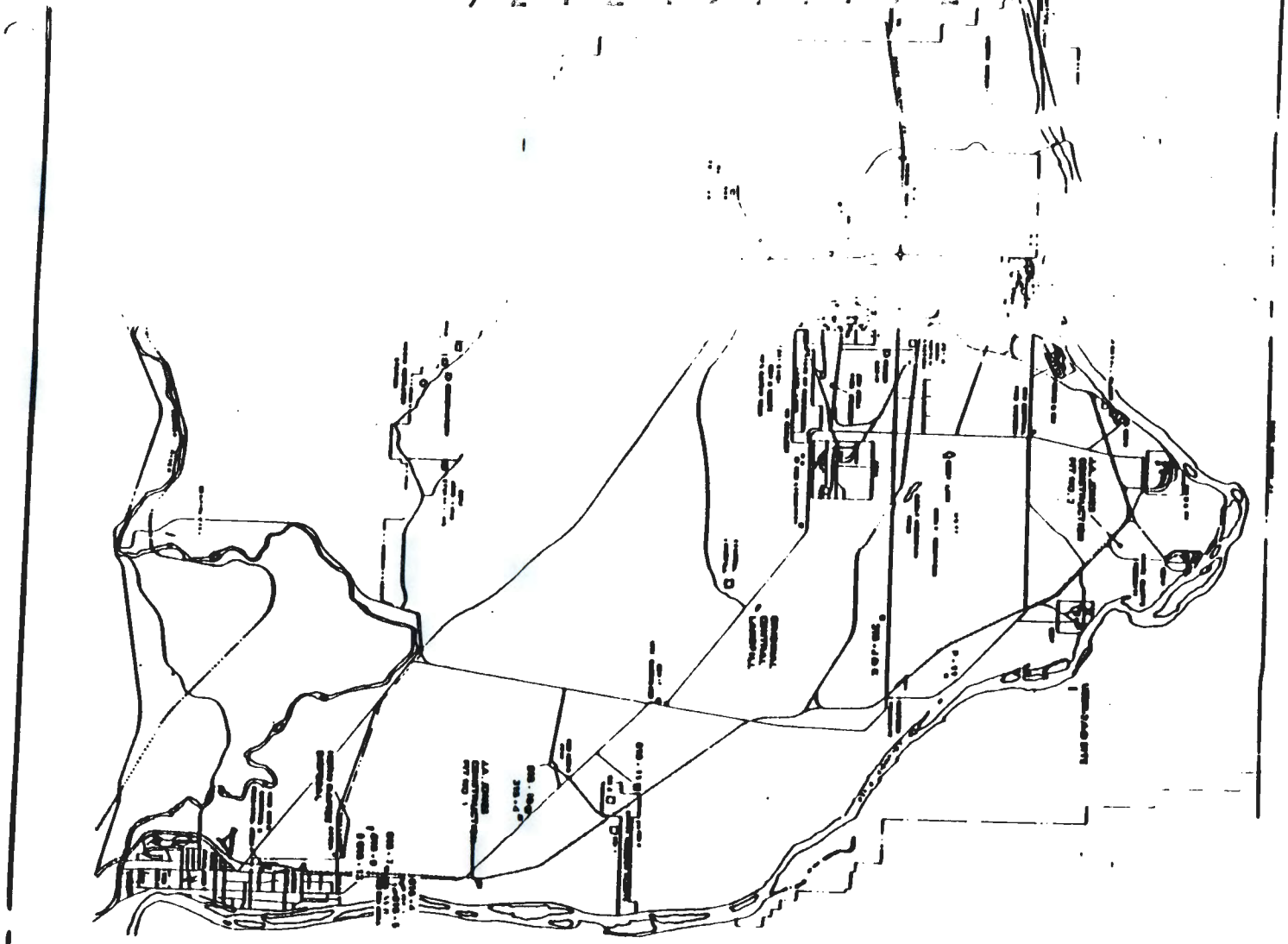


NOT TO SCALE

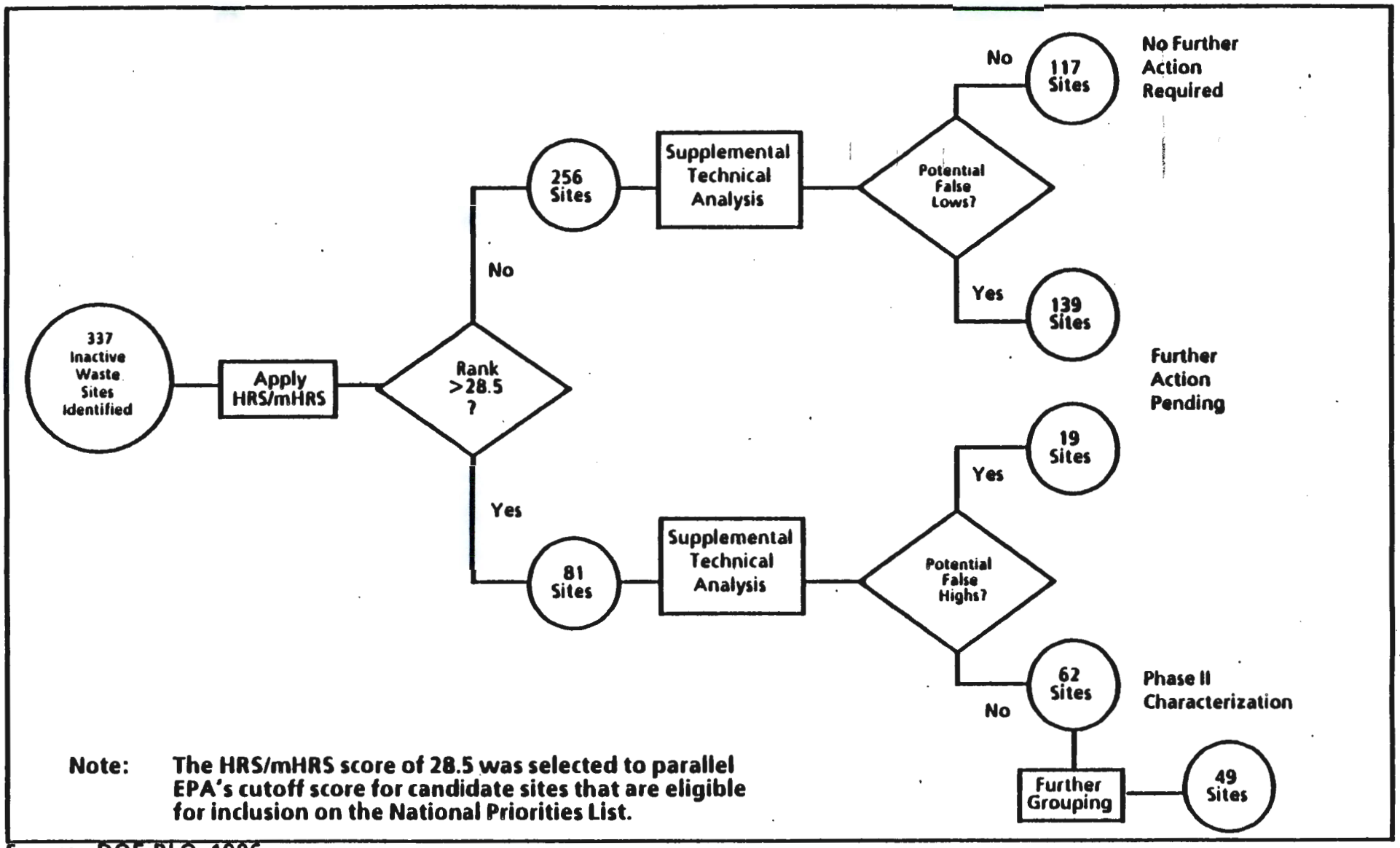
INACTIVE WASTE SITES (PRE NOVEMBER, 1990)

Source: DOE RLO, 1990.

600 AREA WASTE SITES

FIGURE 4-

4-110



Note: The HRS/mHRS score of 28.5 was selected to parallel EPA's cutoff score for candidate sites that are eligible for inclusion on the National Priorities List.

Source: DOE-RLO, 1986

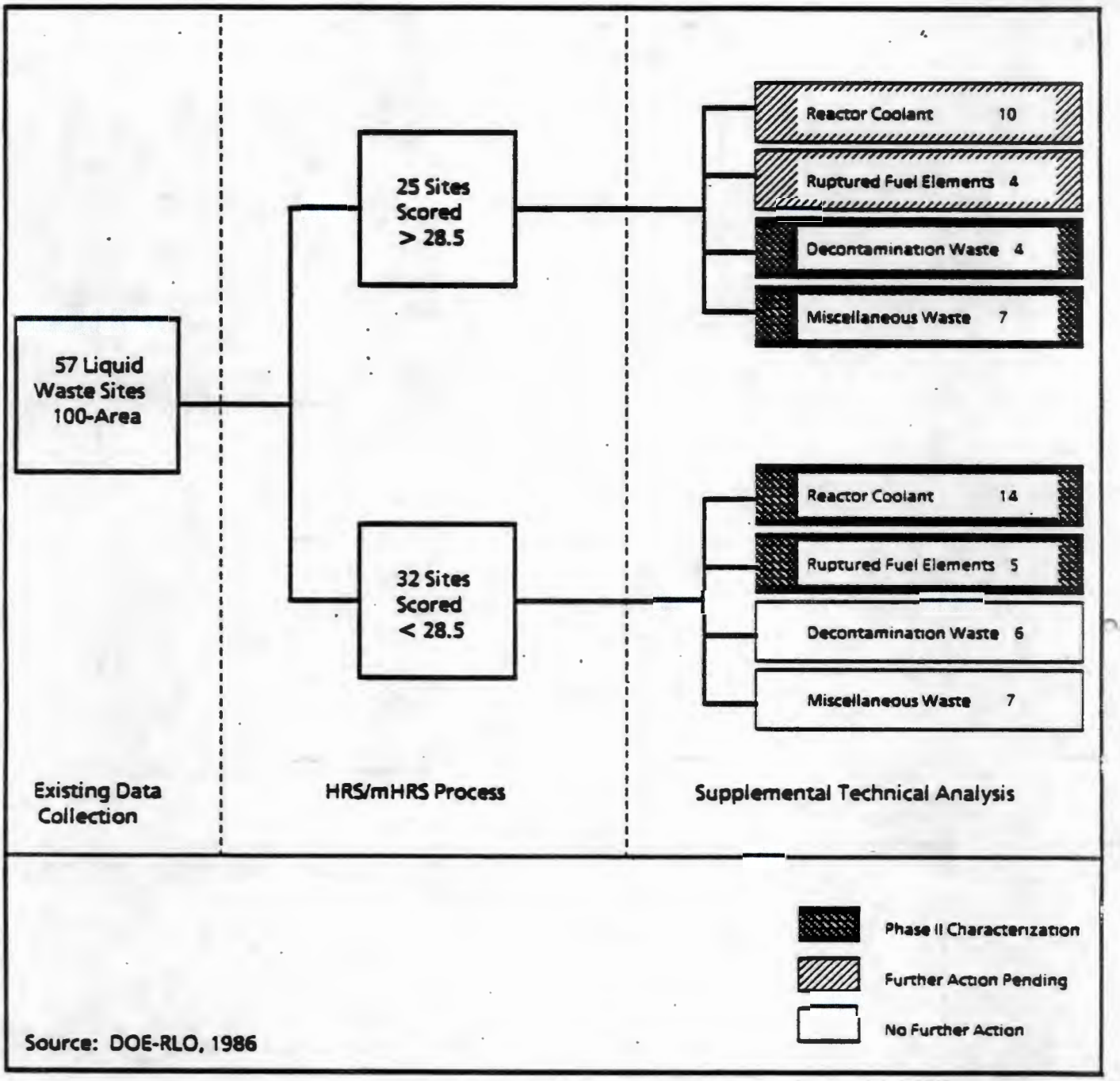
FLOW OF THE PHASE I PROCESS AT THE HANFORD SITE

FIGURE 4-15

TABLE 4-40
INACTIVE WASTE SITES RECOMMENDED FOR PHASE II CHARACTERIZATION AS A RESULT OF THE PHASE I INSTALLATION ASSESSMENT OF THE HANFORD SITE

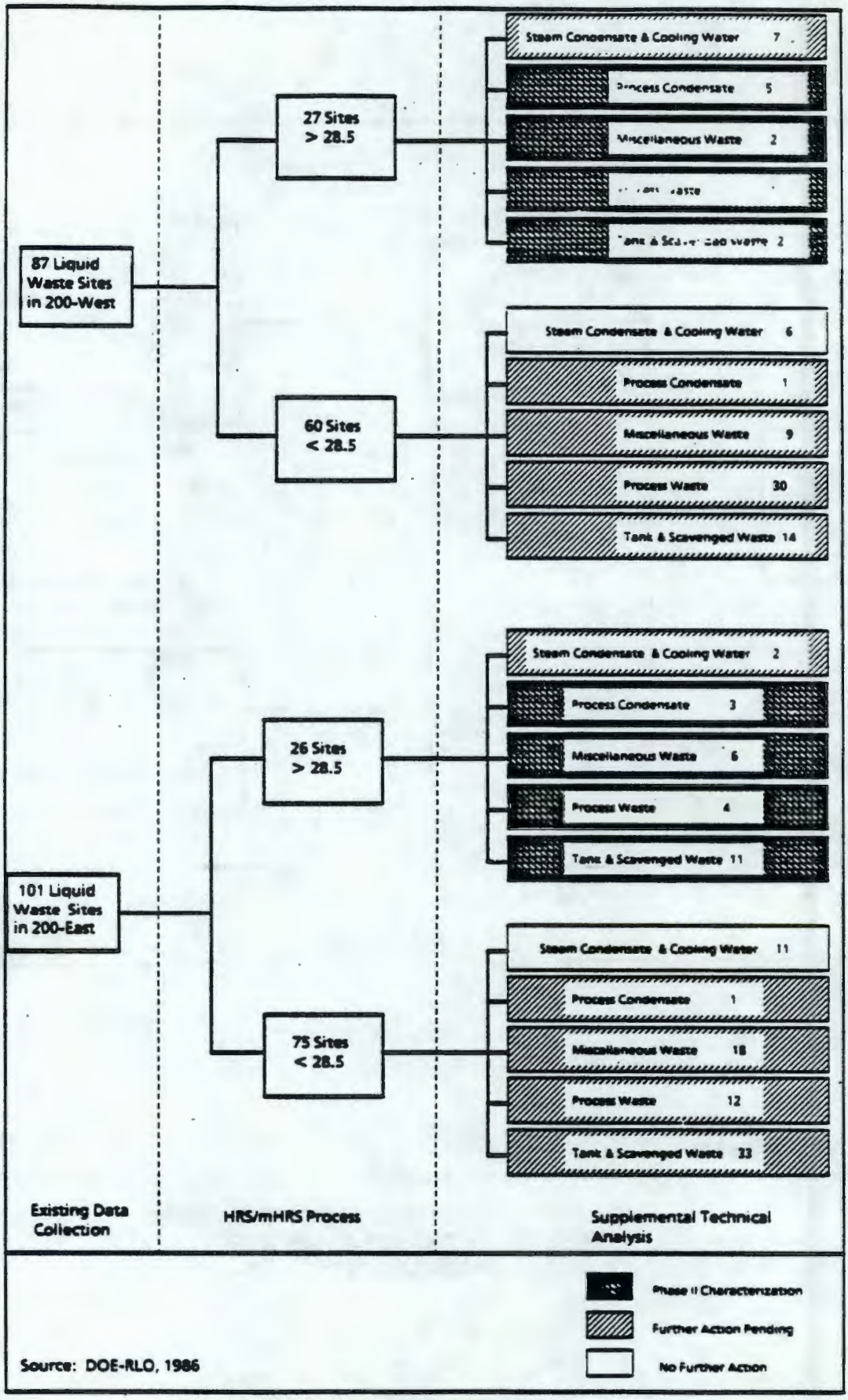
Operational Area	100 Area	200-Area			300-Area	400-Area	600-Area
		200 East	200 West	200 North			
Total No. of Sites Ranked in Each Area	90	117	99	7	4	0	20
Names of Sites Recommended for Phase II Characterization	116-B-4 116-C-2 116-D-1B 116-DR-7 116-F-1 116-F-2 116-F-3 116-F-9 116-H-1 116-H-3 100KE*1 100KE*2 100 KW*1 100KW*2 116-KE-2	216-A-4 216-A-5 216-A-6 216-A-7 216-A-9 216-A-21 216-A-24 216-A-27 216-A-28 216-A-36A 216-B-5 216-B-6 216-7A&B 216-B-10A 216-B-16 216-B-43 216-B-44 216-B-45 216-B-46 216-B-48 216-B-49 216-B-50 216-C-1 216-C-10	216-S-1&2 216-S-7 216-S-9 216-S-20 216-S-21 216-T-2 216-T-3 216-T-7 216-T-8 216-T-19 216-T-28 216-U-1&2 216-U-3 216-U-4 216-U-4A 216-U-4B 216-U-11 216-Z-1&2 216-Z-7 216-Z-10	None	316-1 316-2 316-3	None	None
Total No. of Phase II Sites	15	24			3	0	0

Source: DOE-RLO, 1986



100 AREA LIQUID WASTE DISPOSAL SITES RESULTS OF PHASE I ASSESSMENT HANFORD SITE

FIGURE 4-16



Source: DOE-RLO, 1986

200-AREA LIQUID WASTE DISPOSAL SITES RESULTS OF PHASE I ASSESSMENT HANFORD SITE **FIGURE 4-17**

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

1. Potential Sources of Contamination Remain Unidentified. All inactive waste sites on the Hanford Site have not been identified; consequently, the potential exists for major sources of contaminants to be located on the site that may affect groundwater and/or the Columbia River.

   Spills, unplanned releases, and sites closed since November 1980 have not been identified as inactive waste sites. During the Survey, information obtained indicates that 138 past releases have occurred in the 200 West-Area, most of which involved radionuclides. Also, large volumes of primary cooling water from the 100-Area reactors apparently leaked from the 107 retention basins and their piping systems. Past radioactively contaminated liquid leaks from the 105 KE Fuel Storage Basin were identified during the Survey. In addition, approximately 1 million gallons of radioactively contaminated liquid was accidentally released between 1972 and 1985 at the 100 N-Reactor (Diediker, L.P., 1985). Diesel oil spills and a 10-15 gallon trichloroethane spill at the 100 N-Area were also identified during the Survey (Jacques, L.D., 1985). In addition, three documented spills have occurred in the 300-Area as listed below.

   1982 - 126 gallons of perchloroethylene
   1984 - 15 gallons of perchloroethylene
   1986 - 170 pounds of waste acid (reported because of the hydrofluoric acid)

   The 149 inactive single-shell high-level radioactive waste storage tanks, some of which are known to have leaked (e.g., 115,000 gallons leaked from 106-T Tank in the 241-T Tank Farm), also have not been acknowledged as inactive spill sites. An undetermined number of inactive chemical product storage tanks have not been identified and consequently, the potential for past leaks

has not been addressed. Also, sites that have radioactive surface contamination have not been identified. Further, all decommissioned sites have not been identified to determine if they have been adequately cleaned up according to EPA standards. Other examples of sites identified during the Survey but not acknowledged by the Hanford Site as inactive waste sites or releases are:

- 241-244-WR vault - underground tanks were removed and voids were filled
- 216-A-3 crib retired in 1981
- 216-U-10 pond retired in 1985
- 216-U-16 crib retired in 1985
- 216-Z-19 ditch retired in 1981
- 216-S-19 pond retired in 1984
- Spills associated with underground piping and diversion boxes in the 200-Area
- 1301 N crib retired in 1985
- 400 Area Burial Ground closed in 1984
- Abandoned septic systems

The radioactive and chemical contaminant inventories associated with these sites potentially represent major sources of contamination to the groundwater and/or the Columbia River.

2. 618-10 and 618-11 Burial Grounds. Two burial grounds in the 600 Area received high-level radioactive wastes and are potential sources of contamination to soil and/or groundwater.

The 618-10 Solid Waste Disposal Site (also known as the 300-North Burial Ground) and the 618-11 Solid Waste Disposal Site (also known as 300 Wye Burial Ground) are inactive sites that received high-level radioactive wastes. The 618-10 site was active from 1953 to 1963 and consists of 12 trenches with the largest dimensions being 320 feet long by 70 feet wide by 25 feet deep. Two arrays of vertical caissons, totaling 94, also exist in this landfill. These caissons extend to a depth of approximately 15 feet and have been backfilled.

The 618-11 site is directly west of the WPPSS No. 2 reactor site. The burial ground contains three backfilled trenches, approximately 6 meters in depth, one large buried culvert, and three large underground tanks. The burial ground areal extent is approximately 305 by 114 meters with a total area of about 3.5 hectares. This facility was in service from 1962 to 1967 and was retired in 1968.

According to information in the report titled, "Monitoring and Characterization of Radionuclide Transport in the Hydrogeologic System," BNWL-SA-5494 Part II, prepared in 1975. Low-level, intermediate-level and high level waste were disposed of in these burial grounds. The 618-10 and 618-11 Burial Grounds contain volumes of approximately 5600 cubic meters and 340 cubic meters, respectively, of buried waste. These approximations are based on knowledge of past operational programs and burial site utilization records.

Waste materials disposed of in these burial grounds are a broad spectrum of fission products and plutonium. The estimated contents of the 618-10 site include <2000 curies of beta and alpha emitters and less than 1 kilogram of plutonium. Records for the 618-11 site indicate that it contains <2000 curies of beta and alpha emitters and less than 5 kilograms of plutonium. Assuming that the 5 kilograms of plutonium-239 are uniformly distributed throughout the 340 cubic meters of waste at the 618-11 Burial Ground, and that all the waste is cemented at a density of 1.6×10^6 grams per cubic meter (100 pounds per square foot), the concentration would be >500 nanocuries per gram, which exceeds the current 100 nanocuries per gram value used to classify waste as TRU waste. (Previously, waste greater than 10 nanocuries per gram was considered to be TRU waste.) Based on the descriptions in the report, all the waste is not cemented, and it is likely that the plutonium is not uniformly distributed throughout the site, which would increase the concentration of plutonium in some areas of the burial site.

The groundwater under both burial grounds, as indicated by the tritium plume in the 1985 Environmental Monitoring Report (PNL-5817), is moving east toward the Columbia River. There is a potential for animal intrusion at the sites and for groundwater release to wells at the WPPSS site and to the

Columbia River that may exceed guidelines. According to DOE Order 5820.2 (Radioactive Waste Management), any high-level waste or TRU waste disposed of prior to implementation of the order shall be periodically monitored to assess both radioactive and nonradioactive hazards; program offices shall determine the need for corrective measures, as necessary. Insufficient monitoring has been performed at both of these old burial grounds, especially the 618-11 site, to determine the current environmental conditions and the need, if any, of corrective measures.

4.5.2.3 Category III

1. 200 East- and 200 West-Area Inactive Liquid Waste Disposal Sites. The 188 inactive liquid waste disposal sites in the 200-Area may contain hazardous or toxic chemicals, which to date have not been identified, and potentially may be sources of groundwater and subsurface soil contamination.

Since 1943, approximately 300 billion gallons of liquid wastes have been discharged in land-based disposal sites at the 200-Area. Little or no treatment of the waste was performed prior to disposal. Radionuclide inventories were maintained for these sites but essentially no chemical inventories were recorded. Information on the plant processes that generated the wastes has been used to estimate the types and quantities of chemicals disposed. However, supporting analytical data from tests performed on these waste streams is lacking.

The inactive liquid waste sites were designed to allow the liquids to percolate and/or evaporate. Documentation indicates that groundwater beneath the 200-Area is contaminated with tritium and nitrates, apparently as a result of past waste management practices (see related finding in Section 3.4, Hydrogeology). In the past, the radionuclide content of the liquid waste streams has dictated the method, rate, and volume of disposal with no consideration given to the chemical constituents. The principal philosophy has been that the cation exchange capacity of the native soils would prevent radionuclides from reaching the groundwater. Even with this historical perspective focused on radionuclides, the groundwater has become

radioactively contaminated. Consequently, there is justification to suggest that the chemical constituents of the inactive liquid waste sites may have also contaminated groundwater.

As discussed in subsection 4.5.1.2.2, the liquid wastes generated in the 200-Area can be grouped into five categories. Based on the high volume of wastes received, 16 sites were selected by the Survey team to represent these five categories. The categories and their representative sites are listed below.

Steam Condensate and Cooling Water

200 E	216-B-2-2	Ditch
200 W	216-T-4-1	Pond
	216-T-4-2	Ditch
	216-S-10	Ditch

Process Condensate

200 W	216-S-1	Crib
	216-S-7	Crib

Miscellaneous

200 W	216-U-10	Pond
	216-Z-19	Ditch
	216-S-19	Ditch

Process Waste

200 E	216-C-4	Crib
	216-S-13	Crib
	216-S-14	Crib
	216-Z-18	Crib

Tank and Scavenged Waste

200 E	216-B-7A&B	Crib
	216-B-42	Crib
	216-A-24	Crib

During the sampling and analysis phase of the Survey, subsurface soil samples will be collected from these disposal sites and analyzed to determine the presence of chemical contaminants. The results will be used to broadly assess the chemical characteristics of the 188 liquid waste sites in the 200

East- and 200 West-Areas. Groundwater samples will be also collected from existing monitoring wells in the 200-Area and analyzed to determine the presence of radioactive and chemical contaminants. In addition, the cation exchange capacity of native soil substrata will be determined for the 200-Area, along with the 100- and 300-Areas.

2. Potential Surface Exposure of Wastes or Contaminants in the 100 B/C-Area. Future plans for the 100 B/C Reactors include the possibility of becoming a national historic site and the inactive wastes sites and releases in the area may be a source of potentially hazardous or toxic contaminants that could present an exposure problem.

Site closure plans for the inactive waste sites in the 100 B/C Area apparently do not exist for individual disposal areas. Most sites were covered with native soils to reduce the radiation exposure hazards, but sampling for chemical analyses was not performed. Therefore, the potential exists for wastes or contaminants to be exposed on the surface. In conjunction with this concern, the 100 B Reactor may eventually become a national historic site and be open to the public. This possible future activity in the 100 B/C-Area may lead to direct human contact with waste or surface contaminants.

Three locations in the 100 B/C-Area are of particular concern. One is the entrance to the B-Reactor because this is a relatively high traffic area and potentially may have been subject to accidental spillage. Also, PCB contaminated oils were used in the past to control dust along roads. The next location is in the vicinity of inactive waste sites 116-B-10, 118-B-4, and 118-B-6. Decontamination waste that may contain chemical contaminants was placed in 116-B-10. Also, this corner of the reactor area was noted as being a drum storage area. The third location is the 116-C-1 trench because the surface contour was slightly depressed, which is possibly indicative of some subsidence that could create an avenue for waste exposure.

During the sampling and analysis phase of the Survey, surface soil samples will be collected from these three locations and analyzed to determine the presence of chemical contaminants. Also, the depth of cover material will be

determined at two sites where records are available to demonstrate the reliability of the existing database.

3. Inactive Solid Waste Sites. All solid and dry waste sites on the Hanford Site have been categorically dismissed from further study, yet may still be sources of contamination to the vadose zone or to groundwater.

Many of the inactive burial grounds are known to have received radioactively contaminated waste; however, the chemical nature of the waste is poorly defined. Records show that the burial grounds received metallic waste but little is known about potentially hazardous organic waste materials that may have also been placed in these disposal areas. The solid waste disposal areas were constructed without liners or any groundwater protection measures. In some cases, liquid waste disposal sites are near a solid waste site, which may have enhanced the potential for contaminants to migrate from the fill areas and consequently threaten groundwater quality.

Some of the burial grounds that were dismissed have been documented as receiving containerized liquids, such as the 618-7 Burial Ground. Burial Ground 618-10 is immediately adjacent to a crib (316-4) that had an overflow pipe directed into the fill material. Other burial grounds are adjacent to active liquid waste disposal facilities. Also, the burial grounds in the 100-Area and portions of the 600-Area are in locations where the groundwater is relatively shallow. The slow release of containerized liquids and the potential for leachate generation due to the close proximity to past or active liquid waste disposal facilities may allow contaminants to migrate to the groundwater. Groundwater movement, potential discharge areas, and possible receptors have been discussed in Section 3.4, Hydrogeology.

During the sampling and analysis phase of the Survey, soil gas samples will be collected from eight burial ground locations and analyzed to determine the presence of volatile organics as an indicator of organic waste disposal. The burial grounds selected are: 118-B-1, 118-F-1, 118-F-5, 118-H-1, 618-10, 618-11, Horns Rapids Landfill, and 218-E-1. Many organic contaminants are highly mobile and may migrate more readily than some radionuclides known to be disposed of in the burial grounds. Indications of organic contaminants in a burial ground will provide supporting documentation for additional studies.

4. 100-Area Burning Pits. Residual contaminants from waste disposal operations in the 100-Area burning pits may be present in the shallow subsurface soils and potentially may migrate to groundwater.

The inactive burn pits were estimated to be approximately 100 x 100 ft in area and 10 ft deep. They were used to dispose of nonradioactive combustible materials such as paint waste, office waste, and chemical solvents. There are no records of the volume of waste disposed of in these pits. The ash resulting from burning presumably remains in the pits and the depth of cover or soil spread over these pits is unknown.

During the sampling and analysis phase of the Survey, subsurface soil samples will be collected for anlaysis from four of the 100-Area burning pits to determine the presence of chemical contaminants.

5. 300-Area Inactive Process Ponds. Two inactive process waste ponds in the 300-Area potentially contaminated groundwater in the past and leaching of the bottom sludges may continue to be a source of groundwater contamination.

The north and south process ponds (316-1 and 316-2) once received an estimated 5.3 x 10^9 gallons of liquid waste from the 300-Area operations. The ponds are now inactive although a portion of the south pond continues to receive some liquids. The accumulated bottom sediments in these ponds may contain high concentrations of metals and other chemical constituents, which potentially could be a source of groundwater contamination and subsequent contamination of the Columbia River.

During the sampling and analysis phase of the Survey, samples will be collected and analyzed to determine the presence of potentially hazardous contaminants in the bottom of the two inactive process liquid waste ponds in the 300-Area. Groundwater samples from existing monitoring wells in the vicinity of the ponds will also be collected and analyzed to determine the presence of contamination.

6. 107 B Retention Basin. Chemical contaminants may be present in the sludge of the 100-Area retention basins and potentially may migrate to groundwater and/or surface water.

The 100-Area retention basins received radioactively contaminated cooling water from the reactors. The chemical constituents of this waste stream have not been determined by analysis but are believed to include sodium dichromate. Sludge from the 100 B/C-Area retention basins has been removed from the basin and disposed of on land adjacent to the inactive structure. Migration of the constituents in this sludge may contaminate groundwater and/or the Columbia River.

During the sampling and analysis phase of the Survey, samples will be collected for analysis to determine the presence of contaminants in the sludges disposed of beside the retention basins.

7. Inactive Ash Basins and Pits. The chemical composition of the ash placed in several pits, basins or piles has not been determined and this waste may be a potential source of hazardous contaminants affecting soil and/or groundwater.

Inactive ash disposal areas exist in the 100-, 200-, and 300-Areas of the Hanford Site. The basins in the 100 D/DR-Area, the 100 F-Area, and the 300-Area contain ash generated from different operations. These three basins are also located near the Columbia River, where the groundwater is more shallow than at other areas of the Hanford Site. If mobile contaminants are present in the ash, there may be a greater potential for them to reach groundwater in the 100- or 300-Areas. In addition, water pooled in the 100 D/DR-Area inactive ash basin may contain hazardous chemical contaminants as well as the ash itself. This water may also enhance leachate generation and subsequent migration of contaminants to groundwater or the Columbia River.

During the sampling and analysis phase of the Survey, samples from the three inactive ash basins will be collected and analyzed to determine the presence of chemical contaminants.

8. Herbicide Disposal in an Inactive Waste Site. The herbicide 2,4-D, which can be contaminated with dioxin, was disposed of in one inactive waste site and may migrate to subsurface soils.

A site on the eastern side of the Columbia River was used for disposal of 2,4-D contaminated soil from leaking storage tanks at a USBR Station in Eltopia, WA. The burial consisted of 900 gallons of 2,4-D which had leaked into 50 yards of soil. A second burial consisted of the ten leaking tanks which were flattened and buried in the same location. This site is a trench, 400 x 12 x 4 ft deep covered with 4 ft. of soil. No deliberate disposal of radioactive waste was made to the site. The major concern is that 2,4-D can be contaminated with dioxin and the method of closing the site may not prevent contaminant transport.

9. 116-K-2 Trench. The inactive 116-K-2 trench received radioactively contaminated cooling water from the reactors and currently has a surface grade that may allow contaminants to migrate via infiltration.

The 116-K-2 Trench, which is 4000 feet long by 50 feet wide and 20 feet deep received a large volume of radioactive coolant from the reactors for 16 years. This trench has not been covered with clean soil and graded. The surface of the trench is very roughly graded, which allows water infiltration during rainfall. Because of the radiation hazard, the trench has been posted and roped off to warn of limited access. Contaminants may migrate to groundwater and/or surface water from this inactive site.

During the sampling and analysis phase of the Survey, samples will be collected for analysis to determine the presence of contaminants.

10. Abandoned Tank - 100 KE/KW. An unnumbered abandoned tank in the 100-KE/KW-Area was identified during the Survey that may be a source of contamination should the integrity fail.

The tank presumably contained waste or an abandoned product with an oily sheen on the aqueous fraction. Contractor personnel interviewed had no knowledge of the tank's contents or condition. The tank is a potential source of contamination should the integrity fail.

During the sampling and analysis phase of the Survey, samples will be collected for analysis to determine the chemical constituents of the contents in this underground storage tank.

11. 1303 N Silo. Procedures used for loading reactor fuel spacers at the 1303 N Silo potentially result in the release of radionculide contaminants to surface soils, which may be a source of contamination to groundwater and the Columbia River.

The dummy fuel spacers at the 100N-Reactor, which are used to maintain the proper distance between the fuel rods in the reactor, are radioactive. The spacers are removed from the reactor during normal refueling and placed in a water-filled cooling receptacle. After cooling, the spacers are removed by conveyor to the silos. The spacers are removed from the silos every 4 to 6 months by an electromagnetic crane and placed on railroad cars for disposal in the 200-Area. The area immediately around the silos is roped off because of the radiation hazard in the area.

During the sampling and analysis phase of the Survey, samples will be collected for analysis to determine the presence of radionuclides in surface soils immediately surrounding the 1303 N Silo.

12. 100 N Area Recovery Trench. Spills have occurred at the 100 N-Area Recovery Trench that may have contaminated soils and/or the Columbia River.

An accidental spill occurred at the 100 N-Area recovery trench involving diesel fuel and was cleaned up by the site contractor. Documentation of this cleanup is limited. The potential exists for other spills to have occurred in this area, possibly including chemicals, which have not been previously identified. The recovery trench discharges directly to the Columbia River, leading to a possibility of affecting aquatic life and the public.

During the sampling and analysis phase of the Survey, samples will be collected for analysis to determine the presence of residual contaminants in the recovery trench water and sediment.

13. Mercury Waste in the 100 KE/KW Area. At the 100 KE/KW Area, four inactive sites reportedly received nonradioactive acidic waste that was highly contaminated wiht mercury.

The four sites are 100 KE-1, 100 KE-2, 100 KW-1, and 100 KW-2, which are two inactive dry sumps (4 x 4 x 4 ft deep) and the two french drains (3 ft in diameter and 3 ft deep), with an open bottom. The reactor area is presently being decommissioned, which historically has only dealt with radionuclide contaminated areas and not chemical contamination. Mercury is highly toxic in small concentrations and these four sites may be a source of mercury contamination.

During the sampling and analysis phase of the Survey, samples will be collected to determine the corrosivity and concentration of metals, particularly mercury, in the waste/sludges disposed of in two sumps (100 KE-1 and 100 KW-1) and two French drains (100 KE-2 and 100 KW-2).

4.5.2.4 Category IV

1. Boundaries of 600-Area Burial Grounds. The boundaries of the 600-Area Burial Grounds are not properly defined. Consequently, use of fencing to restrict access may not be effective in preventing accidental exposure to waste areas.

REFERENCES

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APPENDIX A

SURVEY PARTICIPANTS

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The Hanford Site Environmental Survey was conducted by the DOE Office of Environmental Audit, with technical assistance from the NUS Corporation and its subcontractor, ICF Corporation. Dr. D. Elle was the principal point of contact for the DOE Richland Operations Office. The Survey Teams were composed of the following personnel:

Department of Energy

Team Leaders	R. Scott	C. Grundler
Assistant Team Leaders	V. Fayne	D. Caughey
Special Assistant	S. Barisas	

NUS Corporation

Team Coordinators	M. Malloy	D. Worley
Air	R. Andes	R. Lanza
Surface Water	S. Gentry	A. McClure
Waste Management	M. Smith	J. Nelson
Inactive Waste Sites	J. Scott	D. Worley
	J. English	
Hydrogeology	D. Riddle	J. Wilson
	G. Dawson	
Radiation	C. Yates	J. Connelly
	D. Dougherty	
QA/TSCA	M. Malloy	G. Gartseff

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APPENDIX B

SITE-SPECIFIC SURVEY ACTIVITIES

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SUMMARY OF SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The U.S. Department of Energy (DOE) Office of Environmental Audit and Compliance, Assistant Secretary for Environment, Safety and Health, selected a Survey Team for the Hanford Reservation site in June 1986. Messrs. Randal Scott and Christopher Grundler were designated the DOE Team Leaders, the Assistant Team Leaders were Messrs. Vincent Fayne and David Caughey, and Ms. Susan Barisas was the special assistant. Dr. D. Elle was the point of contact in all Survey efforts for the Richland Operations Office. The remainder of the team was composed of contractor specialists from the NUS Corporation and its sub-contractor, ICF Corporation. These individuals and their areas of expertise are listed below.

Specialty	Name
Air	Roger Andes, Robert Lanza
Surface Water	Stephen Gentry, Andrew McClure
Waste Management	Mike Smith, James Nelson
Inactive Waste Sites	Jennifer Scott, Joseph English, Dwight Worley*
Hydrogeology	Douglas Riddle, Gaynor Dawson, John Wilson
Radiation	Carl Yates, David Dougherty, John Connelly
QA/Toxics	George Gartseff, Michael Malloy*

* NUS Coordinators

Survey Team members began reviewing Hanford Reservation general environmental documents and reports in July 1986. Messrs. Scott, Caughey, Malloy, Worley, Alan Crockett (Idaho National Engineering Laboratory — INEL) and Ms. Barisas conducted a pre-Survey site visit on July 15-17, 1986, to gain familiarity with key DOE and site personnel. They toured the facility and completed a cursory review of the data generated in response to an information request of June 26, 1986. The request

listed environmental information of interest to the Survey Team for Survey planning purposes. A meeting was held with a State of Oregon Environmental representative at the Richland Operations Office on July 16, 1986. An additional meeting was conducted in Olympia, Washington, on July 17, 1986, with personnel from the State of Washington Department of Ecology and the Department of Social and Health Services and the U.S. Environmental Protection Agency (EPA), Region X, to review environmental issues and explain the purpose and scope of the Survey.

The Survey Team intensively reviewed the information generated during the pre-Survey visit, and on August 4 through 5, 1986, prepared a Survey Plan for the Hanford Reservation Site. This plan discussed the specific approach to the Survey for each of the technical disciplines and included a proposed schedule for the on-site activities. The Survey Plan was transmitted through the Richland Operations Office to the Hanford Reservation contractors during the week of August 4, 1986.

B.2 On-site Activities

The on-site portion of the Survey was conducted during the period of August 18 - September 5, 1986. The opening meeting was held on August 18, 1986, at the site and was attended by representatives from DOE Headquarters, the Richland Operations Office, United Nuclear Corporation, Rockwell Hanford Operations, Westinghouse Hanford Corporation, Battelle Pacific Northwest Laboratory, Hanford Environmental Health Foundation, the NUS Corporation, and ICF Corporation. Discussions during this meeting centered on the purpose of the Survey, logistics at Hanford Reservation, and an introduction of the key personnel involved.

During the Survey, team members reviewed file materials, permits and applications, background studies, engineering drawings, accident reports, and operating logbooks. The production process was thoroughly analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed. Extensive interviews were conducted with plant personnel regarding environmental controls, operations, monitoring and analysis, past operations, regulatory permits, and waste management.

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Periodic meetings of the Survey Team members were held to report observations and compare findings. The DOE Team Leaders, Assistant Team Leaders, Special Assistant, and the NUS Coordinators met daily to discuss findings and progress, and to arrange for specific site personnel and facilities to be available, as needed, on the following day.

The Survey Team members identified further sampling and analysis requirements necessary to complete the Survey effort. The sampling and analysis requirements were discussed with the INEL representatives on September 4, 1986. The INEL was designated by DOE to provide two sampling teams for Hanford Reservation and to perform the laboratory analytical services.

A site close-out briefing was held on September 5, 1986, where the DOE Team Leaders presented the preliminary observations of the Survey Team. These observations were classified as preliminary, because additional research and, in some cases, additional field sampling were required to positively confirm the observations.

B.3 Sampling and Analysis

Idaho National Engineering Laboratory will perform the sampling and analysis portion of the Survey. The INEL evaluated the sampling requests made by the Survey Team and determined sampling and analysis logistics, costs, and schedules. The sampling plan prepared by INEL includes a quality assurance plan and a health and safety plan. The sampling plan was completed during October 1986 and the sampling team is expected to begin work at the site during November 1986.

B.4 Report Preparation

A Draft Survey Report for Hanford Reservation will be available for DOE review by October 1986. Comments from this review and the results of the sampling and analysis efforts will be incorporated and the report will be reissued as an Interim Report. The timing of the Interim Report is dependent upon the completion of the sampling and the reporting of the analytical results to the Survey Team.

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APPENDIX C

SURVEY PLAN

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ENVIRONMENTAL SURVEY
HANFORD RESERVATION SITE
AUGUST 18-SEPTEMBER 5, 1986
RICHLAND, WASHINGTON

1.0 INTRODUCTION

The Environmental Survey is a one-time baseline inventory of existing environmental problems and environmental risks at U.S. Department of Energy (DOE) operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the Draft Environmental Survey Manual distributed on May 16, 1986.

The Survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Environmental Survey at the Hanford Reservation site will be managed by DOE Team Leaders Randal Scott and Christopher Grundler. DOE Assistant Team Leaders will be David Caughey and Vincent Fayne, and Susan Barisas will be the Special Assistant. Donald Elle will serve as the Richland Operations Office Representative on the Survey Team. Technical support will be provided by NUS Corporation personnel as follows:

Air	Robert Lanza Roger Andes
Radiological	John Connelly Carl Yates David Dougherty
Surface Water/ Drinking Water	Andrew McClure, Jr. Stephen Gentry

RCRA/Radioactive Waste	James Nelson Mike Smith
Inactive Waste Sites/ Releases (CERCLA)	Dwight Worley (NUS Coordinator) Jennifer Scott Joseph English
Hydrogeology	Douglas Riddle John Wilson Gaynor Dawson
QA/TSCA	Michael Malloy (NUS Coordinator) George Gartseff

2.1 Pre-Survey Activities

Survey Team members began reviewing Hanford Reservation general environmental documents and reports in July 1986. Messrs. Scott, Caughey, Worley, Malloy, Alan Crockett (Idaho National Environmental Laboratory) and Ms. Barisas conducted a pre-Survey site visit on July 15-16, 1986 to gain a familiarity with key DOE staff and Contractor personnel from Rockwell Hanford Operations (RHO), Westinghouse Hanford Company (WHC), Pacific Northwest Laboratory (PNL), United Nuclear Industries (UNC), and Hanford Environmental Health Foundation (HEHF). They toured the facility and completed a cursory review of data generated in response to a memorandum of June 26, 1986. The memorandum proposed the Survey dates and listed environmental information of interest to the Survey Team for Survey planning purposes.

A meeting was held with a State of Oregon Environmental representative at the Richland Operations Office on July 16, 1986. An additional meeting was conducted in Olympia, Washington, on July 17, 1986, with personnel from the State of Washington Department of Ecology and the Department of Social and Health Services and the U.S. Environmental Protection Agency (EPA), Region X, to review environmental issues and explain the purpose and scope of the Survey.

This Survey Plan will be transmitted to Hanford Reservation prior to the Survey.

2.2 On-Site Activities

The Survey will be conducted from August 18 through September 5, 1986. The Agenda will be as shown in Table 1, with modifications as appropriate to minimize disruption of site activities and to enhance Survey efficiency and effectiveness.

Interviews and consultations will be conducted with environmental, safety, operations, waste management, and purchasing and warehousing personnel, among others, in the course of the Survey. Also, the Survey Team will continue its review of records and other documentation during the Survey. These records are identified in the "Records Required" sections of this plan. The Survey Team has already reviewed some of these documents so copies do not have to be made. However, the originals should be readily available for reference.

2.3 Sampling and Analysis

Based on available site environmental information and the results of the Survey activities on-site, the sampling and analysis phase of the Survey process will be implemented approximately 4 weeks after completion of the Survey. This effort will have a 2 to 10 week duration and will be conducted by the Idaho National Engineering Laboratory (INEL). Results of the sampling and analysis effort will be transmitted to the Survey Team Leaders.

2.4 Conclusions and Reporting on the Survey

A close-out briefing will be conducted during the third week of the Survey to describe the general conclusions of the site activities. Within 6 weeks of the on-site Survey Team visit, a Draft Survey Report will be developed. Within 6 weeks of the availability of the analytical results from the sampling and analysis phase of the Survey, an Interim Survey Report will be completed.

Table 1

Table 1 (Continued)

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Table 1 (Continued)

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Table 1 (Continued)

3.0 AIR

3.1 Issue Identification

The nonradioactive air-related issues involve an assessment of the plant-wide air emissions, emission control and monitoring equipment, and the acquisition and processing of ambient air quality data. Areas of particular interest are the process emissions of particulates, nitrogen oxides, ammonia, toxic metals and organic vapors, and the emissions of nitrogen and sulfur dioxides from fuel-burning equipment. In addition, operational and procedural practices associated with emission control equipment will be evaluated. Fugitive sources of particulate and gaseous emissions and any mitigative procedures will be investigated.

The general approach to the Survey will involve a review of existing air permits and impact statements, operating procedures, stack test reports, and other relevant documents to identify significant sources of air emissions. Following the document review will be the physical inspection of significant processes, control and monitoring equipment, and potential fugitive sources. The Survey will identify air contaminants from significant processes and fugitive sources in the plant, evaluate the existing control equipment for the air contaminants, and assess the potential for environmental problems from the emissions.

The ambient air monitoring system assessment will involve inspection of the ambient samplers and meteorological equipment and review of procedures applicable to data acquisition, calibration procedures, data validation, and processing. The primary emphasis will be an assessment of these procedures to characterize the environmental impact of plant operation and the defensibility of the collected data.

3.2 Records Required

- o Air permits and Environmental Impact Statements.
- o Source and source emissions inventories.
- o Air quality calculations, Environmental Monitoring Reports.

- o Descriptive documentation on existing and proposed add-on emission controls and ventilation system drawings.

- o Operating and testing/maintenance procedures for control equipment.

- o Correspondence between regulatory agencies: air-related.

- o Reports on accidental releases/unusual occurrences.

- o Ambient air monitoring program procedures:

  - Sample collection procedures.
  - Calibration procedures and records.
  - Laboratory procedures and quality assurance.
  - Ambient air monitoring data.

- o Stack monitoring/sampling program procedures:

  - Calibration procedures and records.
  - Stack monitoring/sampling data.
  - Laboratory procedures and quality assurance.

4.0 RADIOLOGICAL

4.1 Issue Identification

The radiological review will place emphasis on the following major issues: (1) liquid releases from cribs at N-Reactor, atmospheric releases from N-Reactor, direct radiation levels near N-Reactor; (2) liquid releases from the Plutonium-Uranium Extraction (PUREX) Plant (200-East Area), atmospheric releases from the PUREX Plant, and the tritium plumes emanating from the 200-Area; (3) atmospheric releases from the 300-Area (Building 333); and (4) leaking single-shell high-level-waste storage tanks and the identification of radionuclides other than tritium in the groundwater (such as plutonium and americium). Evaluation of these issues and others for the purpose of identifying environmental problems will be accomplished

through observations of equipment to control atmospheric and liquid releases, observations of the monitoring of effluents, and observations of the environmental monitoring program. Dose assessment methodology will also be evaluated.

Particular attention will be paid to the strontium-90 releases from the cribs at N-Reactor, and to the tritium plume coming from the 200-Area. Of special interest are the nontritium radionuclides leaking from the single-shell high-level-waste storage tanks and the release of other radionuclides from processing facilities.

4.2 Records Required

The records required for review include the following:

- o Meteorological data forming basis of siting air samplers.
- o Hydrological data forming basis of siting surface and groundwater monitoring.
- o Land use and demographic surveys forming basis for any other sample types.
- o Impact assessment methodologies.
- o DOE orders, field supplements, facility directives covering quality assurance activities.
- o Procedure and forms indices.
- o Examples of forms cited in procedures.
- o Field and laboratory calibration records.
- o Laboratory QA records.
- o Effluent monitoring equipment calibration records.

- Raw data from effluent and environmental monitoring (including releases to cribs and wells, airborne effluents, and direct radiation readings via instruments and thermoluminescent dosimeters).

- Unusual occurrence and minor events reports and data.

- List of known leaking waste storage tanks (including radionuclides and estimated quantities released).

5.0 SURFACE WATER/DRINKING WATER

5.1 Issue Identification

A number of documents from the Hanford Reservation site have been reviewed with attention being given to data and information concerning surface water (both influent and effluent waters). In the past, site attention has been primarily directed toward the identification of radiological releases, and limited information is available on other pollutants. Except for some water quality parameters in receiving streams, the only other nonradionuclide analyses generally available are those required by the National Pollutant Discharge Elimination System (NPDES) permit.

The Survey will include identification of potential discharges to surface water not mentioned in the NPDES permit or other documents, and potential cross-contamination between process and sanitary waste treatment systems. This will be accomplished by reviewing Standard Operating Procedures (SOPs) for the operation and maintenance of sampling and treatment equipment, then following through by looking at records, interviewing personnel, and observing procedures to determine how they are followed. A walk-through of the plant area will be made to identify liquid waste streams from plant processes and discharges to the environment.

5.2 Records Required

Records that may be reviewed during the visit to obtain information include:

- o Analytical data used for preparation of the NPDES monitoring reports.
- o NPDES discharge monitoring reports for the period 1980 - present.
- o Records of drinking water quality (both plant and Richland potable water).
- o Operators' logbooks and reports for treatment plant operations.
- o Sampling logbooks.
- o Treatment plant and monitoring equipment maintenance records and/or logs.
- o Water balance drawings.
- o Distribution and sewer drawings (process and sanitary floor drain system drawings).
- o Process flow diagrams.
- o Waste stream characterization studies.
- o Analytical data on influent process water and process waste streams.
- o Procedures for the operation and/or maintenance of treatment and monitoring equipment.
- o Spill Prevention Control and Countermeasure (SPCC) plans and records of implementation.
- o Status of NPDES application.

6.0 RCRA/RADIOACTIVE WASTE

6.1 Issue Identification

The hazardous waste review will place emphasis on those facilities seeking hazardous waste permit approval and on the identification of hazardous/radioactive waste management activities that have potential for an adverse environmental effect. Table 2 provides a listing of all active hazardous and radioactive mixed waste (RMW) facilities, and their permit status. Of particular concern are the unlined 13 land-based units, and their groundwater monitoring systems. The Survey review will determine whether the Hanford Reservation hazardous/radioactive waste management activities are conducted to prevent unauthorized releases. Appropriate sections of the Part B application will be reviewed for completeness. In addition, any operating and permitting deficiencies for hazardous/radioactive waste treatment, storage, and disposal (TSD) units will be defined. Solid waste management units (SWMUs) as defined by the Resource Conservation and Recovery Act (RCRA), will be identified, as they are important in delineating sources of environmental contamination. The hazardous waste review will be coordinated with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and hydrogeologic investigations to help identify possible releases from such SWM units. Hanford Reservation will be surveyed to determine hazardous/radioactive waste generation points and the characterization of existing and, to the extent possible, past waste disposal practices. Waste storage practices in underground tanks and waste oil management practices will also be examined. Solid waste disposal operations will be evaluated to ensure that all hazardous and radiological constituents have been identified and are properly managed. All radioactive waste TSD units will also be reviewed.

6.2 Records Required

The following records will be reviewed on-site:

- o Part B permit application.
- o 3016 inventory.
- o Part A application.

Table 2

Hazardous and Radioactive Mixed Waste Facilities
(Part B Application)

Facility Name	Type	Waste Type[1]	Permit Status[2]
Non-Radioactive Dangerous Waste Landfill	Landfill	HW	I/PS
2727-s/200 Storage	Container Storage	HW	I/PS
Solvent Evaporation Unit	Tank Treatment	RMW	NP/CL
3718-F Treatment/Storage Facility	Thermal Treatment, Container Storage	HW	I/PS
E-8 Burning Ground	Thermal Treatment	HW	I
324 Pilot Plant	Tank Treatment	HW	NP/PS
1100 Area Detonation Site	Thermal Treatment	HW	I
Ash Disposal Pit	Thermal Treatment	HW	I
105-DR Na Fire Facility	Container Storage, Thermal Treatment	HW	I/PS
221-T Test Facility	Tank Treatment	HW	I/PS
437 MAS F	Tank Treatment	RMW	PL/PS
Non-Radioactive Dangerous Waste Storage Facility	Container Storage	HW	PL/PS
300 Area Process Trench	Surface Impoundment	HW	NP/CL
218-W-2A Landfill	Landfill	RMW	NP/PS
218-W-6 Landfill	Landfill	RMW	NP/PS
218-W-3AE Landfill	Landfill	RMW	NP/PS
218-W-3A Landfill	Retrievable Storage, Landfill	RMW	NP/PS
218-W-4C Landfill	Retrievable Storage, Landfill	RMW	NP/PS

Table 2 (continued)

Facility Name	Type	Waste Type[1]	Permit Status[2]
218-W-5 Landfill	Landfill	RMW	NP/PS
218-E-10 Landfill	Landfill	RMW	NP/PS
218-E-10B Landfill	Landfill	RMW	NP/PS
218-C-9 Landfill	Landfill	RMW	NP/PS
218-E-12B Landfill	Landfill	RMW	NP/PS
183-H Basins	Surface Impoundments	RMW	NP/CL

1 HW = Hazardous Waste
RMW = Radioactive Mixed Waste

2 I = Interim Status
PS = Part B Permit Application Submitted
NP = No permit or interim status
CL = Closure/Post-Closure Plan submitted and facility no longer accepts hazardous waste
PL = Planned Facility

- o Inspection documentation (State and Federal).
- o Groundwater monitoring, sampling, and analytical documentation.
- o Waste inventory documentation.
- o Enforcement action documentation.
- o Groundwater monitoring system construction documentation.
- o Internal facility inspection documentation.
- o Dangerous Waste Management Plan.
- o Radioactive Waste Management Plan.
- o Process descriptions.
- o Waste reduction certification documentation.

7.0 INACTIVE WASTE SITES/RELEASES (CERCLA)

7.1 Issue Identification

The Survey will identify environmental problems and potential risks associated with the historical handling, storage, and disposal of hazardous substances at the Hanford Reservation. The Survey will focus on current and future risks related to past land disposal practices and past spills/releases.

Facilities that have handled hazardous, mixed, and low-level radioactive wastes will be assessed. These facilities include the waste storage and disposal areas identified in the draft Phase I Installation and Assessment of Inactive Waste-Disposal Sites at the Hanford Reservation. Additionally, information regarding accidental spills and/or releases will be reviewed with follow-up inspections as deemed necessary. Inactive high-level radioactive waste tanks, facilities that are part of DOE Surplus Facilities Management Program (SFMP), and facilities that are part of the active Hanford Reservation remediation program will be included as part of the CERCLA effort. These facilities will be evaluated in terms of the materials they contain, their integrity, and past and potential releases of hazardous substances.

7.2 Records Required

The following records will be reviewed at the site:

- o Waste management plans (past and current).
- o Historical SOPs regarding management of hazardous substances, disposal areas, and storage areas.
- o Hazardous substances inventories.
- o Listing of inactive areas used for use, storage, receiving and shipping, and disposal of hazardous substances.
- o Historical files on past operations and processes, substances used, and methods of handling and disposal.
- o Files on past off-site waste handling and disposal.
- o Records of facility expansion and building rubble disposal.
- o Descriptions and notifications of inactive waste sites and potential areas of contamination.
- o Descriptions and notification of spills/releases (Unusual Occurrence Reports and Minor Release Reports).
- o Descriptions of corrective actions.
- o Description of all waste management facilities, including buried tanks and structures.
- o Ongoing CERCLA-related studies.

8.0 HYDROGEOLOGY

8.1 Issue Identification

The preliminary review of documentation on the Hanford Reservation site indicates that a great deal of previous work has been conducted in the area of groundwater assessments. Previous studies have not resolved questions of potential contaminants other than radionuclides and the nature of the extremely complex groundwater flow regime in some areas around the site. Recent and ongoing studies have recognized these shortcomings and have begun to address them. The issues to be dealt with during the Survey include a determination of the status of those recent and ongoing studies. While some potential contaminant source areas, such as the RCRA sites, have been investigated in the past, a number of potential source areas need further study. These include the underground storage tanks, seepage ponds, the cribs, Drywell 216-C-2, trenches, and the high-level radiation tanks. In addition, transit times for liquid releases from 100N will be investigated.

A general review of data collection efforts that have taken place will be required to verify the value of previous studies. This will include a review of sampling procedures, chain-of-custody and quality assurance/quality control (QA/QC) procedures, compatibility of data from various sources, and monitoring parameters. The reliability, construction, and placement of wells used for groundwater monitoring will be examined. To assess the potential for regional impact from groundwater contamination, principal facility users of groundwater, as well as domestic users, if any, need to be identified. Well construction data will also be evaluated for these sources.

8.2 Records Required

Records and documents to be reviewed include the following:

- New and recent work and work plans.
- Well sampling procedures and schedules.

- o Monitoring parameters, data and results.
- o General groundwater sampling and laboratory QA/QC.
- o Well installation reports, boring logs, and as-built drawings.
- o Air photos (historic—1940 to present).
- o Historic topography records, etc.
- o Groundwater sections of pertinent documents (e.g., RCRA permits, Formerly Utilized Sites Remedial Action Program cleanups).
- o UST reporting forms (May 8, 1986).

9.0 QUALITY ASSURANCE

9.1 Issue Identification

The QA review of the environmental program will be primarily directed to the evaluation of site sampling and analytical capabilities. Activities at the PNL, WHC, RHO, UNC, HEHF, and U.S. Testing will be reviewed. The intent will be to verify and review the QA procedures for obtaining process effluent and environmental samples, performing the analytical work to identify pollutants, and the handling and reporting of data. All aspects of the QA program relating to environmental monitoring and analysis of the Hanford Reservation site will be reviewed, including operator training; equipment and instrument calibration/maintenance; precision and accuracy studies; blank, split, and spiked sample analyses; sample handling and chain-of-custody procedures; data reduction and validation; data reporting and documentation; and calculation and logbook reviews.

The procedures for sampling and analysis will be monitored to appraise proper implementation and conformance to regulatory agency requirements. Quality assurance plans will be reviewed for the sampling and analytical activities, as well as internal QA audits. The QA procedures imposed on any outside sampling or analytical laboratories will also be reviewed in this study effort.

9.2 Records Required

During the site visit, the following records/documents will be reviewed:

- o Analytical Laboratory and Environmental Sampling Quality Assurance Plans.
- o QA Audits of Laboratory and Sampling Program.
- o QC Reports for precision and accuracy.
- o Laboratory and sampling procedures manuals.
- o Operator training records (laboratory and sampling).
- o Instrument maintenance and calibration records (laboratory and sampling).
- o Laboratory and sampling calculations and workbooks.

10.0 TOXIC MATERIALS-TSCA

10.1 Issue Identification

The toxic materials review will address the raw materials and process-related chemicals used on the Hanford Reservation site. The use, handling, and disposal of polychlorinated biphenyls (PCBs), asbestos, pesticides, and herbicides will be within the scope of this effort.

All toxic materials purchased, used, or manufactured by Rockwell and the other site contractors will be surveyed. Tracking, control, and management of these substances will be reviewed. Records of usage will be examined to assess the potential for entering effluent streams.

An inventory of PCB-contaminated electrical equipment in use at the facility areas will be obtained. The condition of this equipment, its potential for leakage, and

the quantity of contaminated fluids will be assessed. Obsolete or used PCB items and contaminated items in storage will be inspected for proper packaging, adequate storage protection requirements, and inventory controls. Disposal practices for current and past inventories will be reviewed to determine the method(s) of disposal and location(s) of disposal sites. Procedures for PCB analysis, removal, handling, and disposal will be reviewed.

The presence of asbestos insulation in Hanford Reservation buildings will be identified. Specifications or plans for modification/removal projects will be reviewed with the site construction contractor, J.A. Jones, and appropriate operations contractors. Procedures for asbestos modification/removal, handling, and disposal will be investigated. Disposal practices will be reviewed to determine disposal methods and locations of disposal sites.

The usage of pesticides and herbicides on the site will be reviewed, as well as personnel training, application records, and storage and disposal practices.

10.2 Records Required

Records will be required from each of the appropriate contractors from the specific site areas and activities. The following records/documents regarding toxic materials should be available for review during the site visit:

- Inventory of toxic materials and purchasing records.
- Toxic materials labeling and tracking system.
- Procedures for handling, control, and management of toxic materials.
- Inventory of in-service PCB-contaminated electrical equipment.
- PCB handling, storage, and disposal procedures.
- Storage records of PCB items.
- Disposal records for PCB items.
- Asbestos handling, removal, and disposal procedures.
- Locations of buildings containing asbestos.
- Asbestos disposal records, including method and location of disposal.
- Inventory of pesticides/herbicides.
- Pesticide/herbicide training, handling, storage, and disposal records.
- Standard operating procedures for pesticides/herbicides.

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APPENDIX D

CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS

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AIHA	- American Industrial Hygiene Association
ALARA	- As Low As Reasonably Achievable
Ar-41	- Argon-41
ASD	- Ammonia Scrubber Discharge
BWIP	- Basalt Waste Isolation Project
BiPo	- Bismuth Phosphate Process
Btu/hr	- British Thermal Units per hour
C-14	- Carbon-14
CAM	- Constant Air Monitor
CE	- Combustion Engineering
CERCLA	- Comprehensive Environmental Response, Compensation, and Liability Act
Cfm	- Cubic feet per minute
CFR	- Code of Federal Regulations
CL	- Closure
CRW	- Cladding Removal Waste
CRW	- Circulating Raw Water
CSL	- Chemical Sewer Line
CWL	- Cooling Water Line
Ci	- curie
cm	- centimeters
Co-60	- Cobalt-60
cpm	- counts per minute
Cs-137	- Cesium-137
°C	- degrees Centigrade
DOE	- U.S. Department of Energy
DW	- Drinking Water
DWIP	- Dangerous Waste Implementation Plan

EPA	- U.S. Environmental Protection Agency
ERDA	- U.S. Energy Research and Development Administration
FCP	- Fuel Cycle Plant
FFTF	- Fast Flux Test Facility
FMEF	- Fuel Materials Examination Facility
ft	- foot
FW	- Foster-Wheeler
°F	- degrees Fahrenheit
G	- glass
GC/FID	- Gas Chromatography/Flame Ionization Detection
GWMP	- Groundwater Monitoring Program - Hanford
H-3	- Tritium
H_2SO_4	- sulfuric acid
HEDL	- Hanford Engineering Development Laboratory (Westinghouse)
HEHF	- Hanford Environmental Health Foundation
HEPA	- High-Efficiency Particulate Air (Filter)
HESP	- Hanford Environmental Surveillance Program
HISS	- Hanford Inactive Site Survey
HLW	- High-Level Waste
HW	- Hazardous Waste
HWM	- Hazardous Waste Management
HRS	- Hazard Ranking System
I	- Interim
I-129	- Iodine-129
I-131	- Iodine-131
IC	- Ion Chromatography
INEL	- Idaho National Engineering Laboratory
JAJ	- J.A. Jones Construction
KEH	- Kaiser Engineers Hanford
Kg	- kilogram

kg/day	- kilogram per day
kr-85	- krypton-85
LLW	- Low-Level Waste
LOW	- Liquid Observation Wells
LWDF	- Liquid Waste Disposal Facility
lb/h	- pounds per hour
MASF	- Maintenance and Storage Facility
MSDS	- Material Safety Data Sheet
MT/yr	- metric ton per year
m^3/h	- cubic meters per hour
mg/L	- milligram per liter
mHRS	- modified Hazard Ranking System
mn-54	- manganese-54
mR/yr	- milliroentgen per year
mrem	- millirem
µg/L	- micrograms per liter
$\mu g/m^3$	- microgram per cubic meter
µCi/cc	- microcuries per cubic centimeter
NA	- Not Available
NAAQS	- National Ambient Air Quality Standards
NBS	- National Bureau of Standards
NIOSH	- National Institute of Occupational Safety and Health
NO_2	- Nitrogen Dioxide
NO_x	- Nitrogen Oxides
NP	- No Permit
NPDES	- National Pollutant Discharge Elimination System
NPDWR	- National Primary Drinking Water Regulations
NRDWS	- Nonradioactive Dangerous Waste Storage
NR	- Not Reported
NRC	- U.S. Nuclear Regulatory Commission
NRDW	- Nonradioactive Dangerous Waste
NSM	- N-Springs Monitoring
NaOH	- Sodium Hydroxide

Nb-95	- Niobium-95
nCi/g	- nanocuries per gram
P	- plastic
PCB	- Polychlorinated Biphenyls
PCD	- Process Condensate Discharge
PCE	- Perchloroethylene
PEDF	- Protective Equipment Decontamination Facility
PETF	- Process Effluent Treatment Facility
PFP	- Plutonium Finishing Plant
PL	- planned
PNL	- Battelle Pacific Northwest Laboratory
PRF	- Plutonium Reclamation Facility
PS	- RCRA Part B Submitted
PUREX	- Plutonium-Uranium Extraction (process)
Pu-239/240	- Plutonium-239/240
pCi/g	- picocuries per gram
pCi/L	- picocuries per liter
ppb	- parts per billion
ppm	- parts per million
QA	- Quality Assurance
QC	- Quality Control
R	- Roentgen
RCG	- DOE Radioactivity Concentration Guides
RCRA	- Resource Conservation and Recovery Act
REDOX	- Reduction-Oxidation (process)
REM	- Roentgen Equivalent Man
RHO	- Rockwell Hanford Operations
RLW	- Radioactive Liquid Waste
RMW	- Radioactive Mixed Waste
RPT	- Radiation Protection Technician

S&A	- Sampling and Analysis
SAMP	- Separations Area Monitoring Program
SCD	- Steam Condensate Discharge
SCF	- Standard Cubic Feet
SFMP	- Surplus Facilities Management Program
SNM	- Special Nuclear Materials
SSM	- Shoreline Seepage Monitoring
SST	- Single-Shell Tank
SWHW	- Site-Wide Hazardous Waste Groundwater Monitoring
Sr-90	- Strontium-90
SWMU	- Solid waste management unit
TBP	- Tributyl Phosphate
TLD	- Thermoluminescent dosimeter
TOC	- Total Organic Carbon
TOH	- Total Organic Halogen
TOX	- Total Organic Oxidants
TRU	- Transuranic
TSD	- Treatment, Storage, and Disposal
TSP	- Total Suspended Particulates
U	- Uranium
UNC	- United Nuclear Corporation
UNH	- Uranyl nitrate hexahydrate
UNI	- UNC Nuclear Industries
UO_3	- Uranium trioxide
UST	- U.S. Testing
VOC	- Volatile organic compound
WHC	- Westinghouse Hanford Company
WIPP	- Waste Isolation Pilot Plant
WPPSS	- Washington Public Power Supply System

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APPENDIX E

GROUNDWATER ANALYTICAL PARAMETERS

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TABLE E-1

LIST OF TYPICAL GWMP GROUNDWATER ANALYTICAL PARAMETERS

Tritium(1)	Uranium
Copper	Nitrate(1)
Fluoride	Gross Beta
Gamma Scan	Chromium

(1) Most common parameters

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TABLE E-2

LIST OF TYPICAL SWHW GROUNDWATER ANALYTICAL PARAMETERS

Primary Drinking Water Constituents	Groundwater Quality Parameters	Groundwater Contamination Indicators	Additional Metals	Additional Inorganic Ions	Site-Specific Parameters[a]
Arsenic	Chloride	pH	Nickel	Phosphate	Ammonium
Barium	Iron	Specific conductance	Vanadium		Carbon tetrachloride
Cadmium	Manganese	Total organic halogen (TOH)	Copper		Trichloroethylene
Chromium	Sodium	Total organic carbon (TOC)	Aluminum		Polychlorinated biphenyls (PCBs)
Fluoride	Sulfate		Antimony		Xylene
Lead			Potassium		Hydrazine
Mercury					
Nitrate					
Selenium					
Silver					
Endrin					
Lindane					
Methoxychlor					
Toxaphene					
2,4-D					
2,4,5-TP Silvex					
Radium					
Gross Alpha					
Gross Beta					
Coliform					

(a) Only selected samples taken near operating areas were analyzed for these parameters.

TABLE E-3

LIST OF TYPICAL RCRA GROUNDWATER ANALYTICAL PARAMETERS

Constituent	Constituent
beryllium	osmium
strontium	zinc
calcium	barium
cadmium	chromium
silver	sodium
nickel	copper
vanadium	antimony
aluminum	manganese
potassium	iron
arsenic	mercury
selenium	thallium
thiourea	1-acetyl-2-thiourea
1-(o-chlorophenyl) thiourea	diethylstilbesterol
ethylenethiourea	1-naphthyl-2-thiourea
N-nitroso-N-ethylurea	N-nitroso-N-methylurea
N-phenylthiourea	endrin
methoxychlor	toxaphene
alpha-BHC	beta-BHC
gamma-BHC	delta-BHC
DDD	DDE
DDT	heptachlor
heptachlor epoxide	kepone
dieldrin	aldrin
chlordane	endosulfan I
magnesium	endosulfan II
lead (graphite furnace)	Arochlor 1016
Arochlor 1221	Arochlor 1232
Arochlor 1242	Arochlor 1248
Arochlor 1254	Arochlor 1260
tetrachloromethane	benzene
dioxane	methyl ethyl ketone
pyridine	toluene
1, 1, 1 - trichloroethane	1, 1,2 - trichloroethane
trichloroethylene	perchloroethylene
xylene-o, p	acrolein
acrylonitrile	bis(chloromethyl) ether

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TABLE E-3 (continued)

Constituent	Constituent
bromoacetone	methyl bromide
carbon disulfide	chlorobenzene
2-chloroethyl vinyl ether	chloroform
methyl chloride	chloromethyl methyl ether
crotonaldehyde	1,2-dibromo-3-chloropropane
1,2-dibromoethane	dibromomethane
1,4-dichloro-2-butene	dichlorodifluoromethane
1,1-dichloroethane	1,2-dichloroethane
trans-1,2-dichloroethene	1,1-dichloroethylene
methylene chloride	1,3-dichloropropene
1,2-dichloropropane	1,1-dimethyldrazine
N,N-diethylhydrazine	hydrogen sulfide
1,2-dimethylhydrazine	
iodomethane	methacrylonitrile
methanethiol	pentachloroethane
1,1,1-2-tetrachlorethane	1,1,2-2-tetrachlorethane
bromoform	trichloromethanethiol
trichloromonofluoromethane	trichloropropane
1,2,3-trichloropropane	vinyl chloride
xylene-m	diethylarsine
acetonitrile	acetophenone
warfarin	2-acetylaminofluorene
4-aminobyphenyl	5-(aminomethyl)-3-isoxazolol
amitrole	aniline
aramite	auramine
benz(c)acridine	benz(a)anthracene
benzene, dichloromethyl	benzenethoil
benzidine	benzo(b)fluoranthene
benzo(c)fluoranthene	p benzoquinone
benzyl chloride	bis(2-chloroethoxy) methane
bis(2-chloroethyl) ether	bis(2-ethylhexyl) phthalate
4-bromophenyl phenyl ether	butyl benzyl phthalate
2-sec-butyl-4,6-dinitrophenol	chloroalkyl ethers
p-chloroaniline	p-chloro-m-cresol
1-chloro-2,3-epoxypropane	2-chloronaphthalene
2-chlorophenol	chrysene
cresols	2-cyclohexyl-4,6-dinitrophenol
dibenz(a,h)acridine	dibenz(a,j)acridine
dibenz(a,h)anthracene	7H-dibenzo(c,g)carbazole
dibenzo(a,e)pyrene	dibenzo(a,h)pyrene

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TABLE E-3 (continued)

Constituent	Constituent
dibenzo(a,i)pyrene	di-n-butyl phthalate
1,2-dichlorobenzene	1,3-dichlorobenzene
1,4-dichlorobenzene	3,3'-dichlorobenzidine
2,4-dichlorophenol	2,6-dichlorophenol
diethyl phthalate	dihydrosafrole
3,3'-dimethoxybenzidine	p-dimethylaminoazobenzene
7,12-dimethylbenz(a)anthracene	3,3'-dimethylbenzidine
thiofanox	alpha,alpha-dimethylphenethylamine
2-4-dimethylphenol	dimethyl phthalate
dinitrobenzene	4,6-dinitro-o-cresol and salts
2,4-dinitrophenol	2,4-dinitrotoluene
2,6-dinitrotoluene	di-n-octyl phthalate
diphenylamine	1,2-diphenylhydrazine
di-n-propylnitrosamine	ethyleneimine
ethyl methanesulfonate	fluoranthene
hexachlorobenzene	hexachlorobutadiene
hexachlorocyclopentadiene	hexachloroethane
indeno (1,2,3-cd) pyrene	isosafrole
malononitrile	melphalan
methapyrilene	metholonyl
2-methylaziridine	3-methylcholanthrene
4,4'-methylenebis (2-chloroaniline)	2-methyllactonitrile
methyl methacrylate	methyl methanesulfonate
2-methyl-2- (methylthio) propionaldehyde-o(methylcarbonyl)oxime	methylthiouracil
1,4-naphthoquinone	1-naphthylamine
2-naphthylamine	p-nitroaniline
nitrobenzine	4-nitrophenol
N-nitrosodi-n-butylamine	N-nitrosodiethanolamine
N-nitrosodiethylamine	N-nitrosodimethylamine
N-nitrosomethylethylamine	N-nitroso-N-methylurethane
N-nitrosomethylvinylamine	N-nitrosomorpholine
N-nitrosonornicotine	N-nitrosopiperidine
nitrosopyrrolidine	5-nitro-o-toluidine
pentachlorobenzene	pentachloronitrobenzene
pentachlorophenol	phenacetin
phenylenediamine	phthalic acid esters
2-picoline	pronamide
reserpine	resorcinol

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TABLE E-3 (continued)

Constituent	Constituent
safrol	1,2,4,5-tetrachlorobenzene
2,3,4,6-tetrachlorophenol	thiuram
toluenediamine	o-toluidine hydrochloride
1,2,4-trichlorobenzene	2,4,5-trichlorophenol
2,4,6-trichlorophenol	0,0,0-triethyl phosphorothioate
sym-trinitrobenzene	tris(2,3-dibromopropyl) phosphate
benzo(a)pyrene	chlornaphazine
bis(2-chloroisopropyl) ether	hexachloropropene
hydrazine	hexachlorophene
naphthalene	1,2,3-trichlorobenzene
phenol	1,3,5-trichlorobenzene
1,2,3,4-tetrachlorobenzene	1,2,3,5-tetrachlorobenzene
tetraethylpyrophosphate	chlorobenzilate
carbophenothion	disulfoton
dimethoate	methyl parathion
parathion	total organic halogen
total organic carbon	cyanide
formalin	nitrate
sulfate	fluoride
chloride	phosphate
perchlorate	sulfide
kerosene	ammonium ion
ethylene glycol	coliform bacteria
radium	gross alpha
gross beta	dioxin
citrus red #2	cyanogen bromide
cyanogen chloride	paraldehyde
strychnine	maleic hydrizide
nicotinic acid	acrylamide
allyl alcohol	chloral
chloroacetaldehyde	3-chloropropionitrile
cyanogen	dichloropropanol
ethyl carbamate	ethyl cyanide
ethylene oxide	ethyl methacrylate
fluoroacetic acid	glycidylaldehyde
isobutyl alcohol	methyl hydrazine
n-propylamine	2-propyn-1-ol
2,4-D	2,4,5-TP silvex
2,4,5-T	bicarbonate
total dissolved solids	

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TABLE E-4

LIST OF TYPICAL SAMP GROUNDWATER ANALYTICAL PARAMETERS

Gross Alpha	Cobalt-60
Gross Beta	Tritium
Strontium-90	Nitrate
Cesium-137	Uranium
Ruthenium-106	

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TABLE E-5

LIST OF TYPICAL NSM GROUNDWATER ANALYTICAL PARAMETERS

Tritium	Iodine-131
Polonium-32	Xenon-133
Chromium-51	Cesium-137
Cobalt-60	Plutonium-238
Strontium-89	Plutonium-239/240
Strontium-90	pH
Mo-Tc-99m	Temperature
Ruthenium-103	Oil and Grease
Ruthenium-106	Iron
Tin-124	Ammonia
Tin-125	Chromium

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TABLE E-6

LIST OF TYPICAL SSM GROUNDWATER ANALYTICAL PARAMETERS

Tritium	Nitrate	Uranium

TABLE E-7

LIST OF TYPICAL DW GROUNDWATER ANALYTICAL PARAMETERS

Arsenic	Sodium
Barium	Color Units
Cadmium	Chloride
Chromium	Copper
Fluoride	Iron
Lead	Manganese
Mercury	Total Dissolved Solids
Nitrate	Sulfate
Selenium	Zinc
Silver	Gross Alpha
Gross Beta	Tritium
Iodine-131	Strontium-90

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APPENDIX F

RADIOLOGICAL MONITORING PROGRAM

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APPENDIX F
RADIOLOGICAL MONITORING

Radioactive materials were released into the environment as air emissions and water effluents from Hanford operations during 1985. The radiological impacts of these releases plus the impact of direct radiation from the facilities were evaluated to determine compliance with DOE Order 5480.1, the Vaughan memorandum (Vaughan, 1986) and EPA regulations in 40 CFR 61 and 40 CFR 141.

Basically, DOE limits the maximally exposed individual to 100 mrem/yr for prolonged exposure (or to 500 mrem/yr for occasional exposure, if the exposure is from DOE operations or DOE-caused conditions that are temporary in nature and will not continue for more than 5 years). The EPA (in 40 CFR 61) limits airborne emissions of radionuclides to amounts that cause a dose equivalent rate of 25 mrem/yr to the whole body and 75 mrem/yr to a critical organ of any member of the public. The EPA (in 40 CFR 141) limits radionuclides in community water systems to levels that shall not result in an annual dose equivalent to the whole body or any internal organ greater than 4 mrem/yr.

To comply with the pertinent regulations and standards, PNL determines the maximum dose rate at a publicly accessible location onsite or at the perimeter (often called the fence-post dose rate) using TLDs (see Figure F1 and F2 for locations). The concentrations of radionuclides in the off-site environment are too low in many cases to measure reliably. Therefore, as is the standard, PNL uses air emission data and liquid effluent data together with approved mathematical models to calculate doses off-site. They calculate the dose to a hypothetical maximally exposed individual at an off-site location, expressed as the cumulative 50-year dose equivalent (more commonly called dose) in units of rem. The average dose in various sectors around Hanford is calculated and multiplied by the popultation in the sector to obtain a total dose in units of man-rem. The doses for the various sectors are added to give the population dose within a 50 mile (80 km) radius of Hanford. The doses for the maximally exposed individual for 1980 to 1985 are shown in Table F-1 and for the population dose for the same period in Table F-2.

The data indicates the doses were well below all applicable regulatory limits. The calculated whole body dose to a hypothetically maximally exposed individual increased from 1 to 3 mrem from 1983 to 1985, with corresponding increases in the bone dose. This is due to the strontium-90 releases to the Columbia River from the 1301N LWDF (at N-Reactor), which has since been taken out of service.

For the population dose, increases in the bone dose resulted from increases in strontium-90 releases. The irrigation pathway for strontium-90 was the primary source of radiation dose to bone. The increased thyroid dose resulted primarily from the consumption of foods containing the long lived iodine-129. This resulted primarily from airborne emissions from the 200 Area.

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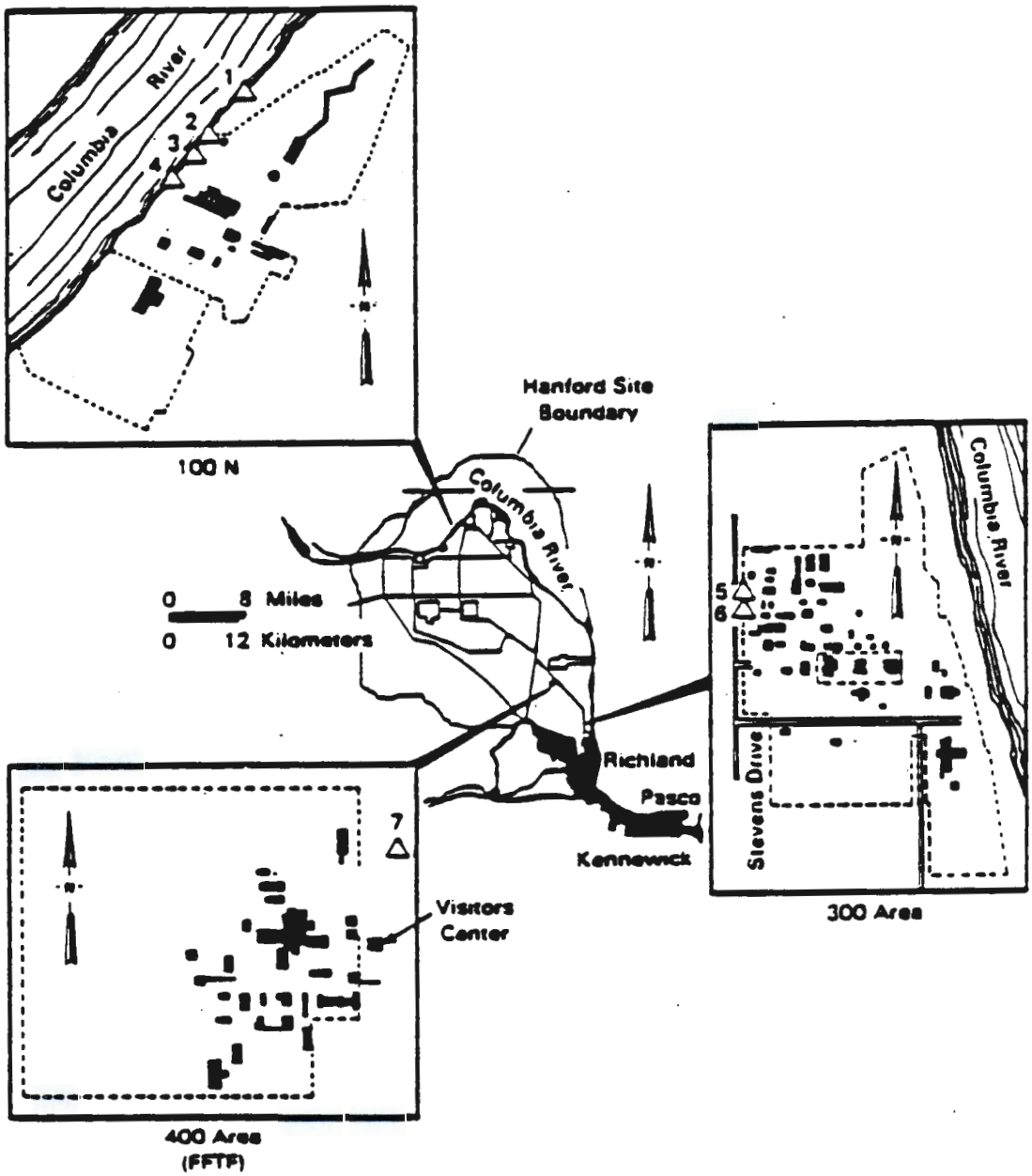
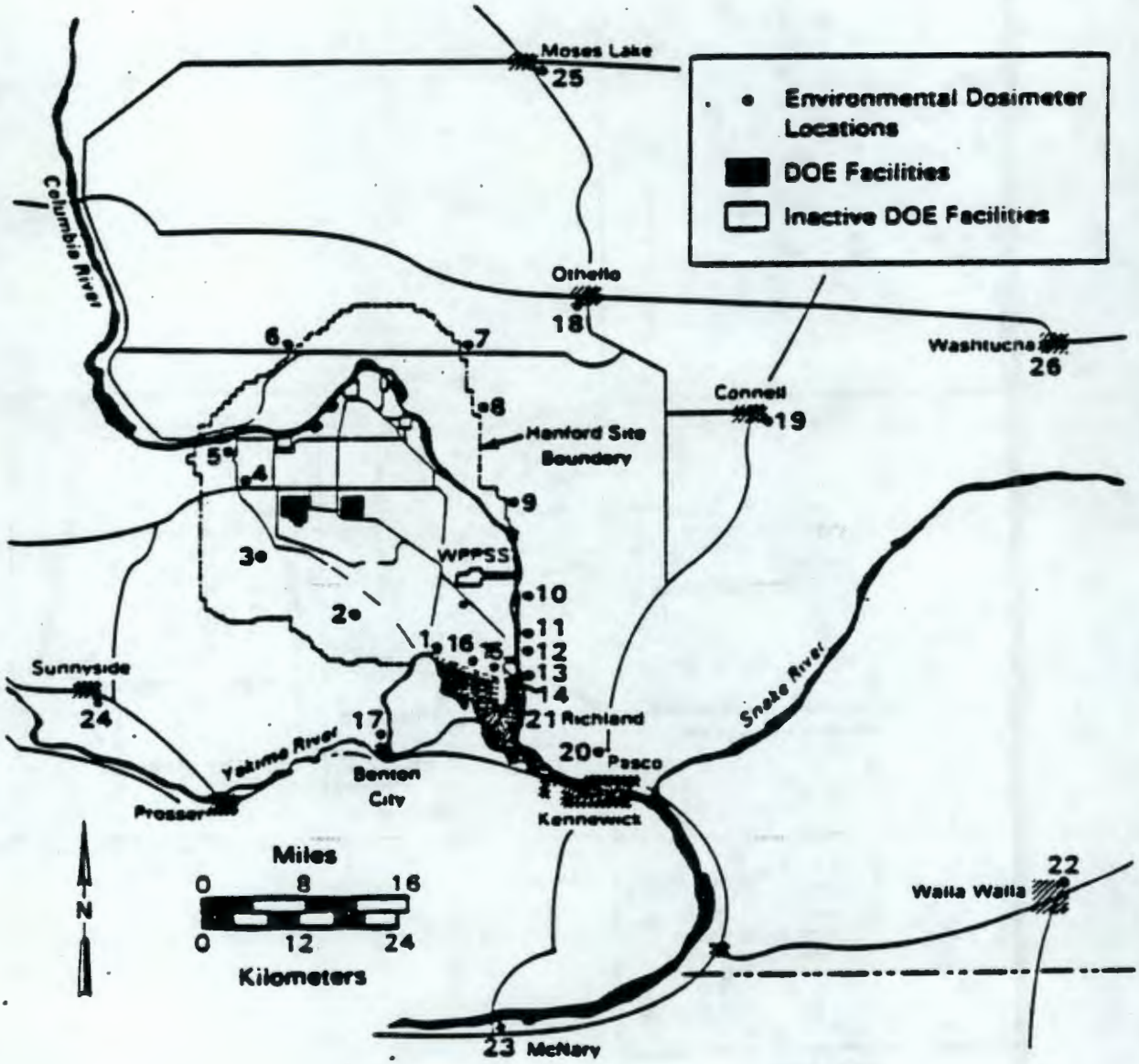


Source: Price 88, Figure 54.

HANFORD TLD LOCATIONS AT PUBLICLY ACCESSIBLE ON-SITE LOCATIONS

FIGURE F - 1



Source: Price 86, Figure 51.

TLD LOCATIONS AT THE SITE PERIMETER, NEARBY COMMUNITIES AND DISTANT COMMUNITES

FIGURE F - 2

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TABLE F-1

CALCULATED DOSES TO THE HYPOTHETICAL MAXIMALLY EXPOSED INDIVIDUAL FROM HANFORD OPERATIONS, 1980 TO 1985

Organ	50-Year Cumulative Doses (mrem)(a)					
	1980	1981	1982	1983	1984	1985
Whole Body	0.6	0.5	0.7	1	2	3
GI(b)	0.1	0.06	0.07	0.2	0.3	0.3
Bone	2	2	2	4	8	10
Lung	<0.01	0.01	0.02	0.01	0.02	0.04
Thyroid	0.2	0.2	0.2	0.2	0.8	2

(a) Total dose to each organ from exposure to all available pathways.
(b) Gastrointestinal tract (lower large intestine).

TABLE F-2

CALCULATED DOSES TO THE 80-km POPULATION FROM HANFORD OPERATIONS, 1980 TO 1985

Organ	50-Year Cumulative Doses (man-rem)(a)					
	1980	1981	1982	1983	1984	1985
Whole Body	2	3	4	4	5	7
GI(b)	1	3	3	3	3	4
Bone	5	5	7	7	13	19
Lung	1	3	4	3	4	8
Thyroid	4	5	7	17	43	200

(a) Total dose to each organ from exposure to all available pathways.
(b) Gastrointestinal tract (lower large intestine).

Source: Data from Price et al, 1986

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APPENDIX G

BIBLIOGRAPHY

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9 2 1 2 4 6 1 1 8 5 4

Adams, J. A., et al., 1984. Hanford 100 Area Long Range Decommissioning Plan, UNI 2533 United Nuclear Corporation, September.

Atlantic Richfield Hanford, Characterization of the Contents of Organic Waste Storage Tanks, ARH-CD-685, Richland, Washington.

Anderson, J. D., 1973. Chemical Processing Division Waste Status Summary, October 1, 1972, Through December 31, 1972, ARH-2456 D, Atlantic Richfield Hanford, Richland, Washington, January.

Backman, G. E., 1965. Summary of Environmental Contamination Incidents at Hanford, 1958 - 1964, HW-84619, Hanford Atomic Products Operation, General Electric Company, Richland, Washington, April 12.

Battelle Northwest Laboratory. Collection and Analysis of Pump Test Data for Transmissivity Values, BNWL-1709, Richland, Washington.

Battelle Northwest Laboratory. Failure of 307 Basin Transfer Line and Resultant Ground Contamination, BNWL-CC-2617, Richland, Washington.

Brown, D. J., Status of the Ground Water Beneath Hanford Reactor Areas, January 1962, to January 1963, HW 77170, Chemical Effluents Technology Chemical Laboratory, Richland, Washington.

Brown, D. J., 1979. Status of Liquid Wastes Leaked from the 241-T-106 Tank, RHO-ST-1, Rockwell Hanford Operations, Richland, Washington, February.

Christensen, G. M., et al., 1982. Active and Retired Solid Waste Burial Grounds Safety Analysis Report, RHO-CD-1554, Rockwell Hanford Operations, Richland, Washington, August.

Chistie, M. A., et al., 1984. Long-Range Plan for Interim Stabilization: Site Prioritization Elements, SD-WM-PAP-038, Rockwell Hanford Operations, Richland, Washington, July.

Conklin, A. W., et al., 1985. Rockwell Hanford Operations Environmental Surveillance Annual Report CY 1984, RHO-HS-SR-84-13P, Rockwell Hanford Operations, Richland, Washington, August.

DOE (U.S. Department of Energy), 1980. Application for Prevention of Significant Deterioration (PSD) Permit for Hanford PUREX and Uranium Oxide Plant, Washington, D.C., February 25.

DOE (U.S. Department of Energy), 1983. Order RL5700.1A: Quality Assurance, Washington, D.C., July 14.

DOE (U.S. Department of Energy), 1985. Letter from Gerton: Request for 1984 Emissions Inventory Information, Washington, D.C., May 20.

DOE (U.S. Department of Energy), 1986. Hanford Site RCRA Waste Stream Compliance, Richland Operations Office, Richland, Washington, January.

DOE (U.S. Department of Energy), 1985. Hazardous Waste Ground-Water Monitoring Plan, Richland Operations Office, Richland, Washington, July.

DOE (U.S. Department of Energy), 1985. Implementation Plan for Hanford Site Compliance to DOE Order 5820.2, Radioactive Waste Management, Washington, D.C., August.

DOE (U.S. Department of Energy), 1985. Letter: Interim Guidance for Compliance with RCRA, V. J. DeCarlo, Washington, D.C., July 23.

DOE (U.S. Department of Energy), 1985. Hanford Site, Hazardous Waste Ground-Water Monitoring Plan, Richland Operations Office, Richland, Washington, July.

DOE (U.S. Department of Energy), 1985. Interim Hanford Waste Management Plan, Washington, D.C., September.

DOE (U.S. Department of Energy), 1985. Interim Hanford Waste Management Technology Plan, Washington, D.C., September.

DOE (U.S. Department of Energy), 1985. Letter: NPDES Permit #WA-000374-3 Reapplication, Fitzsimmons, Washington, D.C., June 28.

DOE (U.S. Department of Energy), 1985. Letter: 5480.2 Implementation Plan: Hazardous and Radioactive Mixed Waste Management, R. Scott, Washington, D.C., August 6.

DOE (U.S. Department of Energy), 1985. Surplus Facilities Management Program: Plan, UNI-3560, Washington, D.C., October.

DOE (U.S. Department of Energy), 1986. Draft Environmental Impact Statement on Process Facility Modifications (PFM) Project, Hanford Site, Richland, Washington, DOE/EIS-0115D, Washington, D.C., April.

DOE (U.S. Department of Energy), 1986. Environmental Impact Statement: Disposal of Hanford Defense High-Level Transuranic and Tank Waste, Volumes I, II, and III, Washington, D.C., March.

DOE (U.S. Department of Energy), 1986. Environmental Impact Statement: Process Facility Modification Project, Washington, D.C., April.

DOE (U.S. Department of Energy), 1986. Environmental Compliance Task Force, Hanford Environmental Management Program, (Draft), Washington, D.C., July.

9 2 1 2 4 6 1 1 8 5 6

DOE (U.S. Department of Energy), 1986. Letter: Asbestos Notification and Reporting Requirements of 40 CFR 61, Gorton, Washington, D.C., April 1.

DOE (U.S. Department of Energy), 1986. Overview—Richland Operations Office, Washington, D.C., February 26.

DOE (U.S. Department of Energy), 1986. Revised Ground-Water Monitoring Compliance Plan for the 183-H Solar Evaporation Basins, Richland Operations Office, Richland, Washington, September.

DOE (U.S. Department of Energy), Ground-Water Surveillance at the Hanford Site for CY 1983.

DOE (U.S. Department of Energy), Hanford Defense Waste Management Program, Washington, D.C.

DOE (U.S. Department of Energy), Hanford Site: Graphic Overview System of DOE's Effluent and Environmental Monitoring Programs, Washington, D.C.

DOE (U.S. Department of Energy), Radiological Status of the Ground Water Beneath the Hanford Project, January - December 1979.

DOE (U.S. Department of Energy), Radiological Status of the Ground-water Beneath the Hanford Site. January - December 1980.

Dorian, J. J., and V. R. Richards, 1978. Radiological Characterization of the Retired 100 Areas, UNI-946, United Nuclear Corporation, May 26.

Eddy, P. A., 1985. Program Plan: Ground-Water Monitoring Program, Fiscal Year 1986, Pacific Northwest Laboratory, Richland, Washington, October 1.

Eddy, P. A., and J. S. Wilbur, 1980. Radiological Status of the Ground Water Beneath the Hanford Project, January - December 1979, PNL-3346, Pacific Northwest Laboratory, Richland, Washington, April.

Ellington, D. R., and J. K. Soldat, 1983. Aging Waste Facility Safety Analysis Report, SD-HS-SAR-010, Rockwell Hanford Operations, Richland, Washington, June.

EPA (U.S. Environmental Protection Agency), 1981. Letter: NPDES Permit #WA-000374-3, Burd, Washington, D.C., December 7.

EPA (U.S. Environmental Protection Agency), Approval of Application to Construct, PSD-X80-14, Washington, D.C.

Friedrichs, D. R., 1980. CJRMIS Data System: Volume 4, Driller's Logs, PNL-3161-4UC-70, Pacific Northwest Laboratory, Richland, Washington, January.

Hall, M. D. Hydrology of the Separation Area, RHO-ST-42, Rockwell Hanford Operations, Richland, Washington, July.

Hanford Engineering Development Laboratory, 1981. Waste Management Manual, MG-75, Westinghouse Hanford Company, Richland, Washington, October.

9 2 1 2 4 1 1 8 5 7

Hanford Engineering Development Laboratory, 1985. HEDL Industrial Safety Manual; WHAN-MIL, Westinghouse Hanford Company, Richland, Washington, April.

Hanford Engineering Development Laboratory, Facilities Catalog, 300 Area MG-17, Westinghouse Hanford Company, Richland, Washington.

Hanford Engineering Development Laboratory, Facilities Catalog, 400 Area, MG-189, Westinghouse Hanford Company, Richland, Washington.

Hanford Engineering Development Laboratory, Hanford Environmental Protection Manual, MG-99, Westinghouse Hanford Company, Hanford, Washington.

Hanford Engineering Development Laboratory, Hazardous Materials Packaging and Shipping Manual, MG-137, Westinghouse Hanford Company, Richland, Washington.

Hanford Environmental Health Foundation, 1982. Evaluation of 300 Area Sanitary Sewage System, Richland, Washington, January.

Maas, L. J., 1985. Hanford Sanitary Water Quality Surveillance, CY 1984, Hanford Environmental Health Foundation, Richland, Washington, April.

Hanford Environmental Health Foundation, 1985. RL-Nonradiological Hazardous Materials Emergency Plan, Richland, Washington, October.

Hanford Environmental Health Foundation, 1985. UNC-300 Area Copper Emissions, 313 Building Copper Foundry Exhaust, November 13, 1985, Richland, Washington, December 2.

Hanford Environmental Health Foundation, 1986. Ambient Nitrogen Dioxide Monitoring, CY 1985, Richland, Washington, February 18.

Hanford Environmental Health Foundation, 1986. Hanford Sanitary Water Quality Surveillance, CY 1985, Richland, Washington, April.

Hanford Reach Project, 1986. Search Technical Services Spring 1986 Date Report, Richland, Washington, April 27.

Harmon, K. M., et al., 1975. Resources Book--Decommissioning of Contaminated Facilities at Hanford, Volumes 1-4, PNL-MA-588, Pacific Northwest Laboratory, Richland, Washington, August.

Isaacson, R. E., 1982. Supporting Information for the Scientific Basis for Establishing Dry Well Monitoring Frequencies, RHO-RE-EV-4-P, Rockwell Hanford Operations, Richland, Washington, September.

Isaacson, R. E., and D. J. Brown, Environmental Assessment Related to Hanford Radioactive Waste Burial, RHO-SA-36, Rockwell Hanford Operations, Richland, Washington.

Jungfleisch, F. M., Sampling and Analysis Plan for Liquid Discharges to Ground in the 200 Areas, SD-WM-TI-241, Rockwell Hanford Operations, Richland, Washington.

9 2 1 2 4 5 1 1 8 5 8

Kasper, R. B., 1982. 216-2-12 Transuranic Crib Characterization: Operational History and Distribution of Plutonium and Americium, RHO-ST-44, Rockwell Hanford Operations, Richland, Washington, November.

Killand, W. D., 1979. Radiation Monitoring Manual of Standard Practices, Richland, Washington, April.

Killand, W. D., 1979. Radiation Work Procedures, Rockwell Hanford Operations, Richland, Washington, February.

Law, A. G., 1979. Ground-Water Hydrology and Radioactive Waste Disposal at the Hanford Site, RHO-SA-26, Rockwell Hanford Operations, Richland, Washington, February.

Law, A. G., and R. M. Allen, 1984. Results of the Separations Area Ground-Water Monitoring Network for 1983, RHO-RE-SR-84-24P, Rockwell Hanford Operations, Richland, Washington, July.

Marratt, M. C., 1984. The 216-2-8 French Drain Characterization Study, RHO-RE-EV-46P, Rockwell Hanford Operations, Richland, Washington, September.

Maxfield, H. L., 1979. Handbook: 200 Areas Waste Sites, Volumes 1, 2, and 3, RHO-LD-673, Rockwell Hanford Operations, Richland, Washington, April.

Newcomb, R. C., et al., 1972. Geology and Ground Water Characteristics of the Hanford Reservation of the U.S. Atomic Energy Commission, Professional Paper 717, U.S. Geological Survey, Reston, Virginia.

NUS Corporation, 1986. Environmental Assessment, Reference Repository Location, Hanford Site, Washington, Volumes I, II, and III, Gaithersburg, Maryland, May.

Oberg, G. C., 1978. Nuclear Criticality Safety Standards, RHO-MA-136, Rockwell Hanford Operations, Richland, Washington, July.

Pacific Northwest Laboratory, 1980. Test Well Analyses (Service Activity), PSD-38 Richland, Washington, May 28.

Pacific Northwest Laboratory, 1983. Environmental Samping Locations Manual, PNL-MA-514, Richland, Washington, December.

Pacific Northwest Laboratory, 1984. Environmental Surveillance Program (Subsurface) (Service Activity), O&EP-1, Richland, Washington, March 19.

Pacific Northwest Laboratory, 1984. Letter from G. A. Sandness, Ph.D., Pacific Northwest Laboratory, to C. C. Meinhardt, Rockwell Hanford Operations, October 16.

Pacific Northwest Laboratory, 1985. Construct and Develop a Special Environmental Test Well for Sampling Organics (Project QA Plan), O&EP-40, Richland, Washington, February 28.

Pacific Northwest Laboratory, 1985. Environmental Monitoring Procedures, PNL-MA-580, Richland, Washington, February.

Pacific Northwest Laboratory, 1985. Hanford Wells, PNL-5397, Richland, Washington, February.

Pacific Northwest Laboratory, 1986. Environmental Monitoring Procedures Manual, Richland, Washington, July.

Pacific Northwest Laboratory, 1986. Hazardous Materials Monitoring Project/RCRA Compliance Ground-Water Monitoring Project (QA Plan), ED-41, Richland, Washington, April 8.

Pacific Northwest Laboratory, 1986. Hazardous Materials Sampling, Richland, Washington, July.

Pacific Northwest Laboratory, 1986. Outline for a Revised Ground-Water Monitoring Plan—183H Basins, Richland, Washington, April.

Pacific Northwest Laboratory, Draft Phase Installation Assessment of Inactive Waste-Disposal Sites at Hanford, July 1986: Volume I, Methods and Analyses; Volume II, HISS Database, Richland, Washington.

Pacific Northwest Laboratory, Environmental Surveillance at Hanford, CY 1977, PNL-2614, Richland, Washington.

Pacific Northwest Laboratory, Environmental Surveillance at Hanford, CY 1978, PNL 2932, Richland, Washington.

Pacific Northwest Laboratory, Environmental Surveillance at Hanford, CY 1980, PNL-3728, Richland, Washington.

Pacific Northwest Laboratory, Environmental Surveillance at Hanford, CY 1981, PNL-4211, Richland, Washington.

Pacific Northwest Laboratory, Environmental Surveillance at Hanford, CY 1983, PNL-5038, Richland, Washington.

Pacific Northwest Laboratory, Fiscal Year 1987 Sampling Plan—Hazardous Materials Monitoring Project, Richland, Washington.

Pacific Northwest Laboratory, Ground-Water Monitoring at the Hanford Site, January - December 1984, PNL-5408, Richland, Washington.

Pacific Northwest Laboratory, Hanford Inactive Waste Site Surveillance (CERCLA): Executive Summary, Richland, Washington.

Pacific Northwest Laboratory, Hazardous Materials Monitoring Project: Executive Summary and Work Element, Richland, Washington.

Pacific Northwest Laboratory, Meteorological and Climatological Services: Executive Summary, Richland, Washington.

Pacific Northwest Laboratory, Offsite Radiation Doses Summarized from Hanford Environmental Monitoring Reports for the Years 1957 - 1974, Richland, Washington.

Pacific Northwest Laboratory, Outline for a Revised Ground-Water Monitoring Plan for the 300 Area, Richland, Washington.

9 2 1 2 4 6 1 1 8 6 0

Rockwell Hanford Operations, 1983. Radiological Standards and Operations Controls, Revision 1, RHO-MA-220, Richland, Washington, February.

Rockwell Hanford Operations, 1983. Special Safety Rules: 222-S Analytical, Richland, Washington, June 2.

Rockwell Hanford Operations, 1983. Warehousing of Non-Radioactive Hazardous Materials in 1100 Area, RHO-MA-135, Richland, Washington, August.

Rockwell Hanford Operations, 1984. An Assessment of Aquifer Intercommunication in the B Pond-Bable Mountain Pond Area of the Hanford Site, RHO-RE-ST-12, Richland, Washington, March.

Rockwell Hanford Operations, 1984. Draft 5480.2 Hazardous Chemical Management Plan, Richland, Washington, May.

Rockwell Hanford Operations, 1984. Environmental Surveillance and Control Manual, RHO-HS-MA-2, Richland, Washington, October.

Rockwell Hanford Operations, 1984. Track Maintenance - Herbicide Applications, Mixing, Spraying and Clean-up, RHO-MA-153, Richland, Washington, November 15.

Rockwell Hanford Operations, 1985. Environmental Protection Manual, RHO-MA-139, Richland, Washington, January.

Rockwell Hanford Operations, 1985. Hazardous Materials Inventory, Richland, Washington, October 21.

Rockwell Hanford Operations, 1985. 1984 Airborne Effluent Sampling Equipment Release Data and Offsite Doses, RHO-200 Area, Richland, Washington, August.

Rockwell Hanford Operations, 1985. Nonradiological Asbestos Disposal Report for CY-85, Richland, Washington.

Rockwell Hanford Operations, 1985. Perchloric Acid Handling in the PUREX Laboratory, Richland, Washington, July 30.

Rockwell Hanford Operations, 1985. Radioactive Liquid Wastes Discharged to Ground in the 200 Area during 1984, RHO-HS-SR-84-3, Richland, Washington, March 6.

Rockwell Hanford Operations, 1985. Rockwell Hanford Operations Exposure Summary for 1984, RHO-HS-SR-84-14, Richland, Washington, March.

Rockwell Hanford Operations, 1985. Quality Assurance Program Plan; Analytical Laboratories, RHO-QA-PL-19, Richland, Washington, August 12.

Rockwell Hanford Operations, 1985. Water-Level Measurements Data Maps, Richland, Washington, December.

Rockwell Hanford Operations, 1986. Asbestos Inventory, Richland, Washington, July 10.

Rockwell Hanford Operations, 1986. Compliance Ground Water Monitoring Plan for the Non-Radioactive Dangerous Waste Landfill on the Hanford Site, Richland, Washington, March.

Rockwell Hanford Operations, 1986. Current Status of Ground Water Beneath the Separation Area, Richland, Washington, June.

Rockwell Hanford Operations, 1986. Dangerous Waste Implementation Plan, Richland, Washington, June.

Rockwell Hanford Operations, 1986. Facility ALARA Plan, RHO-LD-179, Radiological Engineering Group, Richland, Washington, September.

Rockwell Hanford Operations, 1986. Facility Asbestos Survey, RHO-1984, Richland, Washington, July 10.

Rockwell Hanford Operations, 1986. Historical Timeliness of Hanford Operations, Richland, Washington, August.

Rockwell Hanford Operations, 1986. Outline of Proposed Ground Water Monitoring Plan: Low-Level Burial Grounds and Retrievable Storage Units, Richland, Washington, June.

Rockwell Hanford Operations, 1986. PCB Storage Inventory, Richland, Washington, July 10.

Rockwell Hanford Operations, 1986. PCB Waste Implementation Plan, Richland, Washington, May.

Rockwell Hanford Operations, 1986. Pesticide Inventory, 1986, Richland, Washington.

Rockwell Hanford Operations, 1986. Results of Separation Area Ground Water Monitoring Network for 1984, RHO-RE-SE-85-24P, Richland, Washington, January.

Rockwell Hanford Operations, 1986. Summary of Radioactive Solid Waste; Burial in the 200 Area During CY 1985, Richland, Washington, February 11.

Rockwell Hanford Operations, 1986. Waste Management; Sampling and Analysis Plan for Liquid Discharges to Ground in the 200 Area, SD-WM-T1-241, Richland, Washington, June 16.

Rockwell Hanford Operations, Emergency Plan: Health, Safety & Environment, RHO-MA-111.20, Richland, Washington.

Rockwell Hanford Operations, Historical Environmental Problems in the Separations Area, Richland, Washington.

Rockwell Hanford Operations, Inspection of Retrievably Stored Transuranic Waste Containers, SD-WM-TRP-002.

Rockwell Hanford Operations, Liquid Waste Discharged to Ground in the 200 Area During 1984 - Nonradiological Parameters, RHO-HS-SR-84-10 4WP, Richland, Washington.

9 2 1 2 4 6 1 1 8 6 2

Rockwell Hanford Operations, Radiation Monitoring: Manual of Standard Practices, RHO-MA-145, Richland, Washington.

Rockwell International, 1980. Internal Letter: Dev., Van I Results for 618-8 Burial Grounds, 72720-80-424, V.W. Hall et al., October 31.

Rockwell International, 1980. Internal Letter: Investigation of Contamination Near the 618-8 Burial Ground, G.V. Last, October 20.

Rockwell International, 1980. Internal Letter: Investigation of Contamination Near the 618-8 Burial Ground, 72720-80-453, November 7.

Rockwell International, 1981. Internal Letter: Engineering Report on Contamination Near 618-8 Burial Ground, 65461-81-133, K.W. Owens, December 3.

Rockwell International, 1984. Internal Letter: Estimated Costs for Characterization of the 618-9 Burial Ground, 65632-013, C.C. Meinhardt, November 1.

Rockwell International, 1986. Internal Letter: Identification of Boundaries at 600 Area Retired Burial Grounds, 12700-86-SAW-059, S.A. Wiegman, June 16.

Rockwell International, 1986. Internal Letter: Response to Audit Observation Number J-86-03, 38620-FT-86-034, F. Torres, March 27.

Rockwell International, 1984. Internal Letter: 600 Area Retired Burial Grounds, 72400-84-106, G.F. Boothe, December 10.

Routson, R.C., et al., 1980. Hanford Site Sorption Studies for the Control of Radioactive Wastes: A Review, Revision 1, RHO-SA-155, Rockwell Hanford Operations, Richland, Washington, December.

Routson, R.E., et al., 1981. Proposed Siting Criteria for the Arid Shallow-Land Burial of Solid Low-Level Radioactive Wastes, RHO-LD-81, Rockwell Hanford Operations, Richland, Washington, February.

Schatz, A.L., 1985. Unconfined Aquifer Water Table Map, Rockwell Hanford Operations, Richland, Washington, June.

Selby, J.M. and J.K. Soldat, 1958. Summary of Environmental Contamination Incidents at Hanford, 1932 - 1957, Hanford Atomic Products Operation, General Electric Company, Richland, Washington, January 25.

Smith, R.M., 1980. 216-B-5 Reverse Well Characterization Study, RHO-ST-37, Rockwell Hanford Operations, Richland, Washington, November.

Smith, R.M., 1981. Radionuclide Distributions Around a Retired Nuclear Waste Disposal Well, Rockwell Hanford Operations, Richland, Washington, December.

Strickland, G.C., 1981. ALARA Program, RHO-MA-278, Rockwell Hanford Operations, Richland, Washington, September.

Tanaka, H., et al., 1979. Hydrologic Bibliography of the Columbia River Basalts in Washington with Selected Annotations, RHO-BWI-C-45, Rockwell Hanford Operations, Richland, Washington, August.

9 2 1 2 4 1 1 8 6 3

United Nuclear Corporation, 1979. Environmental Report on the Operation of N. Reactor and Fuels Fabrication Facilities, UNI-UNI-1313, May 9.

United Nuclear Corporation, 1979. Onsite Environmental Surveillance Program for the 100-N Area, UNI-UNI-1347, October 1.

United Nuclear Corporation, 1979. Total Dissolved Gas Saturation in the Columbia River Near 100N Reactor Outfall, 3/79 to 9/79, UNI-PNL, December.

United Nuclear Corporation, 1980. Radiological Surveillance Report for the 100N Area Environmental—1980, UNC-UNI-1581, October 3.

United Nuclear Corporation, 1983. UNC-PNL, N. Reaction Thermal Plume Characterization Study During Dual-Purpose Mode of Operations, September.

United Nuclear Corporation, 1984. UNC Program for Reduction of Effluent Releases, UNC-UNI-2897, June 27.

United Nucelar Corporation, 1985. Letter: Application for NPDES Permit, Renberger, June 25.

United Nuclear Corporation, 1985. Memorandum: Accidental Spills in the 100 Area, Diediker, October 28.

United Nuclear Corporation, 1985. Oil Spill Prevention, Control and Countermeasures Plan, Revision 4, UNC-UNI-228, November 4.

United Nuclear Industries, Inc., 1985. 300 Area Release Controls: Environmental and Occupational Safety Section, UNI-M-31, September.

United Nuclear Corporation, 1986. Environmental Upgrade Program—FY 86, UNC-UNI-M-123.

United Nuclear Corporation, 1986. Letter: Asbestos-Notification and Reporting Requirements of 40 CFR 61, Renberger, January 31.

United Nuclear Corporation, 1986. Letter: CY 1985 PCB Report, Renberger, May 8.

United Nuclear Corporation, 1986. Letter: Waste Volume Projections for UNC-1986, Payne, January 27.

United Nuclear Corporation, 1986. Memorandum: Designated Numbers for Controlled Waste Sites, Hall, June 18.

United Nuclear Corporation, 1986. Memorandum: 117N Filter Efficiencies, Reisenauer, July 9.

United Nuclear Corporation, Air Quality: Nonradioactive Airborne Emissions from 100-N Area.

United Nuclear Corporation, Air Quality: UNC Radioactive Airborne Discharge Points.

United Nuclear Corporation, Process Standards—N Reactor: NPDES Effluent Discharge Limits & Monitoring Requirements.

9 2 1 2 4 6 1 1 8 6 4

Van Luik, A.C. and R.M. Smith, 1982. 216-5-1 and 5-2 Mixed Fission Product Crib Characterization Study, RHO-ST-39, Rockwell Hanford Operations, Richland Washington, March.

Vogt, E.C., 1983. PUREX MK II Cannister Decapping/Charging Machine Hazards Analysis, SD-HS-SAR-016, Rockwell Hanford Operations, Richland, Washington, April.

Washington Department of Ecology, 1983. Letter from Stanley: Order #DE-83-163, March 11.

Washington Department of Ecology, 1984. Letter from Miller: Order #DE84-720, December 26.

Washington Department of Ecology, 1984. Memorandum from Stanley: Hazardous Waste Compliance Status, Hanford Reservation, U.S. Department of Energy, Richland, Washington, July 19.

Washington Department of Ecology, 1985. Letter: RCRA Compliance Inspection Report, Stanley, October 18.

Washington Department of Ecology, 1985. Letter from Miller: Notice #DE85-130, January 29.

Washington Department of Ecology, 1985. Letter from Miller: Notice of Violation #DE85-677, October 1.

Washington Department of Ecology, 1986. Letter: Dangerous Waste Annual Report, Gerton, March 14.

Washington Department of Ecology, 1986. Letter: Order #DE 85-677, Miller, January 15.

Weakley, E.A., 1970. Analysis of North Pond Precipitate and North Pond Crud, United Nuclear Industries, March 17 and December 7.

Weakley, E.A., 1986. History and Status of Environmental Improvements for Fuels Production Division, UNI-652, United Nuclear Industries, October 22.

Westinghouse Hanford Corporation, 1986. Hazardous Materials Monitoring Projects/RCRA Compliance Ground Water Monitoring Project, ED-41, April 8.

9 2 1 2 4 1 1 8 6 5

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9 2 1 2 4 5 1 1 8 6 6

Cothern, C. Richard and William L. Lappenbusch, 1983. "Occurrence of Uranium in Drinking Water in the U.S." Official Journal of the Health Physics Society, Vol. 45, No. 1, p. 92.

Diediker, L.P., 1985. Memorandum on Accidental Spills in 100 Areas, UNC Nuclear Industries, Richland, Washington, October.

DOE (U.S. Department of Energy), 1986. Disposal of Hanford Defense High Level, Transuranic and Tank Wastes, Volumes 1, 2, and 3, DOE/EIS-0113, Washington, D.C., March.

Dorian, J.J., 1978. Radiological Characterization of the Retired 100 Areas, UNI-946, United Nuclear Industries, Inc., prepared for the U.S. Department of Energy, May.

EG&G, 1979. Graphic Overview System for the Hanford Site

Elder, R.E., et al., 1986. Rockwell Hanford Operations Environmental Surveillance Annual Report - CY 1985, RHO-HS-SR-85-13P, Rockwell Hanford Operations, Richland, Washington, May.

English, C.J., 1984. An Inventory of Chemical Wastes and Disposal Sites at the Hanford Site, prepared for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830, Pacific Northwest Laboratory, Richland, Washington, October.

ERDA (Energy Research and Development Administration), 1975. Final Environmental Impact Statement Waste Management Operations-Hanford Reservation, Volumes 1 and 2, ERDA-1538, Washington, D.C., December.

EPA (U.S. Environmental Protection Agency), 1985. Environmental Radiation Data, 520/5-86-007. Washington, D.C.

Fuchs, M. R., Chapman, Riggsbee, Dillon, Rouston, and Snow, 1985. Request for Waiver from WAC Requirement for Ground-Water Monitoring at the Non-Radioactive Dangerous Waste Landfill, Hanford Site, Washington State, Rockwell Hanford Operations, Richland, Washington, June.

Graham, M. J., 1986. Hanford Defense Waste Disposal Program: Volume I, EPA-Staff Site Visit, Pacific Northwest Laboratory, Richland, Washington, February.

Graham, M. J., et al., 1981. Separations Area Ground Water Monitoring Plan, RHO-CD-866, Rockwell Hanford Operations, Richland, Washington, July.

Greager, E.M., 1984. UNC Environmental Surveillance Report for the 100 Areas - FY 1984, UNI-3069, United Nuclear Corporation, Richland, Washington, December.

Harmon, K.M., ed., 1985. Resource Book - Decommissioning of Contaminated Facilities at Hanford, PNL-MA-588, Vol. 1, prepared for Pacific Northwest Laboratory, U.S. Department of Energy, August.

Jacques, I.D. 1986. UNC Environmental Surveillance Report for the 100 Area—FY 1985, UNI-3760, United Nuclear Corporation, Richland, WA. February.

Jang, J., K. Rabatin, and L. Cohen, 1986. NRC TLD Direct Radiation Monitoring Network, NUREG-0837, Vol. 6, No. 1., U.S. Nuclear Regulatory Commission, Washington,D.C.

Lindberg, J. W., and F. W. Bond, 1979. Geohydrology and Ground-Water Quality Beneath the 300 Area, Hanford Site, Washington, PNL-2949, Pacific Northwest Laboratory, Richland, Washington, June.

McConiga, M. W., 1955. Changes in the Hanford Ground-Water Table, 1944-1945, HW-40469, Radiological Sciences Department, Hanford Atomic Products Operation, General Electric Company, Richland, Washington.

McCormack, W. D., and J. M. V. Carlile, 1984. Investigation of Ground-Water Seepage from the Hanford Shoreline of the Columbia River, PNL-5289, Pacific Northwest Laboratory, Richland, Washington, November.

McGhan, V. L., et al., 1985. Hanford Wells, PNL-5397, Pacific Northwest Laboratory, Richland, Washington, February.

9 2 1 2 4 5 1 1 8 6 8

McLaughlin, T.J., 1986. Draft of HISS Database exclusive of sites in Volume 2 of Draft Phase I Installation Assessment of Inactive Waste - Disposal Sites at Hanford, July 1986, Pacific Northwest Laboratory, Richland, Washington.

Myrick, T. E., B. A. Berver, and F. F. Haywood, 1983. "Determination of Concentrations of Selected Radionuclides in Surface Soil in the U.S." Official Journal of the Health Physics Society, Vol, 45, No. 3. pp. 635-637.

NCRP (National Council on Radiation Protection and Measurements), 1975. National Background Radiation in the United States, Report 45, NCRP, Washington, D.C., April.

Oakley, Donald T., 1972. National Radiation Exposure in the United States, U.S. Environmental Protection Agency, Washington, D.C., June.

Phillips, S.J. and Raymond, J.R., 1975. Monitoring and Characterization of Radionuclide Transport in the Hydrogeologic System, BNWL-SA-5494 Part II, Pacific Northwest Laboratories, Richland, Washington.

PNL (Pacific Northwest Laboratory), 1979. Environmental Surveillance at Hanford for CY-1978, PNL-2932, Richland, Washington, May.

PNL (Pacific Northwest Laboratory), 1986b. Environmental Monitoring at Hanford for 1984: Supplement, PNL-5407 (Supplement), Richland, Washington, January.

Price, K. R. et al., 1984. Environmental Monitoring at Hanford for CY 1983, PNL-5038, Pacific Northwest Laboratory, Richland, Washington, May.

Price, K. R. et al., 1985. Environmental Monitoring at Hanford for 1984, PNL-5407, Pacific Northwest Laboratory, Richland, Washington, May.

Price, K. R., 1986. Environmental Monitoring at Hanford for 1985, PNL-5817, prepared for the U.S. Department of Energy by Pacific Northwest Laboratory, Richland, Washington, May.

9 2 1 2 4 1 1 8 5 9

Rockwell International, May 1986a. Polychlorinated Biphenyl Waste Implementation Plan, DOE Richland Operations, Hanford Site, Rev. 3.

Rockwell International, 1986b. Polychlorinated Biphenyl 1985 Annual Report DOE Richland Operations, Hanford Site, June.

Rockwell International, 1986c. Department of Energy - Richland Operations, Hanford Site RCRA Waste Stream Compliance, Rockwell Hanford Operations, January.

Rockwell International, 1986d. Environmental Control Programs, Rockwell Hanford Operations, July.

Smith, D.A., 1986a. Single-Shell Tank Isolation Safety Analysis Report, SD-WM-SAR-006, Rockwell Hanford Operations, Richland, Washington, January.

Smith, D.A., 1986b, Hazard Identification and Evaluation for Nonstabilized Single-Shell Tanks, SD-WM-SAR-022, Rockwell Hanford Operations, Richland, Washington, August.

DOE-RLO (U.S. Department of Energy, Richland Operations Office), 1986. Draft Phase I Installation Assessment of Inactive Waste-Disposal Sites at Hanford, Volume 1 and 2. Richland, Washington, July.

U.S. DOE, 1986, "Draft Environmental Impact Statement Disposal of Hanford Defense High-Level, Transuranic and Tank Wastes", DOE/EIS-0113, Vol. 3, March.

UNC (United Nuclear Corporation), 1979. Environmental Control Manual, UNC-UNI-M-31, August 30.

UNC (United Nuclear Corporation), 1984. Effluent Radioanalytical Program Manual, UNC-UNI-M-76, November 15.

UNC (United Nuclear Corporation), 1985. Reactor and Fuels Production Facilities: 1985 Effluent Release Report, UNC-UNI-3880.

9 2 1 2 4 6 1 1 8 7 0

UNC (United Nuclear Corporation), 1986. Environmental Control Manual UNI-M-31.

Vaughan, M.A., 1985. Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities, DOE, Washington, D.C., August.

WPPSS (Washington Public Power Supply System), 1986. 1985 Radiological Environmental Monitoring Program, Annual Report - Plant 2. April.

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