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Rev. 0

RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-1 Operable Unit, Hanford Site, Richland, Washington

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

ACRONYMS

ARARs	applicable or relevant and appropriate requirements
ASTM	American Society for Testing and Materials
BHI	Bechtel Hanford Incorporated
BPA	Bonneville Power Administration
CARs	Corrective Action Requirements
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMI	corrective measures implementation
CMS	corrective measures study
CRP	Community Relations Plan
D&D	decommissioning and decontamination
DOE	U.S. Department of Energy
DOW	Description of Work
DQOs	data quality objectives
DW	dangerous waste
Ecology	Washington Department of Ecology
ECS	emergency cooling system
EDB	emergency dump basin
EDT	emergency dump tank
EHQ	environmental hazard quotient
EHW	extremely hazardous waste
EIIs	Environmental Investigations Instructions
ENU	elementary neutralization unit
EPA	U.S. Environmental Protection Agency
ERA	expedited response action
FS	feasibility study
HDPE	high-density polyethylene
HGP	Hanford Generating Plant
HSRAM	Hanford Site Risk Assessment Methodology
HSP	Health and Safety Plan
HSWA	Hazardous and Solid Waste Amendments (of 1984)
ICR	incremental cancer risk
IMO	Information Management Overview
IRM	interim remedial measure
LERF	liquid effluent retention facility
LFI	limited field investigation
LWDF	liquid waste disposal facility
LWLS	liquid waste loadout station
MCL	maximum contaminant level
MCS	Management Control System
NCP	National Oil and Hazardous Substances Contingency Plan
NOEL	no observable effect level
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCBs	polychlorinated biphenyls
PCE	tetrachloroethylene

ACRONYMS (cont)

POTW	publicly owned treatment works
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QC	quality control
QRA	qualitative risk assessment
RCRA	Resource Conservation and Recovery Act of 1976
RCS	reactor coolant system
RCW	Revised Code of Washington (State)
RFA	RCRA facility assessment
RfD	reference dose
RFI	RCRA facility investigation
RI	remedial investigation
RL	Richland Operations Office
ROD	record of decision
SAFER	Streamlined Approach For Environmental Restoration
semi-VOL	semi-volatile organic compound
SS	Washington Public Power Supply System
SWMU	solid waste management unit
TAL	target analyte list
TBC	to-be-considered
TCL	target compound list
TPHs	total petroleum hydrocarbons
TSD	treatment, storage, or disposal
UTL	upper threshold limit
VOC	volatile organic compound
WAC	Washington Administrative Code
WHC	Westinghouse Hanford Company
WIDS	Waste Identification Data System

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1.0 INTRODUCTION

Four areas of the Hanford Site (the 100, 200, 300, and 1100 Areas) have been included on the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Figure 1-1 shows the location of these areas. Under the *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 1990a), signed by the Washington Department of Ecology (Ecology), EPA, and the U.S. Department of Energy (DOE), more than 1,000 inactive waste disposal and unplanned release sites on the Hanford Site have been grouped into a number of source and groundwater operable units. These operable units contain contamination in the form of hazardous waste, radioactive/hazardous mixed waste, and other CERCLA hazardous substances. Also included in the Tri-Party Agreement are 55 Resource Conservation and Recovery Act (RCRA) treatment, storage, or disposal (TSD) facilities that will be closed or permitted to operate in accordance with RCRA regulations, under the authority of Chapter 173-303 Washington Administrative Code (WAC). Some of the TSD facilities are included in the operable units.

The Tri-Party Agreement requires that the cleanup programs at the Hanford Site integrate the requirements of CERCLA, RCRA, and Washington State's dangerous waste (the state's RCRA-equivalent) program. The EPA maintains authority for CERCLA, and Ecology implements RCRA under the authority of the state's dangerous waste program. The state has also received authorization to implement the EPA's radioactive mixed waste program. The state does not yet have authority to implement the most recent amendments to RCRA, the Hazardous and Solid Waste Amendments (HSWA); this authority remains under EPA. A comparison of CERCLA and RCRA terminology used in this work plan is provided in Table 1-1. Pursuant to the Tri-Party Agreement, the 100-NR-1 Source Operable Unit is subject to RCRA corrective action authority.

The Change Number M-15-94-04 Change Number to the Tri-Party Agreement (Ecology et al. 1994a) recognizes the need to ensure consistent, effective, and nonduplicative cleanup. To ensure this, actions taken under Ecology, DOE, and EPA authorities will need to be implemented in a coordinated fashion. Therefore, the three parties have agreed to utilize the N Area as a pilot project with the objective of ensuring coordinated, streamlined cleanup efforts. The M-15-94-04 Change Number includes actions presently deemed necessary to address near-term environmental and human health related concerns, and is intended to carry N Area through early cleanup and the deactivation process. Integration of activities within the 100 N Area by the 100 N Area Pilot Project is discussed in detail in the *100 N Area Pilot Project Management Plan* (BHI 1994a).

This work plan and the attached supporting project plans establish the operable unit setting and the objectives, procedures, tasks, and schedule for conducting the RCRA facility investigation/corrective measures study (RFI/CMS) for the 100-NR-1 Source Operable Unit. Source operable units include facilities and unplanned release sites that are potential sources of contamination. The 100-NR-2 Operable Unit underlies the 100 N Area, (Figure 1-2). The 100-NR-2 operable unit includes all contamination found in the aquifer soils and water within its boundary. A separate work plan has been initiated for the 100-NR-2 Groundwater Operable Unit (DOE-RL 1994a).

All work conducted under this work plan will conform to the conditions set forth in the Tri-Party Agreement. In accordance with the Tri-Party Agreement, relevant EPA guidance documents were consulted in the preparation of the work plan, including the following:

- *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a)

- *Data Quality Objectives for Remedial Response Activities* (CDM Federal Programs Corporation 1987)
- *Superfund Exposure Assessment Manual* (EPA 1988b)
- *Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual, Part A, Interim Final* (EPA 1989a)
- *Risk Assessment Guidance for Superfund, Volume II, Environmental Evaluation Manual* (EPA 1989b).

This chapter sets forth the general purpose, scope, and goals of the project. The organization of the work plan and functions of the various chapters and attachments are outlined in the following sections.

1.1 IMPLEMENTATION OF THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Pursuant to the Tri-Party Agreement Change Number M-15-94-04 environmental restoration activities undertaken following the past-practice strategy (DOE-RL 1991a) and actions leading to the closure of RCRA treatment storage and/or disposal facilities in the 100 N Area will be coordinated. This coordination will satisfy the intent and milestones of the M-15-94-04 Change Number and fulfill the documentation requirements for RCRA TSD facility closure/postclosure plans, RCRA past-practice site RFI/CMS, and CERCLA remedial investigation/feasibility study (RI/FS) activities. This coordinated effort is designed to conform with the conditions set forth in the Hanford Tri-Party Agreement and its amendments and to fulfill the documentation requirements for closure of RCRA TSD facilities per WAC Section 173-303-610. The effort uses a phased approach through interim actions at higher priority sites consistent with the past-practice strategy (DOE-RL 1991a).

The following sections introduce the *Hanford Past-Practice Strategy* (DOE-RL 1991a) (Section 1.1.1), the 100-NR-1 Operable Unit RFI/CMS (Section 1.1.2), the coordination strategy to implement Change Number M-15-94-04 (Section 1.1.3), and the 100 Area NPL Site Record of Decision (ROD) (Section 1.1.4). The process discussed in the following sections results in three ROD levels as shown in Figure 1-3.

1.1.1 Hanford Site Past-Practice Strategy

Through the experience gained to date on developing work plans and permit applications at the Hanford Site, the signatories to the Tri-Party Agreement (the three parties) have recognized the need for a new strategy of RCRA/CERCLA integration, in contrast to a traditional CERCLA approach to an RI/FS. The new strategy was necessary because the complexity of the Hanford Site operable units (particularly with regard to characterizing existing mixed waste and hazardous waste contamination, and the need to obtain sufficient quantities of data for a high degree of certainty in decision making) has caused unexpected growth of the schedules for investigations and the cost for conducting the RI/FS. With a traditional CERCLA approach, cleanup actions would not commence until the ROD was issued following the RI/FS. This raised the concern that too much time and too large a portion of a limited budget would be spent before actual cleanup would start. Another motivation for a new strategy was the need to coordinate past-practice investigations with RCRA closure activities since some operable units contain RCRA TSD facilities.

In response to the above concerns, the three parties decided to manage and implement all past-practice investigations under one characterization and remediation strategy, regardless of the regulatory agency

lead, as defined in the Tri-Party Agreement (Ecology et al. 1990a). In order to enhance the efficiency of ongoing CERCLA RI/FS and RFI/CMS activities at the 100 Area of the Hanford Site, and to expedite the ultimate goal of cleanup, more emphasis is placed on initiating and completing waste site cleanup through interim actions.

This streamlined approach is described and justified in *The Hanford Federal Facility Agreement and Consent Order Change Package*, dated May 16, 1991 (Ecology et al. 1991). To implement this approach, the three parties developed the *Hanford Past-Practice Strategy* (DOE-RL 1991a). This strategy provides new concepts for:

- accelerating decision-making by maximizing the use of existing data consistent with data quality objectives

- undertaking expedited response actions (ERAs) and/or interim remedial measures (IRMs), as appropriate, to either remove threats to human health and welfare and the environment, or to reduce risk by reducing toxicity, mobility, or volume of contaminants.

The *Hanford Past-Practice Strategy* (DOE-RL 1991a) describes the concepts and framework for the RFI/CMS process in a manner that has a bias-for-action through optimizing the use of interim actions, culminating with decisions on final remedies on both an operable unit and a 100 Area aggregate scale. The strategy focuses on reaching early decisions to initiate and complete cleanup projects, maximizing the use of existing data, coupled with focused short-time-frame investigations, where necessary. As more data become available on contamination problems and associated risks, the details of the longer term investigations and studies will be better defined.

The RFI/CMS process under this strategy is a continuum of activities whereby the effort is defined based upon knowledge gained as work progresses (the observational approach). Whereas the strategy is intended to streamline investigations and documentation to promote the use of interim actions to accelerate cleanup, it is consistent with the RFI/CMS and RI/FS processes. As stated in EPA (1988a), the objective of the RI/FS process"... is not the unobtainable goal of removing all uncertainty, but rather to gather information sufficient to support an informed risk management decision regarding which remedy appears to be most appropriate for a given site." Figure 1-4 is a decision flow chart that shows the streamlined Hanford Site past-practice RFI/CMS process. The strategy includes three paths for interim decision-making and a final corrective-action-selection process for the operable unit that incorporates the three paths and integrates sites not addressed in those paths. An important element of this strategy is the application of the observational approach, in which characterization data are collected concurrently with cleanup.

As shown on Figure 1-4, the three paths for interim decision-making are:

- ERA path, where an existing or near-term unacceptable health or environmental risk from a site is determined or suspected, and a rapid response is necessary to mitigate the problem.

- IRM path, where existing data are sufficient to indicate that the site poses a risk through one or more pathways and additional investigations are not needed to screen the likely range of remedial alternatives for interim actions; if a determination is made that an IRM is justified, the process will proceed to select an IRM, and may include a focused FS, if needed, to select a remedy.

- Limited field investigation (LFI) path, where minimum site data are needed to support IRMs or other decisions, and the data can be obtained in a less formal manner than that needed to support

the operable unit ROD (Section 1.1.2, Item 16); however, regardless of the scope of the LFI, it is a part of the RFI process, and not a substitute for it.

The near-term past-practice strategy for the 100 Area provides for ERAs, IRMs, and LFIs for individual waste sites, grouped waste sites, and contaminated groundwater. While these elements may mitigate specific contamination problems through interim actions, the process of final remedy selection must be completed for the operable unit and 100 Area NPL site to reach closure. The information obtained from the LFIs and interim actions may be sufficient to perform the baseline risk assessment, and to select the corrective action for the operable unit. If the data are not sufficient, additional investigations and studies will be performed to the extent necessary to support the operable unit corrective action selection. These investigations would be performed within the framework and process defined for RFI/CMS programs.

1.1.2 Application of the Hanford Past-Practice Strategy at the 100-NR-1 Operable Unit

The framework and process for performing the RFI/CMS at the 100-NR-1 Operable Unit is shown in Figure 1-5 in a time sequenced manner. The following numbered paragraphs match the numbers in Figure 1-5 and provide a discussion of the RFI/CMS process.

1. Begin the Operable Unit Work Plan

The RFI/CMS process began with the development of Draft A of this work plan.

2. Rescoping

As a result of the *Hanford Past-Practice Strategy* (DOE-RL 1991a), the three parties assigned all known and suspected areas of contamination either a high- or low-priority for potential remediation. The three parties agreed that an LFI (Item 5) was necessary for the high-priority sites, and that investigative activities for the low-priority sites would be deferred to the final RFI (Item 12). The three parties also identified certain activities that would be more efficient to implement at the 100 Area aggregate or Hanford Site scale instead of the operable unit scale. This new strategy was not reflected in the scope of work presented in Draft A of this work plan, and rescoping conducted by the three parties necessitated the creation of Draft D.

3. 100 Area Aggregate and Hanford Site Studies

The 100 Area aggregate and Hanford Site studies provide integrated analyses of selected issues on a scale larger than the operable unit. The issues addressed by these studies affect all 100 Area operable units and are more appropriately studied on an aggregate basis. The 100 Area aggregate and Hanford Site studies being conducted include a river impact study, a shoreline study, an ecological study, a cultural resource study, a background study, and development of a baseline risk assessment methodology. These studies provide data to be used in the LFI and the final RFI.

4. 100 Area Feasibility Study and Report

The 100 Area FS develops and screens generic remedial alternatives on a 100 Area-wide basis. The results of this study provide a foundation for all subsequent feasibility studies to be performed for IRM selection and corrective measures studies for selection of operable unit corrective actions. The 100 Area FS identifies contaminants of concern and applicable or relevant and appropriate requirements (ARARs), develops and screens alternatives, and identifies the need for treatability studies and technology demonstrations to support detailed analyses during focused feasibility and final corrective measures studies. The 100 Area FS report is a primary document. In addition to the 100 Area FS report, two

additional (secondary) reports will be prepared: the treatability program plan, which will identify treatability studies to support 100 Area activities; and the IRM program plan, which will identify IRMs to be conducted within the 100 Area.

5. Limited Field Investigation and Report

The RFI for high-priority sites begins with an LFI that is performed to provide additional data and characterization needed to support selection, design and implementation of IRMs, if needed. The LFIs are performed at those high-priority sites where the existing data are considered insufficient by the unit managers to select an IRM (Item 9). The LFI may be conducted in parallel with the focused FS (Item 6), permitting the collection of any additional data identified when conducting the focused FS.

The LFI may consist of data compilation, non-intrusive investigations, intrusive investigations, and data evaluation. The LFI is an integral part of the RFI/CMS process and functions as a focused RFI for selection of IRMs. A qualitative risk assessment is performed as part of the LFI, and is focused on the principal risk drivers in the operable unit. The results of this assessment may be used to help determine the need for IRMs, to select the IRMs, and to determine risk-based cleanup levels for the IRMs.

The LFI report is a secondary document summarizing the data collection and analysis activities conducted during the LFI, and the qualitative risk assessment. The LFI analysis activities include review of pertinent information from previous studies and from the 100 Area aggregate studies. Any additional data needs identified during the report preparation will be collected prior to completing the report.

6. Focused Feasibility Study

The focused FS evaluates the alternatives identified in the 100 Area FS for IRMs at high-priority sites in the operable unit. The information needed to make decisions during the focused FS is taken from existing sources, results of the LFI, results of treatability studies as identified in the Treatability Program Plan described in Item 4, and results of any technology demonstration projects that are conducted. Modeling, if required, may be performed as part of the detailed analysis.

7. Limited Field Investigation/Focused Feasibility Study Report

The LFI/focused FS report is a primary document that presents an evaluation of alternative IRMs for high-priority sites and is intended to provide adequate information for selection of IRMs.

8. Proposed Interim Remedial Measure Plan(s)

The proposed IRM plan(s) is a primary document that provides the public with a summary of the focused FS and identifies the IRMs selected. A single proposed IRM plan may be prepared for all IRMs, or multiple plans may be prepared for grouped and/or individual IRMs.

9. Interim Remedial Measure Record of Decision

The IRM ROD summarizes the LFI/focused FS report as well as any changes to the selected IRM(s) occurring as a result of public comment on the proposed IRM plan(s). The IRM ROD is a primary legal document certifying that the IRM selection process was carried out in accordance with CERCLA, and committing the three parties to perform the IRM(s) in accordance with its specifications. The IRM ROD presents a technical description of the IRM(s); interim engineering, institutional, and remedial action goals; and information regarding the site. The IRM ROD is written and issued by the regulators. A

single IRM ROD may be prepared for all IRMs, or multiple RODs may be prepared for grouped and/or individual IRMs.

10. Interim Remedial Measure Design Report

The IRM design report is a secondary document and provides engineering and technical specifications for implementing the IRMs identified in the IRM ROD.

11. Interim Remedial Measure Implementation

All IRMs are implemented in a construction and operations phase. This phase varies in scope and complexity depending upon the IRM. Any data collected during IRM implementation may be used in the final RFI (Item 12). Although the IRM primarily addresses high-priority sites, adjacent low-priority sites may be incorporated into the implementation. Completing IRM implementation concludes the IRM phase of site remediation. Any further actions needed to achieve final cleanup objectives are addressed during the final CMS (Item 13).

12. Final RCRA Facility Investigation and Report

The final RFI provides any additional data and characterization needed to support selection, design and implementation of a final corrective action for the operable unit. The final RFI is performed at remaining low-priority sites where existing data are considered insufficient by the unit managers, and at any remaining high-priority sites where final cleanup criteria were not achieved upon completion of the IRM. A final RFI may consist of data compilation, non-intrusive investigations, intrusive investigations, and data evaluation. Analyses conducted during the final RFI use data collected during the LFI, during IRM implementation, and in previous investigations.

A baseline risk assessment is performed as part of the final RFI. This assessment provides a quantitative evaluation of residual risk at the operable unit after completion of the IRMs, and is conducted according to the *Hanford Site Risk Assessment Methodology* (HSRAM) (DOE-RL 1994a). The results of this assessment are used to help determine the need for corrective action, to select the corrective action, and to determine risk-based cleanup levels for the corrective action.

The final RFI is conducted in parallel with the final CMS, permitting the collection of any additional data that may be identified when conducting the final CMS. The final RFI and the baseline risk assessment are documented in the final RFI report, which is a secondary document.

13. Final Corrective Measures Study

The final CMS evaluates the alternatives identified in the 100 Area FS for corrective action at the operable unit. The information needed to make decisions during the final CMS is taken from existing sources, results of the IRMs and final RFI, and from any treatability studies and technology demonstration projects that are conducted. Modeling, if required, may be performed as part of the detailed analysis.

14. RCRA Facility Investigation/Corrective Measures Study

The RFI/CMS report is a primary document that summarizes the pertinent data collection and analysis activities conducted during the final RFI and final CMS. The RFI/CMS report also presents the baseline risk assessment, and an evaluation of alternative corrective actions for the operable unit that is intended to provide adequate information for selection of a corrective action.

15. Proposed Corrective Action Plan

The proposed corrective action plan is a primary document that provides the public with a summary of the final CMS and identifies the corrective action selected.

16. Operable Unit ROD

The operable unit ROD summarizes the RFI/CMS report as well as any changes to the selected corrective action occurring as a result of public comment on the proposed corrective action plan. The operable unit ROD is a primary legal document certifying that the remedial action selection process was carried out in accordance with CERCLA, and committing the three parties to perform the corrective action in accordance with its specifications. The operable unit ROD presents a technical description of the corrective action; the final engineering, institutional, and corrective action goals; and information regarding the site. The operable unit ROD is written and issued by the regulators.

17. Corrective Action Design Report

The corrective action design report is a secondary document and provides engineering and technical specifications for implementing the corrective action identified in the operable unit ROD.

18. Corrective Action Implementation

The corrective action is implemented in a construction and operations phase. This phase varies in scope and complexity depending upon the corrective action.

1.1.3 The Coordination Strategy

A coordination of environmental restoration activities at the 100 N Area is required to meet the intent and milestones of the M-15-94-04 Change Number, such as the documentation requirements for RCRA TSD facility closure/postclosure plans, RCRA past-practice site RFI/CMS, and CERCLA RI/FS activities. This coordinated effort is designed to conform with the conditions set forth in the Hanford Tri-Party Agreement and its amendments and to fulfill the documentation requirements for closure of RCRA TSD facilities per the WAC, Section 173-303-610. The effort uses a phased approach through interim actions at high-priority sites consistent with the Hanford Past-Practice Strategy. In accordance with the past-practice strategy, the three parties assigned all known and suspected areas of contamination either a high- or low-priority for potential remediation. Table 1-2 lists the high- and low-priority sites in the 100-NR-1 Operable Unit. Note that sites associated with the Hanford Generating Plant (HGP) are assigned the low-priority rank based on analogous sites in the 100 N Area or in other 100 Area operable units. The HGP sites were added to the 100-NR-1 Operable Unit on August 25, 1994, by Change Number C-93-08 to Appendix C of the Tri-Party Agreement (Ecology et al. 1994b).

The general strategy is a multi-phased approach in developing closure documentation for the waste sites associated with the 100-NR-1 and 100-NR-2 Operable Units. This process, under this strategy, is a continuum of activities that use the observational approach. Whereas the strategy is intended to streamline investigations and documentation to promote the use of interim actions to accelerate cleanup, it is consistent with RCRA TSD closure/postclosure requirements and the RFI/CMS and RI/FS process.

The framework and process for this coordination effort at the 100-NR-1 and 100-NR-2 Operable Unit is shown in Figure 1-6. The process will utilize existing information and data obtained during the 100 N Area RFI/CMS actions such as that from the LFIs and the ERA at N Springs, and deactivation, decontamination, and decommissioning of N Reactor facilities. Some of the information is in documents

already developed or documents to be submitted in calendar year 1994. Background documentation includes:

- *RCRA Facility Investigation/Corrective Measures Study Work Plan for the 100-NR-2 Operable Unit* (DOE-RL 1994a)
- *Limited Field Investigation Report for the 100-NR-1 Operable Unit* (DOE-RL 1994c)
- *Qualitative Risk Assessment for the 100-NR-1 Operable Unit* (BHI 1994b)
- *Limited Field Investigation Report for the 100-NR-2 Operable Unit* (DOE-RL 1994d)
- *Qualitative Risk Assessment for the 100-NR-2 Operable Unit* (BHI 1994c)
- 100 Area Feasibility Study Phase I, II and III Reports (DOE-RL 1992, DOE-RL 1994e)
- existing 100 Area Aggregate and Hanford Site Studies
- N Springs ERA documentation (DOE-RL 1994f)
- documentation describing alternative proposed to abate 116-N-1 (1301-N) and 116-N-3 (1325-N) crib and trench "skyshine."

This information and subsequent documents developed as part of the cleanup of waste sites and facilities within the 100 N Area will be the basis for developing the closure plan/CMS. A closure plan/CMS is required by new milestones in the Tri-Party Agreement Change Number M-15-94-04 (Ecology et al. 1994c). The closure plan/CMS document will be prepared that incorporates the applicable aspects of the following:

- RCRA closure plans, detailed in WAC 173-303-610,
- RCRA Corrective Measures Studies, detailed in 40 Code of Federal Regulations (CFR) 264.524 and 264.535 (proposed Subpart S)
- CERCLA Feasibility Studies, detailed in 40 CFR 300.

Table 1-3 is a comparison of the requirements for closure plans, CMS, and FS documents. The table is separated into three main sections; the report, selection criteria, and range of alternatives. While there are many similarities between the closure plan, CMS, and FS documents, there is one major difference. Both the CMS and FS are designed to evaluate alternative remedial technologies, they do not decide on a remedial approach or detail the steps necessary for remediation. The closure plan, on the other hand, is required to provide detailed descriptions of any remedial activities to be performed for closure. Therefore, more detailed descriptions of the steps necessary to complete remediation and closure will be included in the closure plan/CMS to address specific RCRA closure requirements. The closure plan/CMS document will employ a format similar to the past-practice format, but will include WAC requirements for RCRA closures. Section 5.2.4 provides a general outline and synopsis of the proposed closure plan/CMS.

The closure plan/CMS will consist of several volumes to meet the new milestones established under the M-15-94-04 . Each volume which will document the closure strategy for different waste sites. The volumes will be submitted in phases, starting with a volumes for the 116-N-1/116-N-3 (1301-N/1325-N)

and the high-priority past-practice sites. Sites are assigned to specific volumes of the closure plan/CMS based on the waste site priority category, i.e., high or low, and to avoid including waste sites that have conflicting or incompatible regulatory requirements in the same volume. The waste sites were separated into different volumes based upon the regulatory requirement for a permit modification versus a requirement for a ROD. A permit modification is a specific requirement for RCRA TSD units and would be difficult to separate from a blended closure plan/CMS document. To meet specific requirements for this permit modification, the RCRA TSD units are separated into different volumes. High-priority sites will be closed based on the IRM pathway established in the Hanford Past-Practice Strategy. Lower priority sites will be investigated and remediated, if necessary after the RCRA closures and IRMs have been completed and during final remediation of the 100 N Area.

The following volumes will constitute the closure plan/CMS for the 100 N Area and meet requirements under M-15-94-04:

- *Closure Plan/CMS for the 100 N Area,* Executive Summary
- *Closure Plan/CMS for the 100 N Area,* Volume 1, "1301/1325-N Liquid Waste Disposal Facilities Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01J)
- *Closure Plan/CMS for the 100 N Area,* Volume 2, "100-NR-1 Interim Action Closure Plan/Corrective Measures Study, High-Priority Sites" (Tri-Party Agreement Milestone M-15-01K)
- *Closure Plan/CMS for the 100 N Area,* Volume 3, "1324-N/NA Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01K)
- *Closure Plan/CMS for the 100 N Area,* Volume 4, "100-NR-2 Groundwater Interim Action Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01K)
- *Closure Plan/CMS for the 100 N Area,* Volume 5, "100-NR-1, 100-NR-2 Final Closure Plan/Corrective Measures Study" (includes all lower priority sites) (Tri-Party Agreement Milestone M-15-01K).

There will be an introductory (umbrella) document that will provide an overview of the programmatic strategy for remediation for the 100 N Area operable units. This programmatic document will provide a description of the waste units contained in the subsequent volumes and the planning schedules for each volume. This document will be revised and updated to include summary information on each volume as documents are approved.

Volume 1 and Volume 3 contain the closure/CMS requirements for the RCRA TSD sites. Remedial alternatives selected for comparison in these two volumes will be based upon the 100 Area Phase I, II, and Phase III feasibility study reports (DOE-RL 1992, DOE-RL 1994e). In addition, any relevant new information on remedial technologies developed since submittal of the FS reports will be considered during development of the closure plan/CMS documents. Upon approval of these documents, major RCRA Hanford Facility permit modifications will be required to document the closure remedy selection. Following the permit modification, IRM closure/Corrective Measures Implementation (CMI) design reports will be developed. The CMI document is a secondary document and provides engineering and technical specifications for implementing the IRMs identified in the closure plan/CMS. Once the remedial design is approved and closure is complete, these waste sites will require certification of closure by a independent, registered, Professional Engineer per RCRA (WAC 173-303-610).

Volume 2 will be an interim action closure plan/CMS for high-priority past-practice sites. Remedial alternatives selected for comparison in these volume will be based upon the 100 Area Phase I, II, and Phase III feasibility study reports for the 100 Area's operable units as described above. Following approval of Volume 2, an IRM Proposed Plan documenting the preferred remedy selected for the high-priority sites will be submitted for public review and comment. The IRM ROD will then be developed summarizing the LFI/qualitative risk assessment (QRA) and the closure plan/CMS as well as any changes to the selected IRMs occurring as a result of public comment on the IRM Proposed Plan. The IRM ROD is a primary document presenting the technical description of the IRMs, interim engineering, institutional and remedial action goals, and information regarding the sites. Upon issuance of the ROD, an IRM Closure/CMI design report is required followed by remedy implementation. Unlike the RCRA TSD sites addressed in Volumes 1 and 3, certification of closure is not required for these past-practice sites.

Volume 4 will be an interim action closure plan/CMS for the 100-NR-2 Groundwater Operable Unit. Following approval of this document, interim action proposed plans, RODs, and design reports will be developed as described above for Volume 2. Certification of closure is not required for the groundwater operable unit.

An analogous site approach will be utilized for the low-priority sites within the 100 N Area, based on the approach used at the other 100 Area source operable unit investigations. Supplemental limited investigations will be completed if additional data are required to select the final remediation alternative for all waste sites of the 100 N Area. These supplemental limited investigations will be conducted after development of data quality objectives and a Description of Work (DOW).

A final baseline risk assessment will be performed for the entire 100-NR-1 and 100-NR-2 operable units using all available data such as analogous and historical information, data from supplemental investigations, data from the closure of the RCRA TSD sites, and data from the high-priority sites. This assessment will provide a quantitative evaluation of residual risk at the operable unit after completion of the IRMs. The baseline risk assessment will be prepared following HSRAM (DOE-RL 1994b). The results of this assessment will be used to help determine the need for additional corrective action for high-priority waste sites, to determine the need for corrective action at low priority waste sites, and to determine risk-based cleanup levels for any required corrective action.

Volume 5, the closure plan/CMS for final closure of all waste sites in the 100-NR-1 and 100-NR-2 Operable Units will be developed based on the information obtained in any supplemental investigations and the baseline risk assessment. Volume 5 will detail any additional corrective actions for the high-priority waste sites and necessary corrective action for all the low-priority waste sites. Corrective actions for the waste sites will be based upon the analogous site concept currently being utilized in the 100 Area operable units described in the Phase III Feasibility Study Report (DOE-RL 1994e). Upon approval of Volume 5, a final proposed plan will be issued for public review and comment. A final ROD will be issued. Similar to Volume 2, design reports will be completed and implementation of any necessary corrective action will be conducted. Unlike Volumes 1 and 3, which address RCRA TSD sites, closure certification will not be required for final remediation of operable units.

1.1.4 100 Area NPL Site Record of Decision

Data collected by previous investigations and after implementation of IRMs and operable unit corrective actions will be used in a cumulative risk assessment for the 100 Area. A 100 Area NPL Site ROD may be required to document the results of the cumulative risk assessment and document any additional remedial activities necessary on a 100 Area aggregate basis. The 100 Area NPL Site ROD would be a

primary document written and issued by the regulators in a process similar to the IRM and operable unit RODs as described in Section 1.1.2.

1.2 PROJECT GOALS

The goal of the 100-NR-1 Operable Unit RFI/CMS is to provide sufficient information to optimize the use of IRMs to expedite cleanup, while still maintaining a technically sound and cost-effective program of investigations that culminates in the development and evaluation of final corrective action alternatives in the final CMS.

1.3 ORGANIZATION OF THE WORK PLAN

Eight chapters, including this introduction, are included in this work plan. This work plan has been structured to provide the detailed information needed to initiate the LFIs, and to provide a framework for collecting any additional data that may later be identified. Chapter 2.0 presents the physical and environmental setting of the 100 N Area. The history and current understanding of the waste generation, transfer, storage, and disposal processes and facilities within the 100-NR-1 Operable Unit are also summarized in Chapter 2.0.

Available data on potential contaminant exposure pathways are reviewed in Chapter 3.0. These data are used to develop a conceptual exposure pathway model for the operable unit. Waste sources, quantities, and characteristics are identified, along with the current understanding of the extent of contamination in the various environmental media. Federal and state environmental standards, requirements, criteria, or limitations that may be considered potential corrective action requirements (CARs) are identified, potential impacts to human health and the environment are preliminarily assessed, and preliminary corrective action objectives are presented.

Chapter 4.0 presents the work plan rationale and approach. This chapter describes how the *Hanford Past-Practice Strategy* (DOE-RL 1991a) and the coordinated strategy for 100-NR-1 will be implemented. The data needed for evaluating risk, selecting IRMs, and selecting a final corrective action are described, along with the approach for obtaining the needed data.

Chapter 5.0 presents the tasks and activities necessary to conduct the LFI and the focused FS for selection of IRMs. This section also discusses, in general terms, the 100 Area aggregate and Hanford Site studies, the 100 Area FS, Volumes 1 through 5 of the Closure Plan/CMS for 100 N Area.

A project schedule is presented in Chapter 6.0. This chapter provides a detailed schedule specific to the 100-NR-1 Operable Unit, and a schedule for 100 Area wide activities.

Chapter 7.0 describes the project management tasks necessary to implement the RFI/CMS activities, including responsibilities, organizational structure, and project tracking and reporting procedures. References used to develop the work plan are provided in Chapter 8.0.

Appendices to this work plan include supporting plans that are necessary to conduct and control the RFI/CMS project. These supporting plans are:

- Appendix A: Quality Assurance Project Plan (QAPjP)
- Appendix B: Health and Safety Plan (HSP).

Each of these appendices is meant to be used in conjunction with the work plan, thus minimizing duplication of information.

1.4 QUALITY ASSURANCE

The 100-NR-1 Operable Unit work plan and its supporting project plans have been developed to meet specific EPA guidelines for format and structure, within the overall quality assurance (QA) program structure mandated by DOE-Richland Operations Office (RL) for all activities at the Hanford Site. The 100-NR-1 Operable Unit QAPjP (Appendix A) supports the field sampling program described in Chapter 5.0. It defines the specific means that will be used to ensure that the sampling and analytical data obtained as part of the LFI and aggregate area studies will effectively support the purposes of the investigation. As required by the Bechtel Hanford Incorporated (BHI) QA program plan for RFI/CMS activities and the *Hanford Federal Facility Agreement and Consent Order*, the structure and content of the QAPjP are based on *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (Stanley and Verner 1983). Where required, the QAPjP invokes appropriate procedural controls selected from those listed in the BHI QA program plan for RFI/CMS activities or developed to accommodate the unique needs of this investigation.

Figure 1-1. Hanford Site.

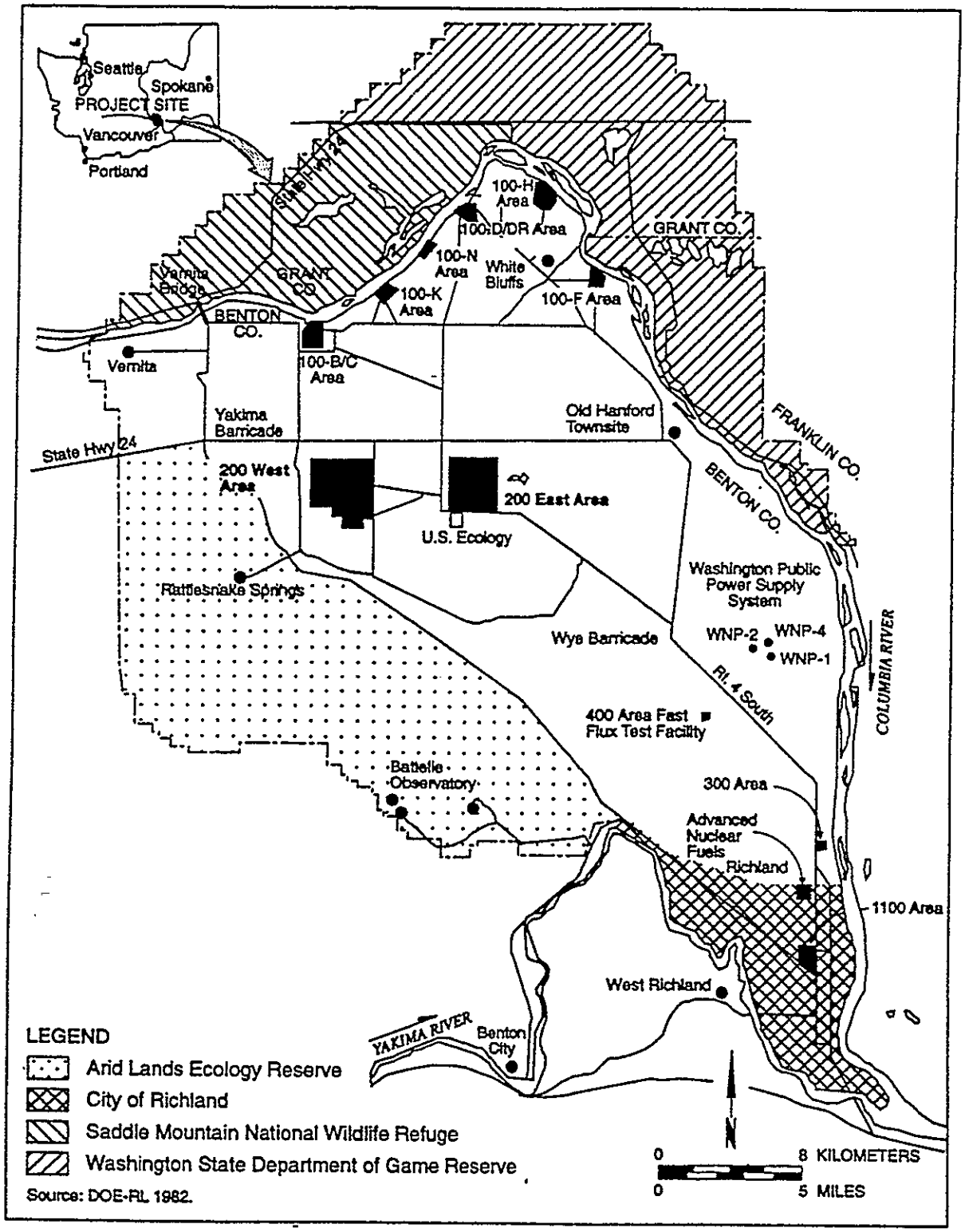

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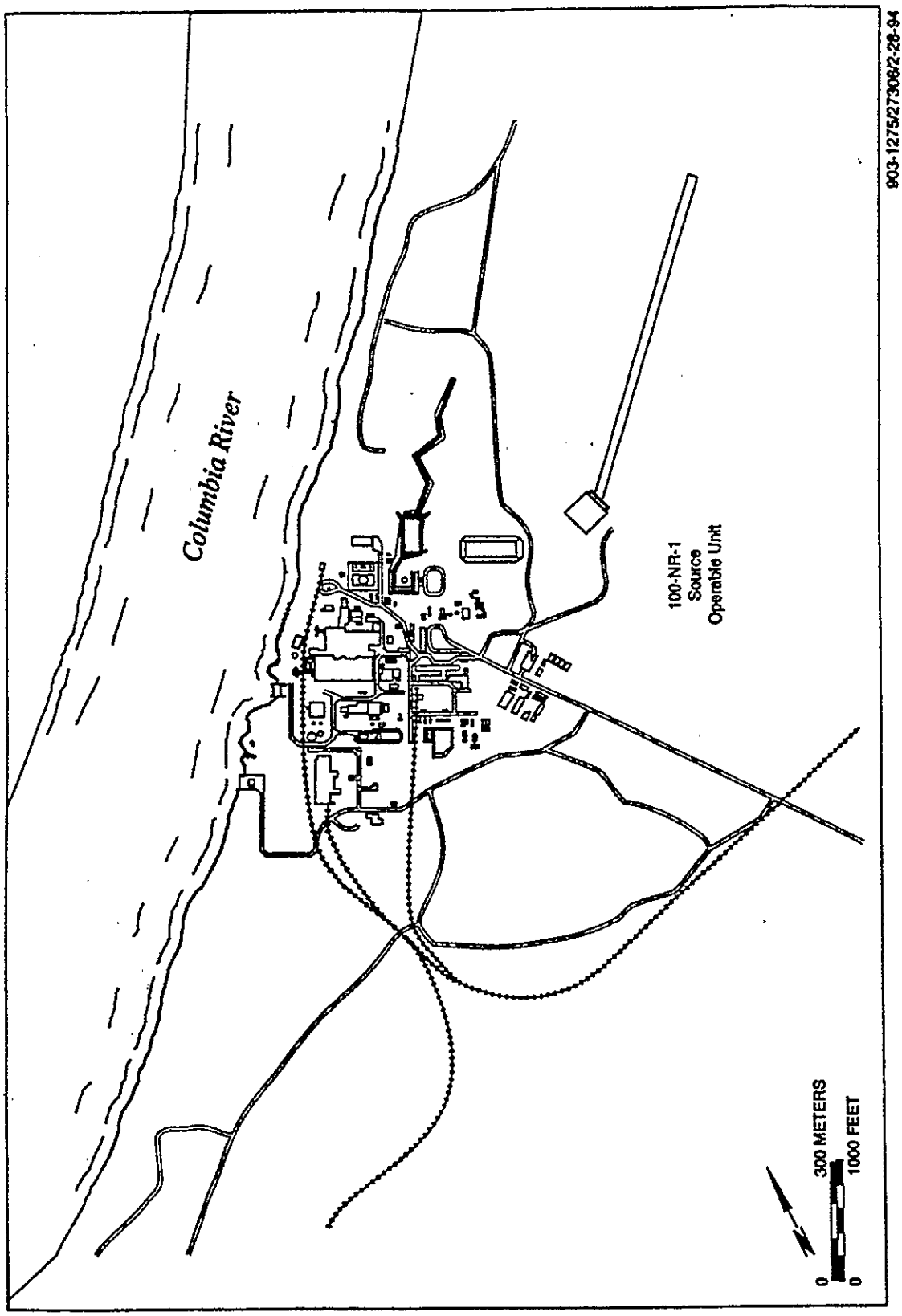
Figure 1-2. The 100-NR-1 Source Operable Unit.



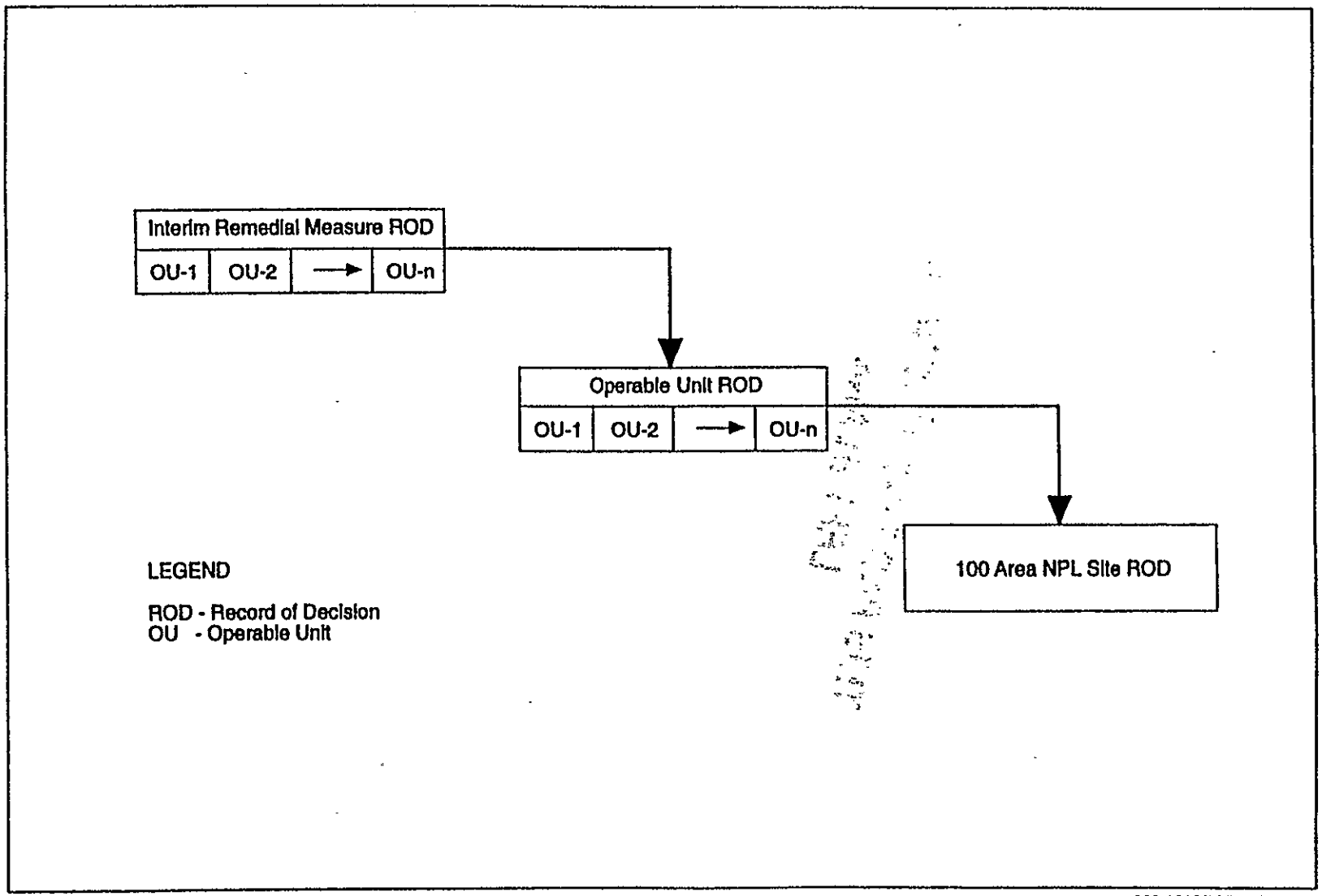


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Figure 1-3. The Three Record of Decision Levels.

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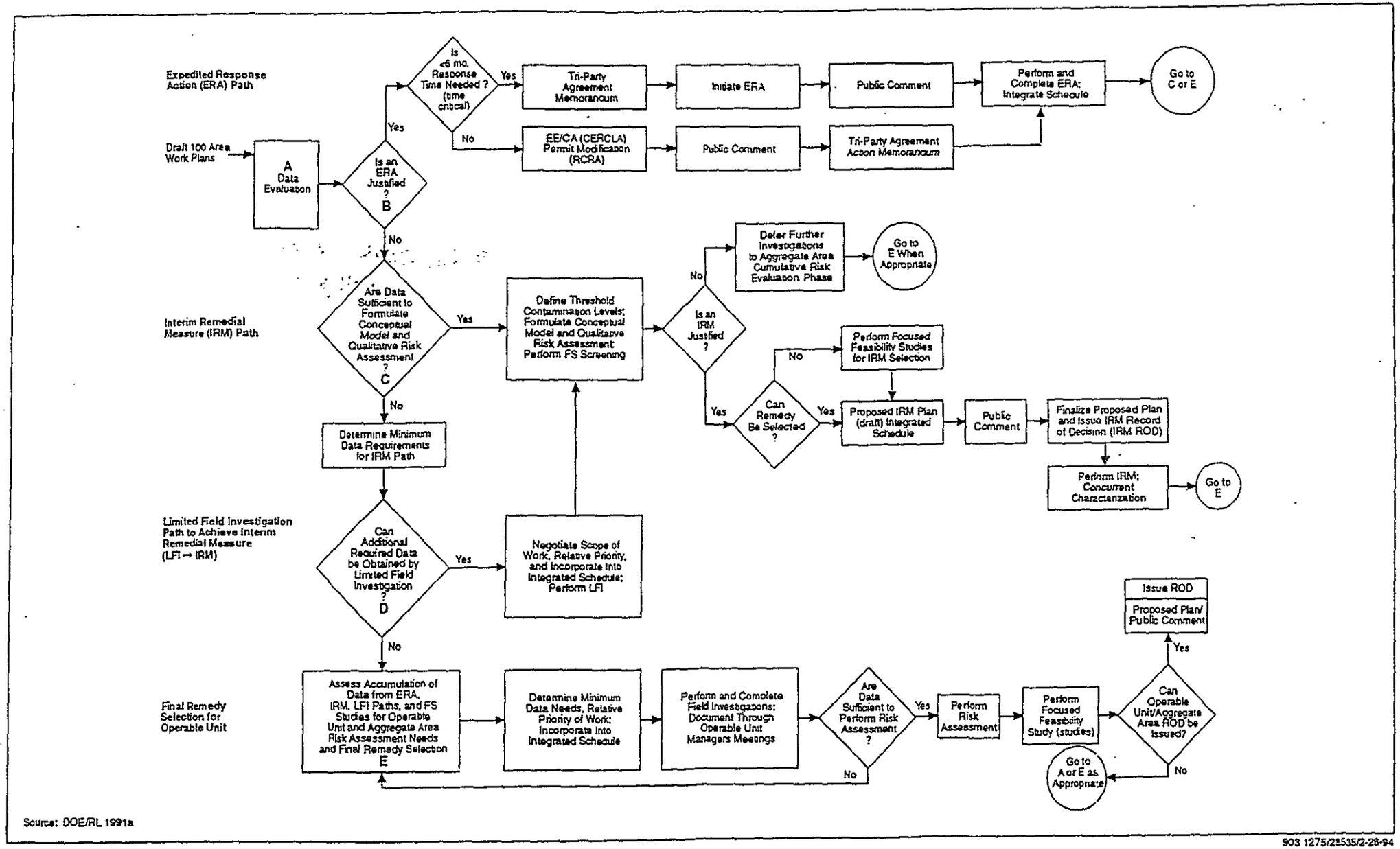
Figure 1-4. Hanford Site Past-Practice RI/FS (RFI/CMS) Process for the 100 Area



Source: DOE/RL 1991a

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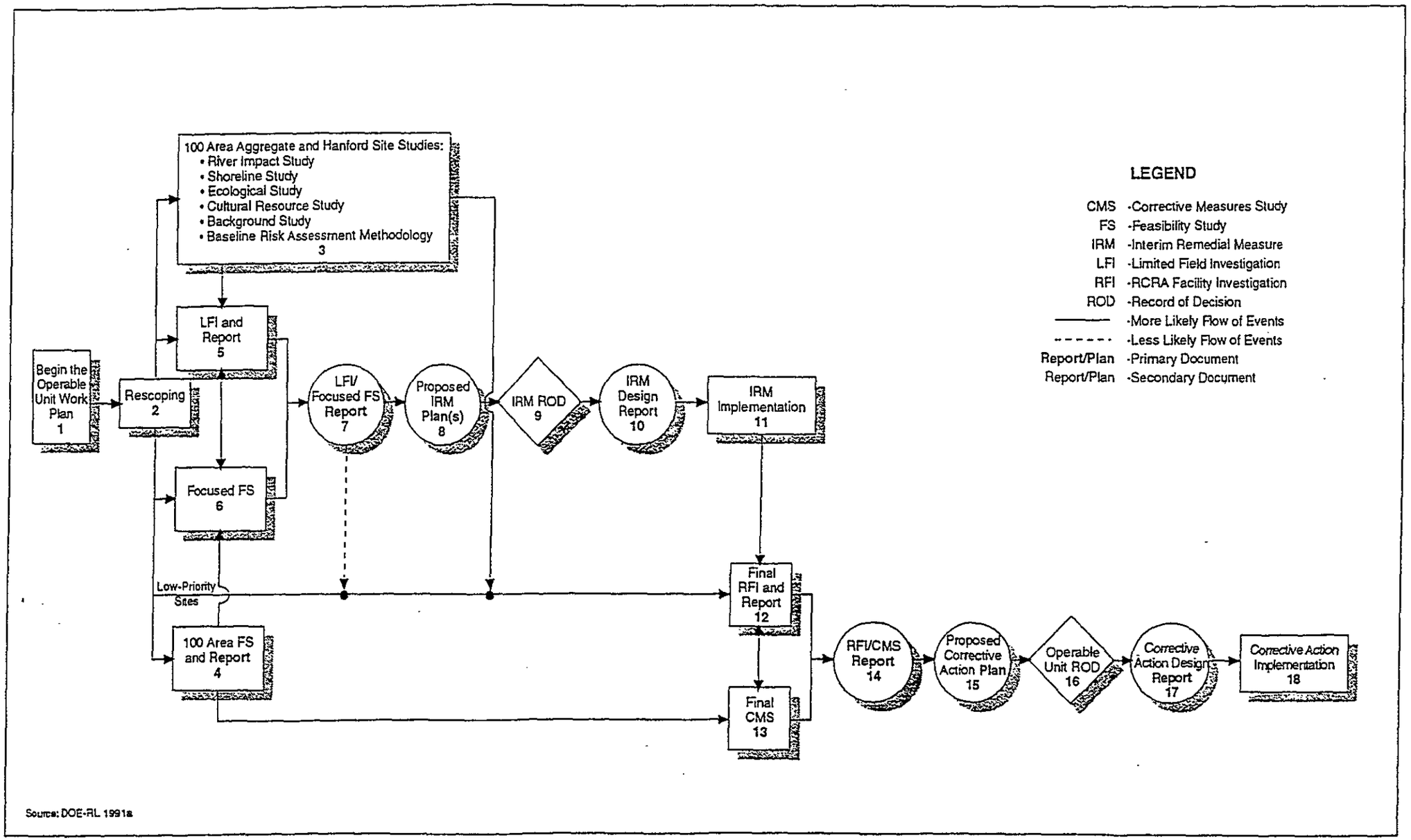
Figure 1-5. RFI/CMS Process of the 100-NR-1 Operable Unit



Source: DOE-RL 1991a

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Figure 1-6. RFI/CMS Closure Plan Coordination Process at the 100-NR-1 and 100-NR-2 Operable Units.

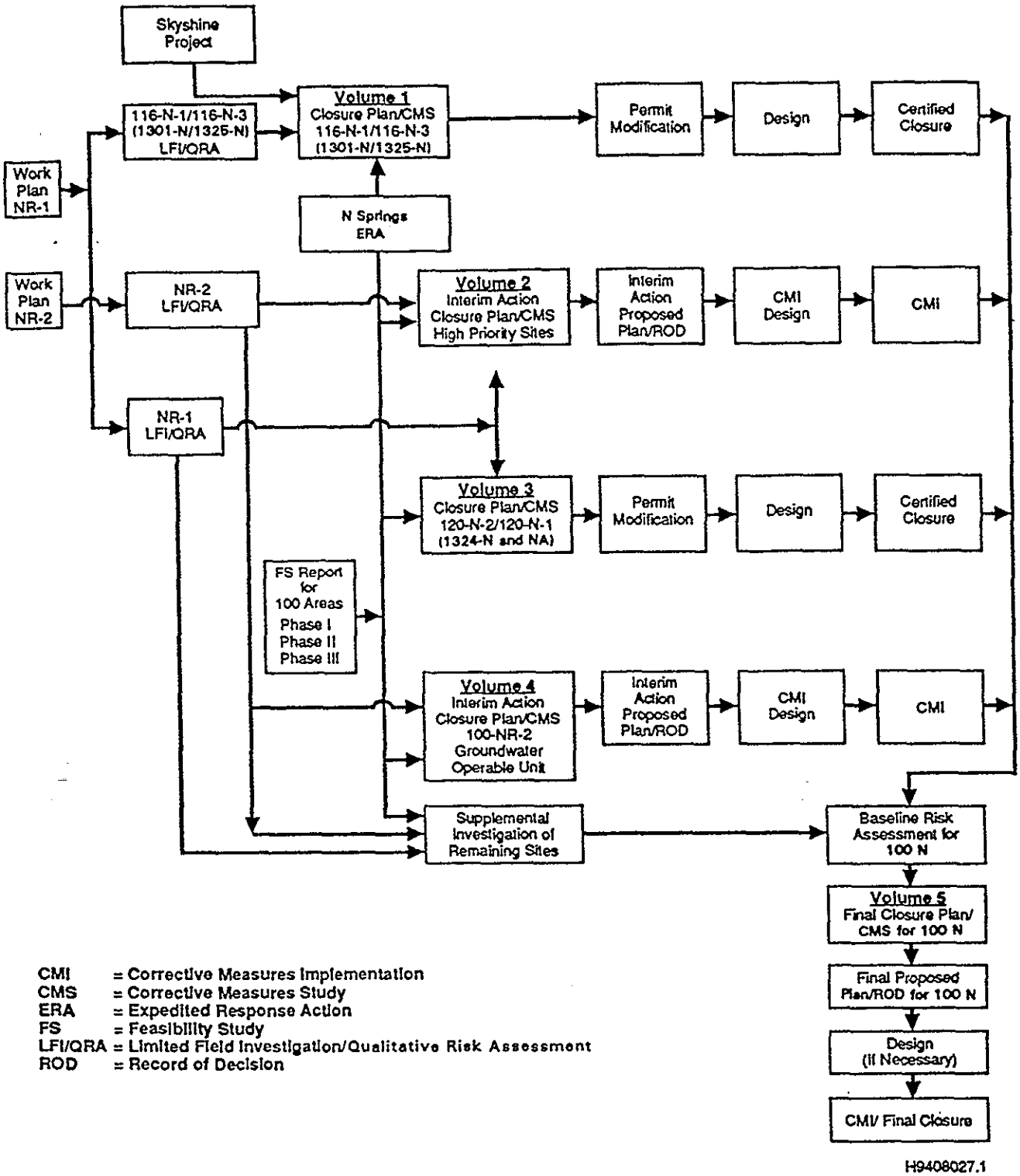

Table 1-1. The Relationship Between RCRA and CERCLA Terminology Used in This Work Plan.

RCRA Terminology	CERCLA Terminology
Resource Conservation and Recovery Act Facility Investigation (RFI)	Remedial Investigation (RI)
Corrective Measures Study (CMS)	Feasibility Study (FS)
Limited Field Investigation (LFI)	Limited Field Investigation (LFI)
Focused Feasibility Study (Focused FS)	Focused Feasibility Study (Focused FS)
Expedited Response Action (ERA)	Expedited Response Action (ERA)
Interim Response Measure (IRM)	Interim Response Measure (IRM)
Proposed IRM Plan	Proposed IRM Plan
IRM Record of Decision (ROD)	IRM Record of Decision (ROD)
IRM Design Report	IRM Design Report
IRM Implementation	IRM Implementation
Proposed Corrective Action Plan	Proposed Remedial Action Plan
Corrective Action ROD	Remedial Action ROD
Corrective Action Design Report	Remedial Action Design Report
Corrective Action Implementation	Remedial Action Implementation
Corrective Action Requirement (CAR)	Applicable or Relevant and Appropriate Requirement (ARAR)

Table 1-2. 100-NR-1 Operable Unit Waste Site Priority Ranking. (page 1 of 3)

Facility Identification		Alias/Former ID	Release/Spill ID
Resource Conservation and Recovery Act Treatment Storage and/or Disposal (RCRA TSD) Facilities			
116-N-1	Effluent Crib and Trench	(1301-N)	Crib and Trench Operations UN-100-N-31 Line Install Release
116-N-3	Effluent Crib and Trench	(1325-N)	Crib and Trench Operations
120-N-2	Surface Impoundment	(1324-N)	Impoundment Operations
120-N-1	Percolation Pond	(1324-NA)	Percolation Pond Operations
South Settling Pond			Settling Pond Operations
High-Priority Sites			
118-N-1	Spacer Storage Silos	(118-N)	Storage Silos Operations UN-100-N-3 Transfer line leak UN-100-N-12 Transfer line leak
1304-N	Emergency Dump Tank		Dump Tank Operations UN-100-N-1 Maint. flow-stop leak UN-100-N-2 Crack in relief line UN-100-N-7 Drain line leak UN-100-N-29 Check Valve leak UN-100-N-30 Vac. break overflow UN-100-N-32 Check valve leak
116-N-4	Emergency Dump Basin	(1300-N)	Dump Basin Operations
105-N	Spent Fuel Storage Basin	N reactor Spent Fuel Storage	Storage Basin Operations UN-100-N-10 Irradiated water leak UN-100-N-35 Irradiated water leak
UN-100-N-6	Decontamination Waste Drain Line		
1322-N/NA	Sample Buildings		Building Operations UN-100-N-8 Sump leak UN-100-N-4 Sump leak
116-N-2	Treatment and Storage Facility	(1310-N; golf ball)	Facility Operations UN-100-N-5 Underground pipe leak UN-100-N-25 Vent line discharge
119-N	Cooling Water Drain Line		UPR-100-N-9 Punctured drain line UPR-100-N-14 Drain Backflow
166-N	Tank Farm & Diesel Collection Trench		Tank Farm Operations UN-100-N-17 Diesel line leak
Low-Priority Sites			
Unplanned Release NaOH Spill (Spring 1993)			(Unloading to 116-N-2)
108-N	Chemical Unloading Facility	(1106-N)	Facility Operations UPR-100-N-15 Neutralizing Sump UPR-100-N-33 Acid transfer spill
120-N-7	Unloading Station French Drain		
120-N-6	Sulfuric Acid Tank French Drain	108-N Acid Tank French Drain	Tank Operations
120-N-8	Sulfuric Acid Day Tank Vent French Drain	163-N Acid Day Tank Vent French Drain	Tank Operations

Table 1-2. 100-NR-1 Operable Unit Waste Site Priority Ranking. (page 2 of 3)

Facility Identification		Alias/Former ID	Release/Spill ID
Low-Priority Sites (continued)			
Drum Storage Area (reported)			
181-N	Waste Oil Tank		
184-N	Day Tanks		UPR-100-N-19 Tank overflow UPR-100-N-21 Tank overflow
UN-100-N-1	Unplanned Release Fuel Oil		
120-N-5	Acid/Caustic Transfer French Drain & Neutralization Unit		
120-N-3	Neutralization Pit & French Drain	163-N Neutralization Pit & French Drain	
Regeneration Waste Transport System			(2 leaks in acid regeneration lines)
166-N	Piping		UN-100-N-18 Line leak UN-100-N-20 Oil line leak UN-100-N-24 Oil line leak
184-N	Piping		UN-100-N-22 Line leak UN-100-N-23 Line leak
124-N-4	Septic Tank & Drain Field	Septic Sewer System No. 4	
124-N-5	Septic Tank	Septic Sewer System No. 5	
124-N-6	Septic Tank	Septic Sewer System No. 6	
124-N-7	Septic Tank	Septic Sewer System No. 7	
124-N-1	Septic Tank	Septic Sewer System No. 1	
124-N-2	Septic Tank	Septic Sewer System No. 2	
124-N-3	Septic System	Septic Sewer System No. 3	
124-N-8	Septic Tank	Septic Sewer System No. 8	
124-N-9	Septic Tank	Septic Sewer System No. 9	
124-N-10	Sewer System	Central Sewer System No. 10	
1314-N	Liquid Waste Loadout Facility		UN-100-N-13 Dry well overflow UN-100-N-26 Rail car overflow
1143-N	Paint Shop		
120-N-4	Storage Area	Nonhazardous Low Level Waste Storage Pad	
128-N-1	Burning Pit		
N-17	Paint Shop		
116-N	Air Stack		Atmospheric gas releases
184-N	Plant Service Power House		Stack Releases
105-N	Lift Station Underground Tank		
102-N	Outfall Line		
181-N	Inlet Screen		
182-N	UST (3)		

Table 1-2. 100-NR-1 Operable Unit Waste Site Priority Ranking. (page 3 of 3)

Facility Identification	Alias/Former ID	Release/Spill ID
Low-Priority Sites (continued)		
116-N-8 Mixed Waste Storage Pad	163-N Storage Pad	
Grass Dump		(105-N UST Grouping)
Tank Farm Overflow		
Drain System		
Construction Debris Dump		(105-N UST Grouping)
Unplanned Release (Turbine oil)		
1716-N UST (2)		100-N-SS-28 Gasoline Storage Tank 100-N-SS-27 Gasoline Storage Tank
Hanford Generating Plant (HGP) transformer yard[a]	SWMU-1[b]	Transformer oil leaks - oil-stained soil
HGP building oil storage[a]	SWMU-2[b]	
HGP building floor drains, sumps, and all piping to settling pond and outfall[a]	185-N turbine generation buildng, SWMU-3[b]	
HGP turbine oil filter unit[a]	SWMU-4[b]	
HGP tile field[a]	SWMU-5[b]	Faciltiy operations - effluent from HGP building sanitary and laboratory waste lines
HGP settling pond[a]	SWMU-6[b]	Facility operations - effluent from HGP building and oil spill on January 2, 1987
HGP outfall[a]	SWMU-7[c]	Facility operations - effluent from settling pond and formerly from HGP building main sump
HGP maintanance garage[a]	SWMU-8[b]	
HGP office building septic system[a]	1703-N septic system, SWMU-9[b]	
HGP gate house septic system[a]	1701-NE septic system, SWMU-9[b]	
HGP maintanance garage french drain[a]	SWMU-9[b]	
HGP disposal and storage area[a]	600-32 Dumping Area, SWMU-10[b]	Oil-stained soil
HGP burn pit[a]	600-32 Dumping Area, 100-N Burning Pit, SWMU-11[b]	(105-N UST Grouping)

[a] = Hanford generating Plant sites assigned to low priority category based on analogous sites in othe 100 Area source operable units
[b] = Solid Waste Management Units 1 through 11 (SWMU-1 through SWMU-11) aliases are from Resource Conservation and Recovery Act (RCRA) facility assessment of the HGP facility (EPA 1992).
[c] = Outfall was operated under National Pollution Discharge Elimination System (NPDES) permit number WA 002487-2, and therefore is not actually a RCRA SWMU. Outfall has not discharged effluent since March 14, 1988.

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2.0 OPERABLE UNIT BACKGROUND AND SETTING

This section presents background information on the 100 N Area relevant to assessing potential contamination of the site by dangerous, radioactive or mixed wastes. A description of site activities is first presented, emphasizing waste-generating processes. This is followed by a descriptive summary of the environment at the area.

2.1 OPERABLE UNIT SITE DESCRIPTION

The history and operations at the 100 N Area are summarized in this section, including descriptions of waste streams. The section is closed with discussions of the status the facility waste streams in relationship to RCRA, and the Washington State Dangerous Waste Regulations (WAC 173-303).

Two primary numbering systems have been used in the 100 N Area, and several buildings, structures, and waste units have two number designations. Under the original Hanford numbering system, buildings, structures (such as river outfalls) and some waste handling units (such as retention basins) were given a unique number (e.g., 105-N for the N Reactor). Most waste units were not assigned a unique number but were instead referred to by the number of the nearby building (e.g., 163-N waste container storage pad). More recently, most of the waste units and some buildings and structures were assigned site designation numbers (e.g., 116-N-8 for the 163-N storage pad) under the current Hanford Site Waste Information Data System (WIDS) (DOE-RL 1991b). Throughout Chapters 2.0 and 3.0, preference is given to the site designation number. The only exceptions to this is the 105-N Reactor building, which will be referred to as the N Reactor.

2.1.1 Location

The Hanford Site is a 1,450 km^2 (560 mi^2) tract of land located in Benton, Franklin, and Grant counties in south-central Washington. The 2.6 km^2 (640 acre) 100 N Area is situated along the Columbia River. Figure 1-1 shows the Hanford Site and the location of the 100 N Area. The city of Richland is approximately 43 air and 61 river km (27 air and 38 river miles) south of the 100 N Area. The 100 N Area is bounded by the Columbia River and the 600 Area (the portion of the Hanford Site which surrounds the primary operation areas). The 100 D/DR Area is northeast of the 100 N Area and the 100 K Area is southwest (Ecker et al. 1983).

For cleanup purposes, the 100 N Area has been divided into two operable units. These are 100-NR-1 and 100-NR-2. The 100-NR-1 Operable Unit is composed of the physical structures, potential source units and the vadose zone within the boundaries of the 100-N area as shown in Figure 1-2. The 100-NR-2 Groundwater Operable Unit includes releases to the groundwater system, surface water, sediments, and aquatic biota from the 100 N Area. The 100 N Area facilities and structures are shown in Figure 2-1. Table 2-1 contains a list of facilities, which includes a brief description of use and period of operations. The HGP is located within the 100-NR-1 boundary but was not originally considered part of the 100-NR-1 Source Operable Unit, however, it has been added to the 100-NR-1 Operable Unit by change request M-15-94-04 to the Tri-Party Agreement (Ecology et al. 1994c). The HGP was operated by the Washington Public Power Supply System (SS). Also included within the boundaries of the 100-NR-1 area, but not considered part of the operable unit, is the Bonneville Power Administration (BPA) electrical substation. Any investigations and remedial actions that may be needed at the BPA electrical substation are not addressed by this work plan. Should any contamination be found to have migrated off of these two sites, into the 100-NR-1 Operable Unit, the three parties (DOE, Ecology, and EPA) must reach agreement with the operator (SS/HGP or BPA) as to the scope and schedule for remediation.

2.1.2 History of Operations

The N Reactor was the last reactor to be constructed as a major production reactor at the Hanford Site. It differs from the other reactors at Hanford in that it was designed as a dual purpose reactor capable of producing special nuclear materials and steam. The steam produced from the N Reactor core cooling systems was piped to the HGP and used for production of electrical power. The N Reactor went into production in December 1963. The HGP was completed and started producing electrical power by April 1966 (WHC 1989a). Both the reactor and the generating plant operated continuously, except for periodic shutdowns for maintenance and repairs until December 12, 1986, when the N Reactor was placed in standdown status for an extensive maintenance and safety enhancements program. In February 1988, the N Reactor was ordered to be placed in cold standby, with that condition achieved by October 1989. Shutdown of the N Reactor was ordered in October 1991. Shutdown will follow current DOE procedures which essentially means ceasing operations, decontaminating the facility, salvaging equipment, and decommissioning the reactor. Table 2-2 presents significant dates for the 100 N Area.

2.1.3 Facility Characteristics and Identification

The N Reactor is a graphite-moderated, light-water cooled, horizontal-pressure-tube nuclear reactor. The reactor piping was designed for 13,000 kPa (1,825 psi) and 320°C (600°F) maximum operating conditions. Normal operating parameters were 11,000 kPa (1,600 psi) and approximately 290°C (550°F). The reactor coolant circulating pumps are single-stage, horizontal, centrifugal pumps with high pressure water injection seals to prevent reactor coolant loss (WHC 1989a).

The N Reactor was designed for two modes of operation: production of special nuclear material only; and production of special nuclear material and production of byproduct steam used by the HGP to generate electricity (Figure 2-2). For special nuclear material production only, steam from the secondary side of ten steam generators was routed through 16 river water-cooled dump condensers. Condensate from the dump condensers was routed back to steam generators for regeneration. For dual-purpose operation, byproduct steam from the steam generators was supplied to the HGP to produce 860 MW (electrical) (WHC 1989a).

For either single- or dual-purpose operation, there were 12 steam generators. Ten of the steam generators were used during five-cell operation and eight for four-cell operation. During dual-purpose operation, most of the steam produced was available for use by HGP to generate electricity, with some reserved to power the reactor coolant system pump drive turbines and the in-plant turbine generator (WHC 1989a).

2.1.3.1 Confinement System. The N Reactor used a confinement system based on the concept to release the initial burst of steam resulting from a postulated reactor coolant pipe break. When the confinement pressure subsided, the steam vents were closed and ventilation valves opened. The ventilated steam was filtered through charcoal and high efficiency filters to prevent any release of fission products from fuel failure (WHC 1989a).

The 1312-N liquid effluent retention facility (LERF) was constructed as part of the safety enhancement program initiated in 1987. This facility served as a backup to the existing containment system and was designed to receive primary cooling water in the event of an emergency, such as fuel failure. The LERF facility consists of a high-density polyethylene (HDPE) bladder contained within a lined and berm impoundment. The facility has never been used.

2.1.3.2 Reactor Coolant System. The portion of the reactor coolant system (RCS) within the N Reactor building consists of 16 parallel lines that conducted cooling water from an inlet water manifold in the 109-N heat exchanger building to the reactor. Each of these 16 lines terminates in a vertical header to

which is attached 54 to 66 individual pressure tube header-to-inlet nozzle connectors. Similar outlet risers and parallel lines conducted the coolant from the pressure tube outlet nozzle-to-header connectors to an outlet water manifold (WHC 1989a). Figure 2-2 is a flow diagram showing the N Reactor coolant components.

In the 109-N heat exchanger building, which is immediately adjacent to the N Reactor building, the reactor coolant system consisted of six cells in parallel, each containing two steam generators (in parallel), a circulating pump and associated valves and instrumentation. Piping and steam generators in each of the six cells could be isolated from the main header piping by means of isolation valves (WHC 1989a).

Reactor coolant pressure and temperature were controlled to prevent boiling at any point in the system. A surge vessel (pressurizer) controlled system pressure and volume surges resulting from normal coolant density changes during reactor transient heat output conditions. The pressurizer consists of a cylindrical pressure vessel with a useful volume of about 34 m^3 (1,200 ft^3) and was connected directly to the reactor outlet piping. Two electric immersion heater systems maintained the pressurizer at saturation temperature and pressure retaining approximately 40% useful surge volume during normal operations. During outsurges of water from the pressurizer, the drop in pressure was compensated for by flashing steam from the saturated water. Increases in system pressure were limited by injecting a water spray into the steam space to condense some of the steam. This spray was reactor coolant fed from either reactor inlet water or from the high pressure injection pumps (WHC 1989a).

2.1.3.3 Nuclear Fuel System. The fuel used for operation of the N Reactor was slightly enriched uranium-235 (0.94% to 1.25%), clad with a zirconium alloy. At shutdown, a concentric tube-in-tube fuel design was in use. In the past, other materials have been used as a target in connection with an enriched uranium driver fuel element to produce useable isotopes such as tritium and plutonium-238. The fuel cladding is zircaloy-2 metallurgically bonded to the uranium by a co-extrusion process. The fuel elements used in N Reactor were manufactured by United Nuclear Corporation and ranged from 38 to 66 cm (15 to 26 in) in length (WHC 1989a).

2.1.3.4 Heat Dissipation System. The secondary steam system for the N Reactor removed the reactor heat from the reactor coolant system by boiling secondary water in the shell side of the steam generator. During operation solely for the production of special nuclear material the major fraction of this steam was routed to 16 dump condensers which were arranged in parallel and cooled by untreated Columbia River water. These condensers operated at a pressure near that of the steam generators and eliminated the need for steam pressure reducing stations. Condensate was pumped from the dump condensers back to the steam generators for recycling. To achieve maximum single purpose production operation, the steam temperature and pressures were maintained as low as practicable. A portion of the steam generated was utilized by the coolant pump drive turbines and by the turbine generator for local station service (WHC 1989a).

During dual purpose operation, the major fraction of steam generated was routed to the HGP (Figure 2-2). A portion of the steam generated was used to drive the reactor coolant pumps, the onsite turbine generator and to keep the dump condensers warm so they were ready to accept full steam load in the event of an HGP turbine generator shutdown (WHC 1989a).

2.1.3.5 Water Supply System. Strained untreated water from the Columbia River was supplied as coolant to the dump condensers as well as the reactor coolant pump drive turbine surface condensers and the local turbine generator condensers. This condenser cooling water was then returned to the river. Untreated water was also supplied to the water treatment facility for the filtered water, sanitary water, and demineralized water systems. The total untreated water system was supplied by four pumps each having a

capacity of 400,000 L/min (105,000 gal/min). Water was supplied from the 181-N river pumphouse to points of process use through two separate headers (WHC 1989a).

The 183-N filtration plant supplied the filtered and potable water needs of the 100 N Area. Filtered water was used for producing demineralized water. Raw water from the Columbia River was treated with chlorine gas (a biocide) and alum (a coagulant) in a mixing tank. From there, it was piped to a coagulator, where a polyelectrolyte was added as a coagulation aid, and then piped to the sand filters where filtration took place. The filtered water was then pumped to the 3,200,000 L (850,000 gal) filtered water storage tank from a clear well south of the 163-N facility (Tuck 1990). This tank supplied: horizontal control rod backup cooling; fuel element storage basin cooling and cleanup; area service water; potable water system; and, demineralization plant influent (WHC 1989a). The filter backwash was discharged to the 130-N-1 filter backwash pond (see Figure 2-3).

The 163-N plant produced high quality, demineralized makeup water from filtered river water for the major coolant systems of the N Reactor. Demineralized water was used to prevent mineral deposits that would foul piping systems and limit the generation of radioactive waste through neutron activation of dissolved and suspended matter. Demineralized water has virtually all dissolved and suspended matter removed by ion exchange (Tuck 1990). The 163-N demineralization system is no longer in operation.

Drinking, heating and ventilation cooling and fire protection supply water is currently imported from 100 B and 100 D Areas via pipeline. Imported water is chlorinated and then filtered through the 183-N sand filters. The 183-N filter is backwashed weekly, with the backwashed material routed to the 130-N-1 filter backwash pond.

Raw process cooling water is currently supplied by a portable pump located in the 181-N pumphouse. This water is not treated or filtered prior to use and is returned directly to the river via Outfall 009 after use.

The physical layout of the 163-N facility is presented in Figure 2-4. The 163-N facility contains demineralization equipment, including ion exchange units, regeneration tanks, treatment tanks (for pH adjustment) that are part of the elementary neutralization unit (ENU), acid and caustic storage tanks, a heater, and a degasifier (Tuck 1990). The basic components of the plant and the demineralization process are described in the following paragraphs.

2.1.3.5.1 Primary Cation Exchange Units. There are four primary cation exchange units, which are the top portions of four large tanks (or ion exchange columns) in the 163-N facility. They contained ion exchange resins saturated with hydrogen ions to displace cation impurities (e.g., calcium, sodium, manganese, and iron) in the water. At the same time, the displaced cations accumulated on the resins and the resins eventually become "exhausted," losing their capacity to absorb more cations. When this occurred, the resins were sent to a regeneration tank, where they were saturated with hydrogen ions while the cation impurities were being removed (Tuck 1990).

2.1.3.5.2 Primary Anion Exchange Units. There are four primary anion exchange units, which are the bottom sections of the tanks that contain the primary cation exchange units. These primary anion units contain ion exchange resins saturated with hydroxide ions. The hydroxide ions displaced anion impurities (e.g., chlorides, fluorides, and sulfates) in the water. The resins eventually become exhausted in the process and required regeneration (Tuck 1990).

2.1.3.5.3 Degasifier. Also referred to as the deaerator, this device used heat and vacuum to remove noncondensable gases (e.g., nitrogen, and oxygen) from the cation effluent water. The degasifier has two

vacuum systems: a steam jet air ejector system that used medium pressure steam to create a vacuum; and, a system that consists of three vacuum pumps (Tuck 1990).

2.1.3.5.4 Heater. Also referred to as the heat exchanger, this device used medium-pressure steam to warm up the water after it exits the primary cation units. The water was heated to reduce the solubility of gases and make the degasifier more efficient (Tuck 1990).

2.1.3.5.5 Booster Pumps. There are four booster pumps, each rated at 2,300 L/min (600 gal/min), used to increase the water pressure after it exits the degasifier (Tuck 1990).

2.1.3.5.6 Secondary Cation and Anion Exchange Units. There are four secondary cation units and four secondary anion units. These units are in four tanks in the top and bottom sections, respectively, in a manner similar to the primary units. The secondary units contained the same ion exchange resins as the primary units. Their purpose was to remove any impurities remaining in the water following treatment in the primary units. Because the water treated in the secondary units has already been largely deionized in the primary units, the resins in the secondary units were exhausted and required regeneration less frequently (Tuck 1990).

2.1.3.5.7 Resin Trap. The resin trap removed any resins that may have escaped from the cation and anion exchange units, and prevented the resins from entering the 163-N facility wastewater. The resin trap is a series of screens through which the demineralized water flowed (Tuck 1990).

2.1.3.5.8 Demineralized Water Storage Tank. This tank stored water from the 163-N facility before the water was used at N Reactor. It is a 3.8 million-L (1 million-gal) capacity tank, located along with other water storage tanks southwest of the 163-N facility (Tuck 1990).

2.1.3.5.9 Regeneration Tanks. These were used to regenerate the cation and anion exchange resins when they became exhausted. There are four regeneration tanks. The regeneration tank for the primary cation units and the regeneration tank for the primary anion units each have an upper compartment where regeneration occurred, and a lower compartment where a spare resin charge was stored. The spare resin was sent to the primary units at the same time as the depleted resin charge was sent to the regeneration tank, allowing near-continuous operation of the primary units (Tuck 1990).

A sulfuric acid solution was used to regenerate cation resins, and a sodium hydroxide solution was used to regenerate the anion resins. The solutions were pumped through the resins in the regeneration tanks and drained to the spent regenerant surge tank (Tuck 1990).

2.1.3.5.10 Acid and Caustic Storage Tanks. Located along the west inside wall of the 163-N facility, acid and caustic storage tanks contained solutions of sulfuric acid (H_2SO_4, 93% by weight) and sodium hydroxide (NaOH, 50% by weight), respectively. These solutions were used to regenerate the resins and to neutralize the spent regenerant (i.e., the wastewater from regeneration). The storage tanks are surrounded by curbs for spill control. The storage tanks were filled, as needed, through below-grade pipelines that run through concrete trenches from larger tanks located at the 108-N chemical unloading facility east of 163-N (Tuck 1990).

2.1.3.5.11 Spent Regenerant Surge Tank. The spent regenerant surge tank is located outside the 163-N facility on its north side. It was designed to store spent regenerant until it was neutralized in the ENU. During normal operation, the surge tank discharged to the ENU system where the effluent stream was then neutralized and discharged to the 120-N-1 percolation pond (Tuck 1990).

An alternate mode of operation allowed the waste stream to be neutralized in the surge tanks by recirculation and pH adjustment. Upon reaching proper pH, the liquid was sent to the 120-N-1 percolation pond by a 20-cm (8 in) chemical waste pipeline. Analyses have confirmed that after neutralization the effluent stream no longer exhibited the dangerous waste characteristic of corrosivity. The surge tank is surrounded by a concrete berm capable of containing the entire volume of the tank in the event of a spill (Tuck 1990).

2.1.3.5.12 Elementary Neutralization Unit. The ENU includes three upright tanks adjacent to the acid and caustic storage tanks inside 163-N building. Spent regenerant was piped from the surge tank to the ENU. After adding the proper amount of acid or caustic solution, the tank contents were mechanically agitated to ensure mixing and pH neutralization. Neutralized spent regenerant was discharged from the ENU to 120-N-1 when its pH was within the 6.0 to 9.0 range. Spent regenerant having a pH outside this range was piped back to the surge tank until it received additional treatment in the ENU. The ENU is surrounded by a curb for spill control (Tuck 1990).

2.1.3.6 Emergency Cooling System. The emergency cooling system (ECS), an engineered safety system, provided a separate independent water system for once-through cooling of the reactor. Three diesel-driven high-lift pumps were provided to deliver the cooling water to the bottom of the inlet risers where it entered the reactor coolant system through check valves when the system pressure fell below approximately 2,000 kPa (300 psi). The high-lift pumps were initially supplied by treated water from the demineralized water storage tank which was maintained with a minimum of 1,700,000 L (452,000 gal) for ECS use only. If this supply were depleted, untreated river water was automatically supplied from two diesel-driven pumps located in a separate section of the river pumphouse (WHC 1989a).

A similar diesel driven pumping system provided emergency once-through coolant to the graphite moderator and shields. This coolant provided backup to the ECS in the event of long-term failure of the ECS (WHC 1989a).

Both ECSs were intended for use only if the normal circulating water heat removal systems were disabled. Activation of the ECSs would be triggered by loss of all normal pumping power caused by a major break in the reactor cooling system which resulted in reactor coolant system depressurization (WHC 1989a).

2.1.3.7 Decontamination. Facilities were provided for chemical decontamination of the entire reactor coolant system or for any of several major portions of the system, including the individual heat exchanger cells. The graphite and shield cooling system could also be chemically decontaminated. Included were equipment for storage and preparation of the necessary chemicals and piping for injection at appropriate points. Chemical wastes from decontamination, along with rinse waters, were normally routed to the 116-N-2 storage tank, then shipped by tank truck or rail car to the 200 Area of the Hanford Site for disposal (WHC 1989a).

2.1.3.8 Plant Service Boilers. During reactor shutdowns, startup, or during periods when offsite power was not available, the onsite plant service boilers provided steam for the reactor coolant pump drive turbines and for the onsite turbine generators to supply power (WHC 1989a).

These facilities consist of one boiler housed in the 184-N plant service powerhouse and two boilers housed in the 184-N building annex. During reactor operation, the boilers were maintained in a condition capable of being brought on line to carry the shutdown load. These boilers can supply the approximately 150,000 kg (340,000 lb) of steam per hour required following a reactor shutdown and during reactor startup periods (WHC 1989a).

Fuel for the boilers was piped from the 166-N tank farm to the 184-N day tanks, located north of the 184-N building. There are two 130,000-L (35,000 gal) No. 6 fuel oil tanks and one 30,000-L (8,000 gal) No. 2 diesel oil tank which provide fuel to the boilers. Underground piping connects the 166-N tank farm, the 184-N day tanks, and the 184-N boilers. All of these tanks are currently empty.

2.1.3.9 Diesel Fuel Storage and Transfer System. The diesel fuel oil transfer and storage system supplied diesel oil to the seven ECSs and fog spray diesel engines, the 182-N high lift pumphouse, the diesel fire pump, and the diesel driven electrical generator located in the 182-N building. The 105-N lift station sump pump diesel engine had an independent underground storage tank. The total storage capacity of the diesel oil storage system is 1,800,000 L (465,700 gal) consisting of four 400,000 L (105,000 gal) bulk storage tanks and five day tanks (three 60,000 L [15,000 gal] and two 1,400 L [360 gal]). The unloading station for the four diesel bulk storage tanks is located northeast of the 166-N building adjacent to the north berm which surrounds the diesel storage tanks in the 166-N tank farm (WHC 1989b).

2.1.3.10 Boiler Fuel Oil System. The boiler fuel oil system supplied No. 6 fuel oil to the plant service boilers. The total capacity of the system is 5,500,000 L (1,445,000 gal). The single bulk storage tank volume is 5,200,000 L (1,375,000 gal); each of two day tanks contain 130,000 L (35,000 gal) of fuel oil. The unloading station for the bulk fuel oil storage tank is located west of the 166-N building adjacent to the diesel oil system unloading station. This unloading system is a concrete trench containing six tank car connections and four tank truck connections (WHC 1989a).

2.1.3.11 Hanford Generating Plant. The HGP is located within the geographical area of the 100-NR-1 Operable Unit and received steam via the steam piping system from the N Reactor. The HGP consists of two 430 MW (electrical) low pressure turbine generator systems in building 185-N (see Figure 2-1), with associated auxiliary equipment normally found in a steam power station. A transformer yard is along the northwest side of the 185-N building. The HGP is operated by the SS. The HGP office building, badgehouse, and boat storage building, buildings 1703-N, and 1701-NE, 1707-N are also shown on Figure 2-1, but tile field, septic tanks, and percolation pond are not. The HGP maintenance garage is shown to be about 80 m north of the 1703-N building, but the garage is not numbered on Figure 2-1. The HGP condensers and auxiliary cooling systems were supplied by raw water pumped from the Columbia River and discharged back to the river at the 1908-NE outfall approximately 90 m (300 ft) upstream from the N Reactor raw water intake structure (Figure 2-1).

2.1.3.12 Bonneville Power Administration Substation. The BPA Hanford switching substation was built in 1968 to supply electrical power produced by the HGP to the SS's main electrical grid. The substation consists of a switch yard and control house on approximately 0.1 km^2 (30 acres). The control house contains the communication equipment by which the substation is remotely run, and is also used to store maintenance equipment.

2.1.4 Waste Generating Processes

Radioactive and dangerous effluents and wastes were generated in various processes which supported the N Reactor. In some cases, effluent and waste streams were considered both dangerous and radioactive and referred to as mixed wastes. The main effluent and waste generating processes are discussed in the following sections which are divided into radioactive (and/or mixed) and dangerous effluent and waste generating processes. The waste streams are summarized in Table 2-3.

2.1.4.1 Radioactive Effluents and Wastes. Radioactive effluents and wastes were generated in a variety of process systems. These radioactive wastes include reactor primary coolant water, spent fuel storage basin cooling water, reactor periphery systems cooling water, reactor primary coolant loop decontamination and rinse solution, and miscellaneous drainage from reactor support facilities (WHC 1987a).

Primarily, radioactive effluents and wastes were generated within the 105-N reactor building and the 109-N heat transfer building. The radioactive process effluent and waste streams ultimately were sent to either the 116-N-1 crib and trench, the 116-N-3 crib and trench, or the 1314-N liquid waste loadout station (LWLS).

2.1.4.1.1 Reactor Primary Coolant System. The reactor primary coolant system was supplied by demineralized water from the 163-N demineralization plant with chemicals added for water quality control. The chemicals which were introduced into the primary coolant system were ammonium hydroxide and hydrazine. These chemicals were added for pH and oxygen control, respectively. Normal operation of the reactor primary coolant system resulted in approximately 760 L/min (200 gal/min) of bleed off and leakage which was discharged to the 116-N-1 and/or the 116-N-3 crib and trench via the 91-cm (36 in) radioactive drainline. Analysis of primary coolant wastewater in 1985 indicated that it did not exhibit any of the characteristics of a regulated dangerous waste (WHC 1987a).

2.1.4.1.2 Spent Fuel Storage Basin Cooling Water System. Until December 1984, essentially all of the strontium-90 and cesium-137 discharged to the 116-N-1 crib originated in the N Reactor spent fuel storage basin. The spent fuel storage basin operated in a single pass cooling mode from the time of initial N Reactor operation until a recirculation system was installed in December 1984.

The single pass cooling system operated on the basis that every six weeks, 20 to 30% of the N Reactor fuel elements were discharged to the spent fuel basin via a large tunnel-like canal located at the outlet face of the N Reactor. During this transfer process a large quantity of reactor primary cooling circuit water, containing considerable amount of suspended and soluble metals and metal oxides was added to the spent fuel storage basin. Excess basin water was routed to the 116-N-1 and/or 116-N-3 cribs by way of the basin overflow weirs and a 91-cm (36 in) drainline (WHC 1987a). Between reactor fuel element transfers, the spent fuel basin water level was maintained by the addition of treated water from the 183-N filtration plant.

Starting December 1984, the 107-N spent fuel storage basin cooling water recirculation system was operated. The 107-N basin recirculation facility treated the basin water supply by filtration and ion exchange. Acidic and caustic regeneration wastes were generated as a result of the ion exchange process. These mixed wastes were routed to the 190,000 L (50,000 gal) tank located in the basement of 107-N, where they were neutralized and then pumped to the 1314-N LWLS (Chien 1989).

2.1.4.1.3 Reactor Periphery Cooling Systems. Three reactor periphery cooling systems, the graphite and shield cooling system, the reactor control rod cooling system, and the reactor secondary coolant loop system, were closed systems using demineralized water from the 163-N demineralization plant. As with the primary coolant system, bleed off and spillage from the periphery cooling systems resulted in small continuous discharges to the 116-N-1 and/or 116-N-3 facilities. Periphery cooling water also had a variety of chemicals added, including, ammonium hydroxide and morpholine for pH control, and hydrazine for oxygen control.

2.1.4.1.4 Reactor Primary Coolant Loop Decontamination System. Approximately every 3 to 5 years, the reactor primary coolant loop was decontaminated with a 70% phosphoric acid/diethylthiourea solution diluted to an 8% solution by weight. This solution was mixed in the 109-N mix tank, then piped to the old RCS manifold in the N Reactor. From the manifold, the solution entered the primary piping through the V-3 valves. The decontamination solution removed the radioactive oxides (containing activation and fission products) that had built up as residues in the piping. The solution exited the primary coolant loop through the V-4 valves and was then routed to the 116-N-2 radioactive chemical waste treatment and storage facility tank (Chien 1989). Decontamination solution and subsequent rinseate was pumped into this tank. This volume was approximately 2,300,000 L (600,000 gal) of mixed waste. Another 380,000 L (100,000 gal) of rinseate was pumped through the primary cooling system and discharged to 116-N-1

and/or 116-N-3 (WHC 1987a). The acidic decontamination solution in the 116-N-2 storage tank was neutralized with sodium hydroxide to a pH greater than 7.0 and pumped to the 1314-N LWLS. Prior to 1987, the pH was required to be between 9.0 and 11.0. From the 116-N-2 tank the waste solution was sent to the 200 Area via rail tank car for disposal (Chien 1989).

2.1.4.1.5 Drainage from Reactor Support Facilities. The radioactive drain system is a network of floor drains which collected radioactive water from throughout the N Reactor building and 109-N building. In addition to pump leakage and system bleed off from reactor primary and periphery cooling systems, spills and waste streams may also have originated at several locations (WHC 1987a,b, Chien 1989), including:

- five wet laboratories which performed chemical analyses on cooling water - to 116-N-1 and/or 116-N-3
- auxiliary power battery lockers (potential spills) - to 116-N-1 and/or 116-N-3
- hydrazine mixing and injection area - to the Columbia River
- room 111 decontamination station - to 116-N-2
- room 307 decontamination station - to 116-N-2
- room 191 decontamination station - to 116-N-2.

2.1.4.2 Dangerous and Effluent Wastes. Dangerous and effluent wastes were generated as a result of three primary process systems: the reactor primary coolant loop decontamination system, the 107-N treatment and recirculation system, and the 163-N demineralization system (ICF Technology, Inc. and Ebasco Services, Inc. 1988). The reactor decontamination wastes and the 107-N treatment wastes were considered low level radioactive wastes. These wastes were neutralized prior to transport to the 200 Area disposal facilities and therefore they did not exhibit any dangerous waste characteristic. The 163-N demineralization plant and process system is discussed below.

2.1.4.2.1 Water Treatment and Demineralization Plants. The 163-N demineralization plant regeneration waste stream is shown in Figure 2-3. Before 1977, the nonneutralized spent regenerant was discharged from the 163-N facility to the Columbia River, as was common practice of industry at the time. The resulting dilution was relied on to mitigate the corrosive nature of this wastewater. Beginning in 1977, spent regenerant from the 163-N facility was discharged to the unlined 120-N-1 percolation pond. The alternate addition of acidic cation regenerant and alkaline anion regenerant served to neutralize the pH of the pond contents over time. In addition, the buffering capacity of the calcareous soil underlying the pond assisted the neutralization process. Waste from the 163-N facility was treated in situ at the 120-N-1 percolation pond by a combination of pH neutralization and eventual percolation or evaporation of the wastewater (Tuck 1990).

Since early 1986, the 120-N-1 percolation pond has received only neutralized wastewater because construction of the lined 120-N-2 surface impoundment in that year provided a means of neutralizing and mixing the spent regenerant (in batchwise fashion from successive regenerations) from the 163-N facility before discharging it to 120-N-1. The neutralization process involves treating individual batches with either sulfuric acid or sodium hydroxide, as appropriate. From 120-N-2, the neutralized wastewater was then piped to the 120-N-1 for disposal (Tuck 1990).

In November 1988, use of the 120-N-2 surface impoundment was discontinued when the newly-constructed ENU was put on line inside the 163-N facility. The ENU neutralizes the spent

regenerant before it is discharged to the 120-N-1 percolation pond, and does so with greater efficiency and operator control than was possible in the 120-N-2 facility (Tuck 1990).

2.1.5 Interaction With Other Operable Units

As shown in Figure 1-2, the 100-NR-1 Source Operable Unit is underlain by the 100-NR-2 Groundwater Operable Unit. The area is bordered on the north by the 100-HR-3 Groundwater Operable Unit and on the south by the 100-KR-4 Groundwater Operable Unit. The RFI/CMS activities at the 100-NR-1 and 100-NR-2 Operable Units are expected to proceed concurrently and to be coordinated with the N Reactor shutdown.

The activities to be performed at other Hanford Site operable units in the 100 Area will be integrated with the work at the 100 N Area. Other operable units for which work plans have been prepared include 100-BC-1, 100-BC-5, 100-DR-1, 100-HR-1, 100-HR-3, 100-KR-1, 100-KR-4, 100-FR-1, and 100-FR-3. Information gathered at one operable unit will be evaluated for relevance by investigators at other operable units and used where appropriate.

2.1.6 RCRA Facilities in the 100 N Area

This section discusses the regulatory and physical interactions between RCRA and CERCLA requirements in the 100-NR-1 Operable Unit. The general approach to integrating RCRA and CERCLA rules (including state requirements) is described in the Tri-Party Agreement Action Plan, and discussed in the introduction to this work plan.

2.1.6.1 RCRA Treatment, Storage and Disposal Units. The 100 N Area active or recently active TSD units which must be operated, permitted and/or closed in compliance with RCRA and the state dangerous waste program regulations identified in Appendix B of the Tri-Party Agreement Action Plan within the 100-NR-1 Operable Unit are listed below.

WIDS No.	TSD Unit	See Section
116-N-1	1301-N crib and trench	3.1.1.4
116-N-3	1325-N crib and trench	3.1.1.6
120-N-1	1324-NA percolation pond	3.1.1.20.1
120-N-2	1324-N neutralization pond	3.1.1.20.3

Potential TSD units in the reactor area are not specifically identified in the Action Plan. However, an assessment of all N Reactor facilities' compliance with RCRA and the state dangerous waste interim status requirements was required in Milestone M-21-00 (Appendix D of the Action Plan). This includes proper categorization of waste management units.

The 100 N Area TSD units historically received hazardous or dangerous wastes, but are either out of service, are receiving significantly reduced discharges or have ceased receipt of such wastes, and are expected to be closed in accordance with the state dangerous waste program as specified in WAC 173-303-610. Closure plans have already been prepared for these units, and were scheduled for rewriting and resubmittal to Ecology in 1994 under Milestones M-20-31 and M-20-35. The revision and resubmittal of these closure plans under Milestones M-20-31 and M-20-35 has been canceled by the June 30, 1994 Change Number M-15-94-04 to the Tri-Party Agreement dated January 25, 1994 (Ecology et al. 1994c).

The sampling and analysis plans developed for the closure plans have been consulted in preparation of the 100-NR-1 and 100-NR-2 Operable Unit work plans. Data produced during implementation of the RFI/CMS work plans will be used to support the closure plan/CMS for the 116-N-1 and 116-N-3 (1301-N and 1325-N facilities), and the 100-NR-1 and 100-NR-2 CMS, which will address 120-N-1 and 120-N-2 (1324-N and 1324-NA facilities). Approval of the Closure Plan/CMS for the 116-N-1 and 116-N-3 (1301-N and 1325-N facilities) and the 100-NR-1 and 100-NR-2 CMS by Ecology will constitute closure plan approval for 116-N-1, 116-N-3, 120-N-1, and 120-N-2 (1301-N, 1325-N, 1324-N, and 1324-NA facilities). Post-closure permit applications may be required if dangerous wastes are left in place (closure as landfills). These procedures are consistent with the Tri-Party Agreement Action Plan.

Resource Conservation and Recovery Act interim status groundwater monitoring programs have been implemented for each of these TSD units. These programs have provided boring logs, groundwater elevations and sample analyses in the vicinity of the four TSD units. Resource Conservation and Recovery Act groundwater assessment programs have been required for the 120-N-2 surface impoundment, the 120-N-1 percolation pond and 116-N-1 crib and trench because one monitoring parameter (specific conductance) was inconsistent with upgradient wells (Bates 1989, Hartman 1990).

The assessment programs have involved analysis for several lists of constituents, including the full list of WAC 173-303-9905 constituents, as well as shorter lists of indicator parameters. The assessment report (Hartman 1990) was reviewed during development of this work plan. The assessment report determined that the effluents discharged to the 116-N-1 crib and trench did not exhibit any of the characteristics of a dangerous waste and are not designated dangerous wastes listed in the WAC 173-303. No listed hazardous wastes were present in the effluent stream from 120-N-1 and 120-N-2 but the effluent is designated as hazardous waste since it exhibited the characteristic of corrosivity.

The Hanford Liquid Effluent Study (WHC 1990a) also looked at the effluents discharged to 120-N-1, 120-N-2, and 116-N-3. At 120-N-1 and 120-N-2 several constituents exceeded the study guidelines, including sodium and sulfate. The study concludes that due to termination of discharge of the 163-N demineralizer wastewater and the reduced volume input, little if any future impact from this facility is expected. Discharge to 116-N-3 crib and trench also exceeded the guidelines of the study, but no significant additional impact on soil and groundwater quality is likely under the current operating mode due to the greatly reduced discharge to the crib (WHC 1990a).

2.1.6.2 Other RCRA Waste Management Units. Other 100 N Area locations where containerized dangerous or mixed wastes have been temporarily stored (< 90 days), or waste management tanks in which elementary neutralization of corrosive dangerous wastes has been conducted in accordance with WAC 173-303, are not subject to closure plan requirements. The 116-N-8 mixed waste storage area and the 120-N-4 nonhazardous and nonradioactive waste storage pad are considered major temporary storage areas. The 107-N recirculation tank, the 116-N-2 radioactive chemical waste treatment and storage facility, and the 163-N demineralization plant ENU, may be considered elementary neutralization units. These units and locations were reviewed during development of this work plan to determine if releases have occurred or may have occurred, in accordance with CERCLA and RCRA guidance.

2.1.6.3 RCRA Past-Practice Units. Under the terms of the Tri-Party Agreement, all other "past-practice" units in the 100 N Area are to be addressed under RCRA corrective action authority, and are therefore classified as RCRA past-practice units. The RCRA past-practice classification includes sites where releases of hazardous, dangerous (including state-listed only) or mixed wastes, or CERCLA hazardous substances (including radioactive only) have occurred or may have occurred, without regard to the date of the release.

2.2 PHYSICAL SETTING

2.2.1 Topography

The topography of the 100 N Area has elevations ranging from approximately 120 m (390 ft) amsl at the Columbia River to approximately 140 m (460 ft) amsl on the east side of the area (Figure 2-5). Some of the area has been reworked as part of construction of the reactor building and related facilities and is relatively flat with an elevation approximating 137 m (450 ft) amsl. The slope along the riverbank is steep with gradients of at least 15%. The surrounding terrain is hummocky, perhaps as a result of catastrophic flooding associated with Pleistocene glaciation.

2.2.2 Geology

2.2.2.1 Regional Geology. The Hanford Site is located in the Pasco Basin, a subsection of the Columbia-Snake River Plateau physiographic province (Hunt 1974). This section summarizes the structural and stratigraphic characteristics of the Hanford Site.

2.2.2.1.1 Structural Geology. The Pasco Basin is bordered on the north by Saddle Mountain, on the west by the Umtanum Ridge, Yakima Ridge, and the Rattlesnake Hills, on the south by a series of doubly plunging anticlines which merge with the Horse Heaven Hills, and on the east by a broad monocline locally known as the Jackass Mountain Monocline (WHC 1987b). Structural features of the Pasco Basin are shown in Figure 2-6.

The Hanford Site itself lies within a structural sequence of anticlines and synclines known as the Yakima Fold Belt. No major faults are known to exist within the site area, and the region is presently tectonically stable. The last orogenic activity in the area occurred during the late Miocene and early Pliocene epochs of the Tertiary period (WHC 1987b). The Wahluke Syncline is the closest structural feature to the 100 N Area, which trends east-west through the Hanford Site. The basalt surface beneath the area dips generally to the north from Gable Mountain towards the synclinal axis (Myers et al. 1979).

2.2.2.1.2 Stratigraphy. The stratigraphy underlying the Pasco Basin is divided into six major units: the basement rocks, the Columbia River Basalt Group, the Ellensburg Formation, the Ringold Formation, the early "Palouse" soil, and the Hanford formation. Alluvium, colluvium and eolian sediments locally veneer the surface of the Pasco Basin (WHC 1987b). The stratigraphic column for the Hanford Site is presented in Figure 2-7. The six principal lithologic units are described in the following sections.

Basement Rocks. Basement rocks that underlie the basaltic flows at the Hanford Site are of uncertain composition. Along the margin of the Pasco Basin, basement rock is composed of sandstones and shales. Magnetelluric surveys indicate that these sediments may also comprise basement rock at the Hanford Site. Granitic rock often occurs below these sediments in areas outside of the Pasco Basin, and could also occur below these sediments at the Hanford Site (WHC 1987b).

Columbia River Basalt Group. Overlying the basement rocks are tholeiitic flood basalts which are collectively referred to as the Columbia River Basalt Group. The majority of the basalts were deposited during a series of volcanic pulses between 13 and 16 million years ago. These basalts encompass an area of over 103,700 km^2 (40,000 mi^2) and are more than 3,000 m (10,000 ft) thick in the Pasco Basin. In the Pasco Basin, older Oligocene to Eocene-age basalts may also occur below the Columbia River Basalt and approximately 100 basalt flows (including the Columbia River Basalt Group and older lavas) have been identified along the western margin of the basin. The Columbia River Basalt Group is subdivided into five formations: the Imnaha Basalt, the Picture Gorge Basalt, the Grande Ronde Basalt, the Wanapum Basalt

and the Saddle Mountains Basalt. The last three basalts comprise the Yakima Basalt Subgroup (WHC 1987b).

Ellensburg Formation. Sedimentary rock units occur between basalt flows of the Yakima Basalt Group, and collectively comprise the Ellensburg Formation. These interbeds are composed of tuffaceous claystones and siltstones, with occasional sands and coarser-grained material. The sedimentary units are fluvial in nature and were deposited in association with paleochannels and related facies of the ancestral Columbia River. The ancestral Columbia River was located west of its present location and flowed in a southerly direction west of the 100 N Area through Gable Gap; as such, sedimentary interbeds between basalt flows are restricted to areas essentially west of the present Columbia River location (WHC 1987b).

Ringold Formation. The Ringold Formation occurs above the Columbia River Basalt, and consists of interbedded clays, silts, and sands that were deposited in response to a period of uplift and erosion that occurred near the end of and after basalt eruption ceased. These sediments were also deposited in association with fluvial systems. The Ringold Formation is up to 360 m (1,200 ft) thick in some areas of the Pasco Basin (WHC 1987b).

The Ringold Formation has been categorized into three type stratigraphic sections: Type I, Type II, and Type III (Tallman et al. 1981). The distribution of these section types is shown in Figure 2-8 and their descriptions are summarized on Figure 2-9. Ringold Section Type I consists of four textural units: basal Ringold unit, comprised of sand and gravel; lower Ringold unit comprised of clay, silt, and sand with minor gravel; middle Ringold unit comprised of sand and gravel (locally cemented); and upper Ringold unit, comprised of silt and fine sand. Section Type II consists of predominately silt, sand and clay with minor gravel lenses, and occurs north and east of Gable Mountain. Section Type III is comprised of coarser-grained gravels and sands as well as finer-grained material representative of talus, slope wash, and stream deposits associated with anticlinal ridges along the Pasco Basin margin (Tallman et al. 1981).

More recently, Lindsey and Gaylord (1990) and Lindsey (1991) have recognized five separate sand and gravel fluvial sequences in the lower Ringold, which are designated FSA, FSB, FSC, FSD1, and FSE. Each of these sequences is thought to be present beneath the 100 B/C Area, except sequence FSD1 (Figure 2-10). These sequences are typically separated by finer-grained overbank and lacustrine facies, except in the northeast portion of the Wahluke syncline, where the Ringold Formation is dominated by these overbank and lacustrine deposits. In particular, the lowermost sands and gravels of the FSA sequence are absent in the Wahluke syncline in the vicinity of the 100 D/DR, 100 H, and 100 F Areas (Figure 2-10), where a lower mud sequence overlies the basalt. If the FSB fluvial sequence underlies the 100 H Area, it is likely thin and interbedded with finer overbank deposits. The FSC sequence pinches out on the north limb of the Wahluke syncline and is absent north of 100 N and 100 H Areas, where the lateral equivalent units of the FSE sequence consist primarily of overbank deposits with minor intercalated fluvial sand (Lindsey 1991). These overbank deposits dominate the remainder of the Upper Ringold in this area as well.

Early "Palouse" Soil. Eolian silt and fine sand are present above the Ringold Formation west of the 100 N Area. However, this unit is not present in the 100 N Area due to either non-deposition or erosion (WHC 1987b). In other areas of the Hanford Site, the Pleistocene age Early Palouse Soil is up to 20 m (65 ft) thick (DOE 1988a).

Hanford Formation. The Hanford formation is composed of coarse sands and gravels as well as fine sands and silts. These sediments are essentially multiple flood deposits that were emplaced when the dams of Pleistocene glacial lakes failed, which caused flooding and associated deposition of glaciofluvial sediments. The coarser-grained sediments occur principally within the center of the Pasco Basin, and are high-energy (flood) deposits that are referred to as the Pasco Gravels. The finer sand and silt units, called

the Touchet Beds, are representative of low-energy sediment deposition (slackwater), and occur principally along the margins of the basin. Lateral facies variation within the gravels is apparent and can be attributed to changes in energy regimes and water levels that occurred during floods. The thickness of the Hanford formation is quite variable, and is thickest in the areas of paleochannel deposition (WHC 1987b).

Eolian Deposits. Loess and sand dunes occur at ground surface in the Pasco Basin. The deposits are essentially fine-grained sediments of the Hanford formation that have been entrained and then deposited by wind. The thickness of these wind-blown sediments varies from 0 to 274 m (0 to 30 ft) thick in the Pasco Basin (WHC 1987b).

2.2.2.2 Geology of the 100 N Area. While the deeper units described above are probably present below the 100 N Area, geologic data are available only for upper units of the stratigraphic column. Stratigraphic units known to be present in the 100 N Area consist of the Saddle Mountains Basalt, the Ringold Formation, and the Hanford formation. A site-specific conceptual geologic column for the 100 N Area is presented in Figure 2-11. Surficial eolian deposits are also reportedly present in the area (Golder Associates, Inc. 1988).

Logs from the installation of approximately 70 wells are available for characterization of the 100 N Area geology. The location of monitoring wells and the deeper borings is presented in Figure 2-12.

Data quality of geologic descriptions on boring logs is highly variable. The level of detail in the descriptions is dependant upon the drilling and sampling methods as well as the personnel logging the borehole. The majority of the shallow holes were drilled using cable tool and samples for lithologic descriptions were collected by bailing the holes. Additionally, geophysical logs are available for a number of borings, and were used to assess lithologic changes within the stratigraphic column. Some of the geologic logs, however, do not provide sufficient information to determine the location of the Hanford/Ringold contact.

The thickness of the sediments overlying the basalts is about 160 m (520 ft). The water table is up to 24 m (80 ft) below the ground surface. Discussions of geology in this section are limited to the unsaturated sediments.

2.2.2.2.1 Ringold Formation. The Ringold Formation unconformably overlies the Saddle Mountains Basalt in the 100 N Area. This formation is approximately 143 to 146 m (470 to 480 ft) thick in the area.

The Ringold unit 1 is composed of light-tan interbedded sands and gravels. This subunit exhibits a more felsic (quartzitic) composition than the underlying Ringold subunits. Lithologic logs indicate that a cemented horizon may be present in the upper portion of this unit. However, the lateral continuity of this zone is not apparent within the 100 N Area. The Ringold unit 1 is approximately 13 to 20 m (42 to 65 ft) thick in the 100 N Area and the top of the Ringold occurs at approximately 120 to 128 m (395 to 420 ft) amsl (approximately 15 m [50 ft] below ground surface). The majority of the wells in the 100 N Area are completed within the Ringold unit 1. As such, most lithologic information deals strictly with this gravelly zone and the overlying Hanford formation. Natural gamma logs taken within the upper portion of the Ringold unit 1 indicate that the top of the interval varies laterally from relatively "clean" gravels to silty gravels (Pratt 1985). Figure 2-13 shows the location of three cross sections for the 100 N Area. These cross sections are shown in Figures 2-14, 2-15 and 2-16 and illustrate the lateral and vertical lithologic variation that can be apparent within the Ringold unit 1 and Hanford formation.

Ringold unit 1 can be differentiated from the Hanford formation based on the composition of the sand. Ringold unit 1 has tan sands derived from primarily metamorphic rocks while the Hanford formation has

black sands derived primarily from basalt. In addition, the Ringold unit 1 is more compact than the Hanford formation.

2.2.2.2.2 Hanford Formation. The Hanford formation overlies the Ringold Formation, and is composed of interbedded sands, gravels and cobbles of the Pasco Gravels. The finer-grained Touchet beds are not present in this area. The unit is described as gravelly sand to sandy gravel that is poorly sorted and composed of rounded basaltic clasts. Caliche deposits are present in parts of the unit. Coarser-grained material such as cobbles appear to be present in the upper portions of the unit, with sandy gravels and gravelly sands downsection. Occasional cemented zones occur within the gravels, but lateral continuity of these intervals in the 100 N Area is questionable. The Pasco Gravels are approximately 18 m (60 ft) thick in the 100 N Area.

Natural gamma logs taken in wells 199-N-36 to 199-N-45 indicate an increase in counts per second at depths of 11 to 13 m (36 to 44 ft) (this corresponds to elevations of 126 to 128 m [414 to 420 ft] amsl). The increase in counts extends from 5 to 9 m (15 to 30 ft). Pratt (1985) stated that this increase was the result of a silt layer in the Hanford formation. Well 199-N-38 was reported to have a series of thin, silty layers interbedded with more sandy/gravelly layers, while well 199-N-42 was reported to have one thick silty unit. The well logs for these wells do not show any indication of silt, and only well 199-N-44 mentions the presence of clay which is located in the Ringold Formation at a depth of 18 m (60 ft). Another explanation for the increase in gamma counts could be an increase in contamination from gamma emitting radionuclides.

2.2.2.2.3 Surficial Deposits. Surficial eolian deposits locally overlie the Hanford formation in the 100 N Area. These deposits are typically heterogenous and poorly mixed, and were derived primarily from reworked Hanford formation sediments (WHC 1987b). Surficial materials also include backfill deposits created during site construction.

2.2.3 Hydrogeology

2.2.3.1 Regional Hydrogeology. Both confined and unconfined aquifers occur at the Hanford Site. The uppermost confined aquifers include the permeable units within the Ringold Formation, as well as the interflow contacts and sedimentary interbeds within the Saddle Mountains Basalt down to the Mabton Interbed of the Ellensburg Formation. The dense columnar portions of each basalt flow act as aquitards surrounding the higher-permeability interflow and interbed zones. The unconfined aquifer is located primarily in the sands and gravels of the Ringold Formation; however, the water table may extend up into the Hanford formation.

Before operations at Hanford began in 1944, the hydraulic gradient in all but the southwestern-most portion of the Hanford Site was about 1.5 m/km (5 ft/mi). Regional groundwater flow was roughly to the east-northeast (see Figure 2-17), although flow near the 100 N Area was more to the north. Effluent disposal at the Hanford site subsequently raised the water table in the recharge sites and altered the existing hydraulic gradients (see Figure 2-18). Regional groundwater flow directions have also been altered, with groundwater flow in the 100 N Area acquiring a more northwesterly component; flow from southern areas to the 100 N Area is also apparent. Local groundwater mounds existed at each reactor site along the Columbia River when ground discharge of effluent was occurring. A minor recharge mound exists under the 300 Area. In addition, there are mounds at the 200 Area as a result of liquid disposal ponds (WHC 1987c).

Recharge to and discharge from both the confined and unconfined aquifers occurs within the Pasco Basin (Gephart et al. 1979). Both recharge and discharge may occur in areas where the confined units are in hydrologic communication with the overlying unconfined aquifer. North of the 200 East Area, the

overlying basalts have been removed, placing the interbedded sedimentary units of the Ellensburg Formation in direct contact with the overlying unconfined aquifer. The vertical hydraulic gradient from the Ellensburg Formation to the unconfined aquifer is primarily slightly upward, implying that discharge from the confined system to the unconfined aquifer could occur. In the Gable Gap area, several basalt flows have been removed by erosion, allowing direct hydraulic communication between highly conductive sediments of the uppermost aquifer system and sedimentary interbeds below the Selah interbed.

Natural recharge to the unconfined aquifer occurs from infiltration of rainfall and runoff from the higher bordering elevations, as well as infiltration of water from small ephemeral streams. Recharge by Columbia River water during high river stage also occurs within portions of the aquifer adjacent to the river. Artificial recharge at the Hanford Site occurs primarily from the discharge of liquid waste in man-made surface impoundments and subsequent percolation into the subsurface (DOE 1988a). Unconfined groundwater flowing from these recharge areas ultimately discharges to the Columbia River.

Lysimeters have been used to acquire infiltration data for various locations at the Hanford Site. The infiltration rate and subsequent recharge to the unconfined aquifer varies widely based on the vegetation and soil type. Minimum recharge occurs where the soils are fine-textured and surfaces are vegetated with deep-rooted plants. Maximum recharge occurs where coarse soils or gravel exists at the surface and soils are kept bare. Observed recharge rates vary from 1 to 10 cm/yr (0.4 to 4 in/yr) or more (Gee 1987).

2.2.3.2 Hydrogeology of the 100 N Area. The conceptual hydrogeologic column for the 100 N Area is shown in Figure 2-11, which illustrates the correlation between hydrogeologic and geologic unit designations. The hydrogeologic designations for the 100 N Area were determined by examination of borehole logs and integration of these data with known regional conditions. Only the uppermost portion of the unconfined aquifer and the vadose zone are described in this work plan. The unconfined system consists essentially of the Hanford and Ringold 1 geologic units, and has been designated the Ringold/Hanford Producing Layer "A". The vadose zone is also located within the Ringold 1 and the Hanford geologic units.

2.2.3.2.1 Site Hydrologic Data. Since 1964, there have been seventy-four groundwater wells installed at the 100 N Area. Groups of wells were installed in the 1980s to evaluate the impact of the 116-N-3 crib and trench. Wells 199-N-16 through 199-N-26 were installed in 1981 as diesel oil detection wells. In 1987, four wells were installed around the 120-N-2 percolation pond and the 120-N-1 surface impoundment for RCRA monitoring.

2.2.3.2.2 Vadose Zone. The unsaturated sediments are in the Hanford formation and the upper portion of the Ringold unit 1 and range up to 24 m (80 ft) in thickness (Jensen 1987, Gilmore et al. 1989). The vadose zone has been reduced in thickness historically due to groundwater mounding. The vadose sediments consist of poorly sorted boulders, cobbles, gravel, sand and silt. The water content at depth in sediments at the Hanford Site is generally low, ranging from 2% to 7% in coarse and medium-grained soils and 7% to 15% in silts (Gee and Heller 1985). The presence of perched water was noted during drilling of well 199-N-35, but no other indication of perched water has been noted.

In a study by Pratt (1985), the percolation rate of water in soils around the 116-N-3 crib and trench was assessed. A percolation test was conducted to accomplish this, the results of which indicated that percolation rates in the area dropped "precipitously" during the first 100 h of testing, then decreased more slowly for the next 375 h. As the column became saturated, the "resistance to infiltration" increased, and after 476 h had dropped to 2.9 m/d (9.8 ft/d). Over the next 200 h the percolation rate increased to 3.9 m/d (13 ft/d). Based on this test, Pratt concluded that the long-term percolation rate in the soils was 2.9 m/d (9.8 ft/d). However, no information concerning unsaturated zone hydraulic conductivities, infiltration rates, etc. were provided.

To assist in the development of a groundwater flow and strontium-90 transport model of the 100 N Area liquid waste disposal facilities (116-N-1, 116-N-3, 120-N-1, and 120-N-2) samples were collected for laboratory analysis from 10 sites in the unsaturated zone downgradient from the disposal facilities (Connelly et al. 1991). From these analyses, the saturated hydraulic conductivity of the Hanford formation soils was estimated to range from 2.2 to 52 m/d (7 to 170 ft/d) with 20 m/d (66 ft/d) determined to be the most representative value. Effective porosities were estimated to range from 9% to 44% (Connelly et al. 1991).

2.2.3.2.3 Ringold/Hanford Producing Layer "A" Unconfined Aquifer. The Ringold/Hanford Producing Unit A is the unconfined aquifer and is located in the silt, sand, gravel and cobbles of Ringold unit 1 and in places, the bottom several centimeters of the Hanford formation. The silts and clays of Ringold unit 2a are thought to separate the unconfined aquifer from the underlying confined aquifers. The surface of the Ringold Formation may have channels or other erosional features which could result in preferred pathways through the higher permeability sediments of the Hanford formation.

2.2.3.2.4 Groundwater Flow. In the 100 N Area, the groundwater flow regime has been heavily influenced by artificial recharge and by river stage fluctuations. The recharge areas include the 116-N-1 crib and trench, the 120-N-1 percolation pond, the 120-N-2 surface impoundment, the 116-N-3 crib and trench and the 130-N-1 filter backwash discharge pond.

Discharge to the 116-N-1 crib and trench began in 1963 with reactor startup, and continued until 1985. The 116-N-1 facility has received as much as 9.8 million L/day (2.6 million gal/day) which resulted in formation of a significant groundwater mound beneath the unit. A search of water-level data in the Hanford Groundwater Data Base has indicated that water levels in the vicinity of 116-N-1 were highest in July 1965 (PNL 1991). These water-level data have been contoured and presented as Figure 2-19. The elevated water levels resulting from discharge to 116-N-1 were observed to be responsible for formation of numerous springs along the bank of the Columbia River (Crews and Tillson 1969). The location of these springs, also known as the "N Springs", are shown in Figure 2-20. Investigation and characterization of the N Springs will be conducted as part of the Surface Water/Sediment Investigation for the aggregate 100 Area, as described in the 100-NR-2 work plan, Appendix D, Aggregate Area Investigation of the 100 Area.

The 120-N-1 percolation pond and the north and south settling ponds began receiving effluent from the 163-N demineralization plant and 183-N filtered water plant in 1977. From 1977 to 1983, these facilities received approximately 1,700,000 L/day (450,000 gal/day) of effluent (Krug 1989). Mounding in the area is expected to have started at this time. However, groundwater monitoring wells were not installed in this area until 1987, so the presence of mounding cannot be confirmed.

In 1983, the north and south settling ponds stopped receiving effluents. Effluent continued to be discharged to the 120-N-1 percolation pond at a rate of 1,700,000 L/d (450,000 gal/d). From 1986 to 1989 discharge to 120-N-1 decreased to 1,600,000 L/d (430,000 gal/d). Approximately, 1,100,000 L/d (300,000 gal/d) of filter backwash was discharged to the 130-N-1 filter backwash discharge pond between 1983 and 1989 (Krug 1989).

Wells were installed in 1987 to monitor the groundwater elevations and chemistry in the area of the 120-N-1 and 120-N-2 ponds. The highest water-level elevations observed to date in the area occurred in June 1988. Water-level contours based on these data are presented as Figure 2-21. These water-level contours indicate mounding that is about 3 m (10 ft) higher than in areas to the northeast in June 1988.

The 116-N-3 crib and trench began intermittent operation in 1983, diverting some of the discharge from 116-N-1. In 1985, all of the discharge from the 116-N-1 delivery pipe was diverted to 116-N-3. The shift

to 116-N-3 resulted in the creation of a groundwater mound beneath the 116-N-3 crib and the formation of new springs further to the north and downstream along the river (Perkins 1990). The location of these springs are shown in Figure 2-20.

The discharge to the 116-N-3 facility has varied greatly since 1985, but has generally been decreasing. Average inflows were 4,680 L/min (1,237 gal/min) in 1986, 1,500 L/min (400 gal/min) in 1987, and 1,100 L/min (300 gal/min) in 1988 (Golder Associates Inc. 1990). Discharge to 116-N-3 crib was increased during 1989 to reach 5,700 to 7,600 L/min (1,500 to 2,000 gal/min), but was reduced in mid-1989 to an average of 1,320 L/min (350 gal/min). The current average rate is approximately 7.6 L/min (2 gpm).

The maximum mounding observed beneath 116-N-3 occurred in June 1989, with the water level at 126 m (412 ft) in well 199-N-27 as compared 119.6 m (392.5 ft) in May 1989. This mound is shown in Figure 2-22. These water-level data indicate that the hydraulic impact on the flow regime was extensive during this period.

After the disposal to 116-N-3 crib and trench was reduced in mid-1989 from 5,700 to 7,600 L/min (1,500 to 2,000 gal/min) to 1,320 L/min (350 gal/min), the mound was observed to dissipate rapidly. The dissipation was reported to occur at a rate of about 0.02 m/day (0.08 ft/day) between May 1989 and January 1990, but the reduced discharge continued to influence the groundwater flow in the 100 N Area (Gilmore et al. 1991). Discharge is scheduled to be discontinued in 1995. The water-table contours for the 100 N Area for May 1990 (Figure 2-23) show the continued decrease in the mounds for the 120-N-1, 120-N-2 and 116-N-3 facilities due to the reduced discharge to these units. This continued decrease can be seen in the recent water-table data for 1991. From these data, it is evident that the water table has returned to near the pre-operational levels (Gilmore et al. 1991).

Groundwater flow in the 100 N Area is also influenced by changes in the Columbia River stage since the aquifer is hydraulically connected to the river. The river stage routinely fluctuates as much as 2.1 m (7 ft) during a 24-h period due to releases from the Priest Rapids Dam (Section 2.2.4). These fluctuations in river stage have been observed to influence water levels in wells located close to the river. A study of the effect of the river on the unconfined aquifer evaluated 1990 water-level data (Gilmore et al. 1991). During this year, groundwater levels continued to decline as a result of decreased discharge to the 120-N-1, 120-N-2, and 116-N-3 facilities, but the rate of decline is decreasing and the water levels in the wells near the river are approaching the average river level. The short-term, daily river-level fluctuations correlate with water levels in wells as far inland as well 199-N-67 which is about 230 m (750 ft) from the river. The seasonal fluctuations correlated with water-level fluctuations in well 199-N-57 which is about 300 m (1,000 ft) from the river. In addition, during the high river stage, for a short period, the river level was higher than the water levels in the wells, indicating a temporary reversal of hydraulic gradient and the flow of river water into the unconfined aquifer.

2.2.4 Surface Water Hydrology

The only permanently flowing surface water at the 100 N Area is the Columbia River. The Columbia River is the largest river in the Pacific Northwest and the fifth largest river (by volume) in North America. Its flow is regulated by 11 dams within the United States: seven upstream and four downstream of the Hanford Site. The nearest upstream dam is the Priest Rapids Dam which is located approximately 27 river km (17 river miles) from the 100 N Area. The nearest downstream dam is the McNary Dam which is located approximately 142 river km (88 river miles) downstream from the 100 N Area. The Hanford Reach of the Columbia River is the only stretch of the Columbia River upstream of the Bonneville Dam not impounded a dam.

Although the Hanford Reach is free flowing, the flow rate is controlled by the discharge of upstream dams. Flows through this stretch fluctuate significantly because of the relatively small storage capacities and the operational practices of the nearby upstream dams. A minimum flow rate of 1,000 m^3/s (36,000 ft^3/s) has been established at Priest Rapids Dam. Typical daily flows during the summer, fall, and winter range from 1,000 to 7,100 m^3/s (36,000 to 250,000 ft^3/s). Flows up to 13,000 m^3/s (450,000 ft^3/s) are frequently recorded during periods of peak spring runoff. Average monthly flow rates generally peak from April through June, and the lowest monthly mean flows are observed during September and October (Ecker et al. 1983). Recent annual average flows at Priest Rapids Dam range from 2,800 to 3,400 m^3/s (100,000 to 120,000 ft^3/s). The long-term average annual flow at Priest Rapids Dam, based on 68 yr of record, is approximately 3,400 m^3/s (120,000 ft^3/s). During low flow periods, average monthly flows may be as low as 1,700 m^3/s (60,000 ft^3/s) (Ecker et al. 1983). Figure 2-24 depicts maximum, mean, and minimum monthly discharges from the Priest Rapids Dam between 1960 and 1977. Data that identify the stage of the Columbia River at the 100 N Area are available from measurements taken at the HGP.

Flow in the Columbia River near the N Reactor is relatively swift and straight. The Columbia riverbed at the 100 N Area varies in width from 430 to 490 m (1,400 to 1,600 ft). Surface current velocities range from 0.9 to 3.4 m/s (3 to 11 ft/s), depending on the flow rate of the Columbia River. Average water depths for normal flows range from 7.6 to 11 m (25 to 35 ft) in this reach of the river. Regulation of the Columbia River flow rate at Priest Rapids Dam results not only in large seasonal and monthly fluctuations in flow but also in large daily fluctuations in the vicinity of the N Reactor (Ecker et al. 1983).

Temperature in the Columbia River varies seasonally. Minimum temperatures normally occur in February and maximum temperatures occur in August. Upstream storage management at dams and flow rates also affect the thermal characteristics of the Columbia River in the vicinity of the N Reactor. The Hanford Reach of the Columbia River responds more rapidly to thermal modifications than do impounded reaches of the Columbia River. As a result, summer heating and winter cooling of the Columbia River in the Hanford Reach are rapid (Ecker et al. 1983).

Maximum Columbia River floods of historical record occurred in 1894 and 1948. Maximum flows during these floods were approximately 21,000 to 19,500 m^3/s (740,000 and 690,000 ft^3/s), respectively. Similar floods today would be of little consequence to the 100 N Area (Cushing 1989). Construction of several flood-control, water-storage and electric power-generation dams upstream of the Hanford Site since the 1948 flood has significantly reduced the likelihood of floods of this magnitude recurring (Cushing 1989). The probable maximum flood, a theoretical maximum flood resulting from the most severe combination of environmental and hydrologic conditions reasonably possible in the region, was calculated to produce a flow of approximately 40,000 m^3/s (1,400,000 ft^3/s). This flood is determined using conditions that result in maximum runoff, such as maximum precipitation falling on the drainage area and the upper limits of other hydrologic factors, including antecedent moisture conditions, snowmelt and tributary conditions. A flood of this magnitude would not be expected to inundate the 100 N Area (Cushing 1989). No well-defined drainage channels exist within the 100 N Area as a result of the relatively flat topography. The soils of the 100 N Area consist primarily of coarse sands, pebbles, cobbles, and boulders that are highly permeable. Typically, there are only two occurrences each year with precipitation of 1.3 cm (0.5 in) or more during a 24-h period (Stone et al. 1983), which may result in some local puddling. However, no runoff from the operable unit is expected during these events. Normal precipitation, 16 cm/yr (6.25 in/yr) (Stone et al. 1983), in combination with high evaporation and soil infiltration capacities, results in minimal surface runoff. Runoff is most likely to occur in the winter months when Chinook winds cause rapid snow melts.

2.2.5 Meteorology

The Hanford Site weather is monitored at the Hanford Meteorology Station and at other points situated through the reservation, including Station 13 of the Hanford Telemetry Network located at the 100 N Area. Unless otherwise indicated, summaries presented in these sections were extracted from DOE (1987a). The Cascade Mountains, to the west of the site, greatly affect the local climate. The Hanford Site is situated in the rainshadow of the Cascade Mountains.

2.2.5.1 Precipitation. The Hanford area receives an average of 16 cm (6.25 in) of precipitation annually. Precipitation falls mainly in the winter months, with almost half of the annual precipitation occurring between November and February. Rainfall during the months from July through September comprises only 10% of the annual precipitation (SS 1977).

Precipitation of 1.3 cm (0.5 in) or more within a 24-h period occurs only twice yearly on the average. Instances of 2.5 cm (1.00 in) or more precipitation within a 24-h period are rare: with only four occurred between 1946 and 1980 (SS 1977). One of these events was the record storm of October 1-2, 1957, when 4.8 cm (1.88 in) of rainfall occurred in 12 h (Cushing 1989).

Winter monthly average snowfall ranges from 13.5 cm (5.3 in) in January, to 0.8 cm (0.31 in) in March. The record snowfall of 62 cm (24.41 in) occurred in February 1916 (Stone et al. 1983). During the months of December through February, snowfall accounts for about 38% of all precipitation (Cushing 1989).

The average yearly relative humidity at the Hanford Site for the period 1946 to 1980 is 54.4%. Humidity is higher in winter than in summer. The monthly averages for the same period range from 32.2% for July to 80% in December. The lowest monthly average (21.9%) occurred in July 1959 and the highest monthly average (90.5%) occurred in December 1950 (Stone et al. 1983).

2.2.5.2 Winds. By serving as a source of cold air drainage, the Cascade Mountains have considerable effect on the wind regime at Hanford. This gravity drainage, plus topographic channelling, results in a northwest to west-northwest prevailing wind direction at the site (SS 1977). The average mean monthly speed for the period 1945 to 1980 is 12.4 km/h (7.7 mi/h), with monthly means ranging from 9.8 km/h (6.1 mi/h) in December to 14.8 km/h (9.2 mi/h) in June (Stone et al. 1983). Peak gust speeds range from 101 to 129 km/h (63 to 80 mi/h) and are generally southwest or west-southwest winds (Stone et al. 1983).

Figure 2-25 presents wind roses for the Hanford Telemetry Network. The Columbia River exerts a strong local channelling effect on the local wind regime. This channelling, along with the gravity drainage from the Cascades, produces a prevailing west-southwest wind at the 100 N Area. In addition, diurnal fluctuations in wind speeds are common during the summer months. In July, hourly average wind speeds range from a low of 8.4 km/h (5.2 mi/h) from 9 to 10 a.m. to a high of 21 km/h (13.0 mi/h) from 9 to 10 p.m. The diurnal fluctuation is less in the winter months, ranging from 8.8 km/h (5.5 mi/h) in the morning to 10 km/h (6.3 mi/h) in the evening (SS 1977).

2.2.5.3 Temperature. Hanford Site average monthly temperatures presented in this section were taken from Stone et al. (1983) for the period 1912 through 1980. During this period the average monthly temperature ranged from -1.5°C (29.3°F) in January to 24.7°C (76.4°F) in July. The lowest recorded monthly average winter temperature was -11.1°C (12.1°F) in January 1950, and the highest recorded monthly average winter temperature was 6.9°C (44.5°F) in February 1929. The highest recorded monthly average summer temperature was 27.7°C (81.8°F), which occurred during July 1963. The coolest summer month on record was in June 1953 at 17.2°C (63.0°F).

2.2.5.4 Evapotranspiration. Mean annual evapotranspiration for the Tri-Cities area immediately southeast of the Hanford Site has been estimated to be about 74 cm (29 in). The annual evapotranspiration rate under current conditions in the northern portion of the Hanford Site is estimated to be about 15.5 cm (6.1 in) (Bauer and Vaccaro 1990).

2.2.6 Environmental Resources

The Hanford Site is characterized as a cool desert or a shrub-steppe and supports a biological community typical to this environment.

2.2.6.1 Flora and Fauna. Over 240 species of plants have been identified on the Hanford Site (Cushing 1989). Near the 100 areas, cheatgrass and riparian plants are the most prevalent. Plants likely to be present at the 100 N Area include: the gray rabbitbrush (*Chrysothamnus nauseosus*); cheatgrass (*Bromus tectorum*); tumbleweed (*Salsola kali*); yarrow (*Achillea millefolium*); yellow salsify (*Tragopogon dubius*); false yarrow (*Chaenactis douglasii*); and tumble mustard (*Sisymbrium altissimum*) (Cushing 1989).

More than 300 species of terrestrial and aquatic insects have been found on the Hanford Site (Cushing 1989). Specific insects likely to be found in fresh water in the 100 N Area include: water striders (*Gerridae*); backswimmers (*Notonectidae*); water boatman (*corixidae*); and diving beetles (*Dytiscidae*). Seasonal inhabitants would include larvae of the cadisfly (*Trichoptena*); mosquito (*culicidae*), and manfly (*Ephemeroptera*) (Jacques 1985).

Approximately 16 species of amphibians and reptile have been observed on the Hanford Site. The side-blotched lizard is the most abundant reptile. Toads (family: *Bufonidae*) and frogs (family: *Ranidae*) are found along the Columbia River (Cushing 1989).

Over 125 species of birds have been identified on the Hanford Site, the horned lark and western meadowlark are the most abundant nesting birds. Wastewater ponds at the Hanford Site are important habitats for songbirds, shore birds, ducks, and geese. The most abundant nesting bird at these sites is the American coot. Waterfowl frequently use the ponds during fall migration. The resident waterfowl include the Canada goose, whose nesting habitat is the islands in the Columbia River. The Hanford Site is located in the Pacific Flyway (Cushing 1989). Birds identified at the 100 N Area include swallows and robins (Jacques 1985).

Of the approximately 30 species of mammals that have been identified on the Hanford Site, most are small and nocturnal. Muskrats and porcupines have been observed along the shorelines of the ponds and ditches, and beavers are resident in the sloughs along the Columbia River. Mule deer are found mostly along the Columbia River and in the Rattlesnake Hills (Cushing 1989).

Two types of natural aquatic habitats are present at 100 N Area, the Columbia River and the artificial water bodies. The Columbia River supports a large diverse community of planktonic and benthic invertebrates, fish, and other communities (Cushing 1989).

Characteristic endemic groups of plankton generally have insufficient time to develop in the Hanford Reach. Phytoplankton and periphyton are abundant in the Columbia River. Phytoplankton and zooplankton populations in the river are largely transient, flowing from one area to another (Cushing 1989).

Forty-four species of fish have been identified in the Hanford Reach of the Columbia River. The chinook salmon (*Oncorhynchus tshawytscha*), sockeye salmon (*Oncorhynchus nerka*), coho salmon (*Oncorhynchus kisutch*), and steelhead trout (*Salmo gairdneri*) use the river as a migration route to and from upstream

spawning areas. The fall chinook salmon and the steelhead trout also spawn in the Hanford Reach (Cushing 1989).

2.2.6.1.1 Threatened and Endangered Species. Table 2-4 includes state-designated endangered and threatened fauna and flora that could potentially occur at the Hanford Site. State designations are as strict as or stricter than federal designations. There are no plants on the federal list of *Endangered and Threatened Wildlife and Plants* that are known to occur on the Hanford Site.

There are two species of plants found at the Hanford Site that are identified on the State of Washington list of threatened or endangered species. These are the Columbia milk-vetch (*Astragalus Columbianus Barneby*), listed as threatened, and persistentsepal yellowcress (*Rorippa columbiae Suksd*), designated endangered. Columbia milk-vetch occurs on dry land benches of the Columbia River in the Priest Rapids Dam, Midway, and Vernita vicinity. Persistentsepal yellowcress occurs in the wetted zone of the water's edge along the Columbia River (Cushing 1989). Both species may exist along the 100 N Area shore, but neither have been specifically identified.

The federal government lists the American peregrine falcon (*Falco peregrinus anatum*) as endangered and the bald eagle (*Haliaeetus leucocephalus*) as threatened. The State of Washington list includes these two birds and also identifies the white pelican (*Pelecanus erythrorhynchos*) and sandhill crane (*Grus canadensis*) as endangered, and the ferruginous hawk (*Buteo regalis*) as threatened. The peregrine falcon does not nest at the Hanford Site but is a casual migrant. The bald eagle is a regular winter resident in areas where it forages on dead salmon and waterfowl along the Columbia River. State of Washington Bald Eagle Protection Rules were issued in 1986 (WAC 232-12-292) pursuant to which DOE will prepare a management plan to mitigate eagle disturbance (Cushing 1989). The frequency of these birds visiting the 100 N Area is unpredictable, but they visit the Hanford Site between October and March.

The pygmy rabbit (*Sylvilagus idahoensis*), identified as threatened, is the only mammal species listed as endangered or threatened having the potential to occur on the Hanford Site.

2.2.6.1.2 Critical Habitats. It is not known if bald eagles or ferruginous hawks roost or forage in the 100 N Area. If roost trees or forage areas for these birds do exist on site, then such areas would be critical habitat. It is also not known if the endangered persistentsepal yellowcress or the threatened eatonella are present on site, but such occurrences would also constitute critical habitat.

2.2.6.2 Sensitive Environments. The Columbia River's importance as a recreational resource and a regional source of drinking and irrigation water, as well as being a productive habitat for waterfowl, economically important fish species, and transitory endangered and threatened wildlife, could merit special concern for this environment during implementation of the remedial activities at the 100 N Area. If critical bald eagle habitat exists on site, then such may be regarded as sensitive environments as defined in 40 CFR Part 300, Appendix A.

The Columbia River is regarded as an important environment with respect to the 100 N Area. The Hanford reach is the only significant stretch of the Columbia River within the United States that is not impounded by a dam (Jaquish and Bryce 1989). The reach has also been designated a class A (excellent) surface water by the State of Washington (WAC 173-201). This designation requires that water quality be maintained for the following uses:

- domestic, industrial, and agricultural water supply
- stock watering
- fish and shellfish migration, rearing, spawning, and harvesting
- wildlife habitat

- recreation (including primary contact recreation)
- commerce and navigation.

2.2.6.3 Land Use. Access to the entire Hanford Site is administratively controlled to ensure public health and safety and for reasons of national security (DOE 1987a). The Hanford Site land use is presently maintained through the Hanford Site development planning process. Land use on federal property is subject to federal approval and control. Compatibility with adjacent, non-federal, land-use activities is maintained through coordination with local land-use authorities.

Land use in the area surrounding the Hanford Site consists primarily of irrigated and dry-land farming, livestock grazing, and urban and industrial development. Principal agricultural crops include hay, wheat, potatoes, corn, apples, soft fruit, hops, grapes, and vegetables. Most industrial activities in the area are associated with either agriculture or energy production (DOE 1987a).

Immediately north and across the river from the 100 Aggregate Area are the 130 km^2 (50 mi^2) Saddle Mountains National Wildlife Refuge and the 225 km^2 (87 mi^2) State of Washington Department of Wildlife Reserve (see Figure 1-1). These lands provide a zone of restricted human activity around the production reactor complexes for wildlife feeding, nesting, and resting areas (DOE 1987a).

Before U.S. Government acquisition of the Hanford Site in 1943, much of the area consisted of grazing or range land, primarily for sheep. Because of the arid nature of the area, the U.S. Department of Agriculture estimated that 9.7 hectares (24 acres) were required to support a single sheep, and the area was used only in the winter and spring. As the season progressed, feed had to be supplied from outside sources. A minor portion, less than 12 percent, of the land at that time was irrigated or irrigatable, but not all of this was under cultivation, and some of the farmlands had been abandoned and orchards had been cut down before 1943. Two small communities, White Bluffs and Hanford, were both evicted when the government acquired the area.

2.2.6.4 Water Use.

2.2.6.4.1 Surface Water Use. The Columbia River forms the northern boundary of the 100 N Area. The portion of the Columbia River that flows through the Hanford Site is known as the Hanford Reach. The entire Hanford Reach is used for boating and fishing. River water is used onsite. The City of Richland located downstream, uses the river for drinking water and this practice is anticipated to continue.

Prior to 1943, Columbia River water was used for agricultural irrigation within the Hanford Site. An arterial irrigation canal was constructed around 1905 as the main arterial canal of the Priest Rapids Irrigation and Power Company. The company later became known as the Hanford Irrigation and Power Company and the irrigation canal was commonly referred to as the "Hanford Ditch". Irrigation and use of the canal ceased when the government took possession of the Hanford Site in 1943.

The main arterial canal originated approximately one mile west of the present day 100 K Area and traversed west to east about one mile south of the 100 N Area. In the approximate location of the 100 D Area the canal turned and traversed in a southeast direction towards the former community of Hanford. Most of the irrigated lands were located along the west bank of the Columbia River from a point north of the community of White Bluffs, located near the present day 100 D Area, and in the area near the community of Hanford. Little irrigation was accomplished west of the 100 D Area and probably none near the 100 N Area.

Columbia River water has been used as the source of cooling water at the N Reactor. Water for the heat dissipation system was drawn from the river through a shoreline intake system, circulated through various

condensers and heat exchangers, and discharged to the center of the river through the 260-cm (102 in) discharge line. The normal pumping rate was 1,100,000 L/min (290,000 gal/min) (Ecker et al. 1983).

2.2.6.4.2 Groundwater Use. No production wells exist at the 100 N Area. Groundwater within the 100 N Area is only withdrawn for chemical analysis. The nearest reported domestic groundwater well is located near Vernita Bridge, over 16 km (10 mi) west (upgradient) of the 100 N Area.

Contaminated groundwater does discharge into the Columbia River, and as noted in Section 2.2.6.4.1, river water is used as a municipal drinking water supply. Groundwater impacts are discussed in the 100-NR-2 Groundwater Operable Unit work plan.

2.2.7 Human Resources

2.2.7.1 Demography. There are no residences on the Hanford Site. The nearest inhabited residences are farm homes on land 9.7 km (6 mi) north of the 100 N Area. There are approximately 258,000 people living within a 80 km (50 mi) radius of the 100 N Area. The primary population centers are the cities of Richland, Kennewick, and Pasco, located southeast of the Hanford Site.

2.2.7.2 Archaeological Resources. Knowledge about the archaeology of the 100 N Area is largely based on reconnaissance-level archaeological surveys. Within 2.4 km (1.5 mi) of the 100 N Area are eight archaeological sites. Three of the sites are located north of the Columbia River. Three of the sites situated on the south shore comprise the Ryegrass Archaeological District. The HGP at the 100 N Area has been test-excavated, and has been nominated for the National Register of Historic Places. No known sites of religious importance actually lie within the 100 N Area (Cushing 1989).

2.2.7.3 Historical Resources. The most common evidence of historic activity now found near the 100 N Area is gold mine tailings on river banks and archaeological sites where homesteads once stood. Few of these vestiges of the early years remain. The double-fenced compound of the 100 N Area has been cleared of cultural resource concerns (Cushing 1989).

2.2.7.4 Community Involvement. The involvement of the potentially affected community with respect to the RFI/CMS for the 100-NR-1 Operable Unit is described in the community relations plan (CRP) (Ecology et al. 1990b) that has been developed for the Hanford Site Environmental Restoration Program. The CRP includes a discussion and analysis of key community concerns and perceptions regarding the project, along with a list of all interested parties.

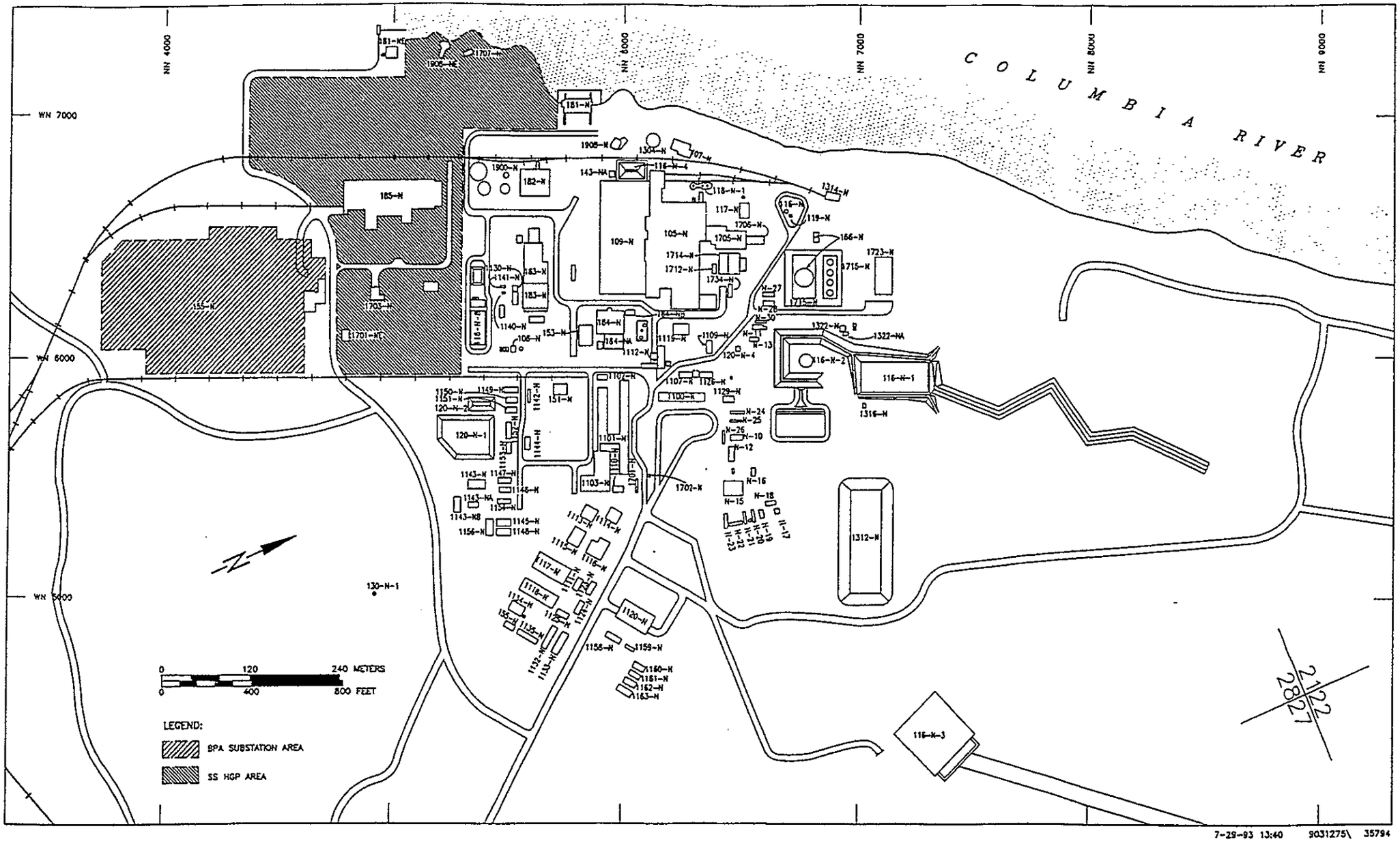

Figure 2-1. Facilities in the 100 N Area

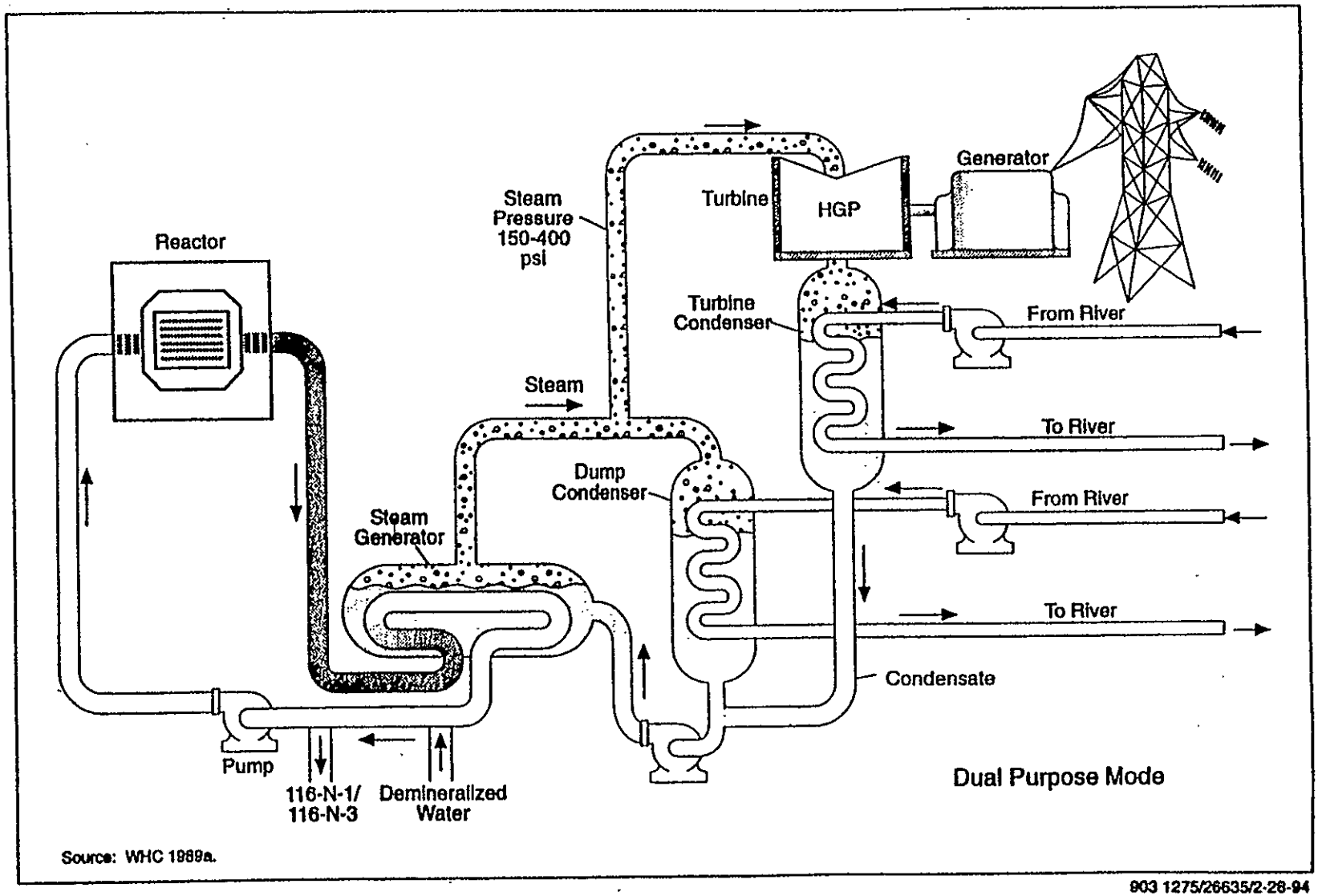

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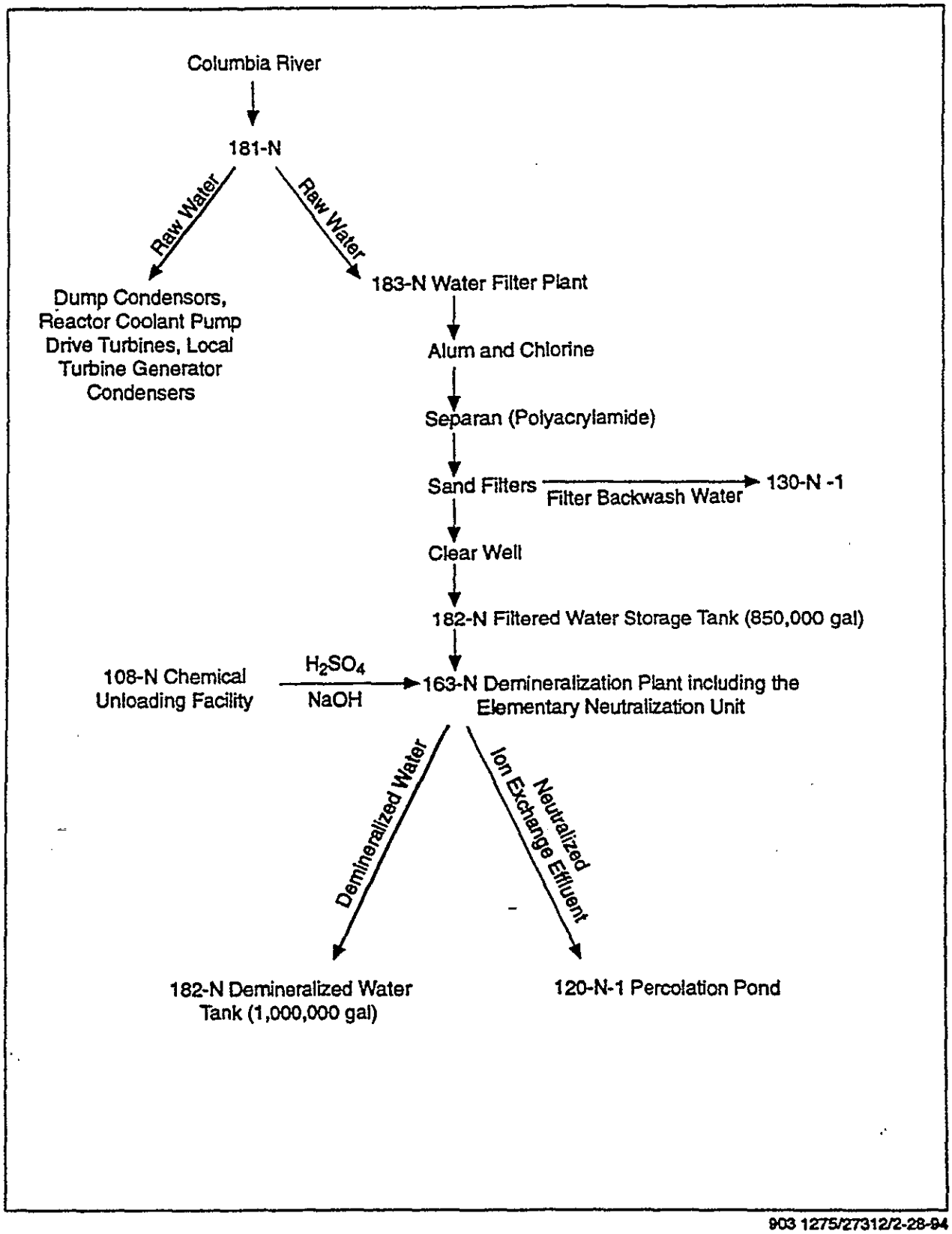
Figure 2-2. N Reactor Coolant Flow Diagram.

Figure 2-3. Flow Diagram of the Water Treatment System.



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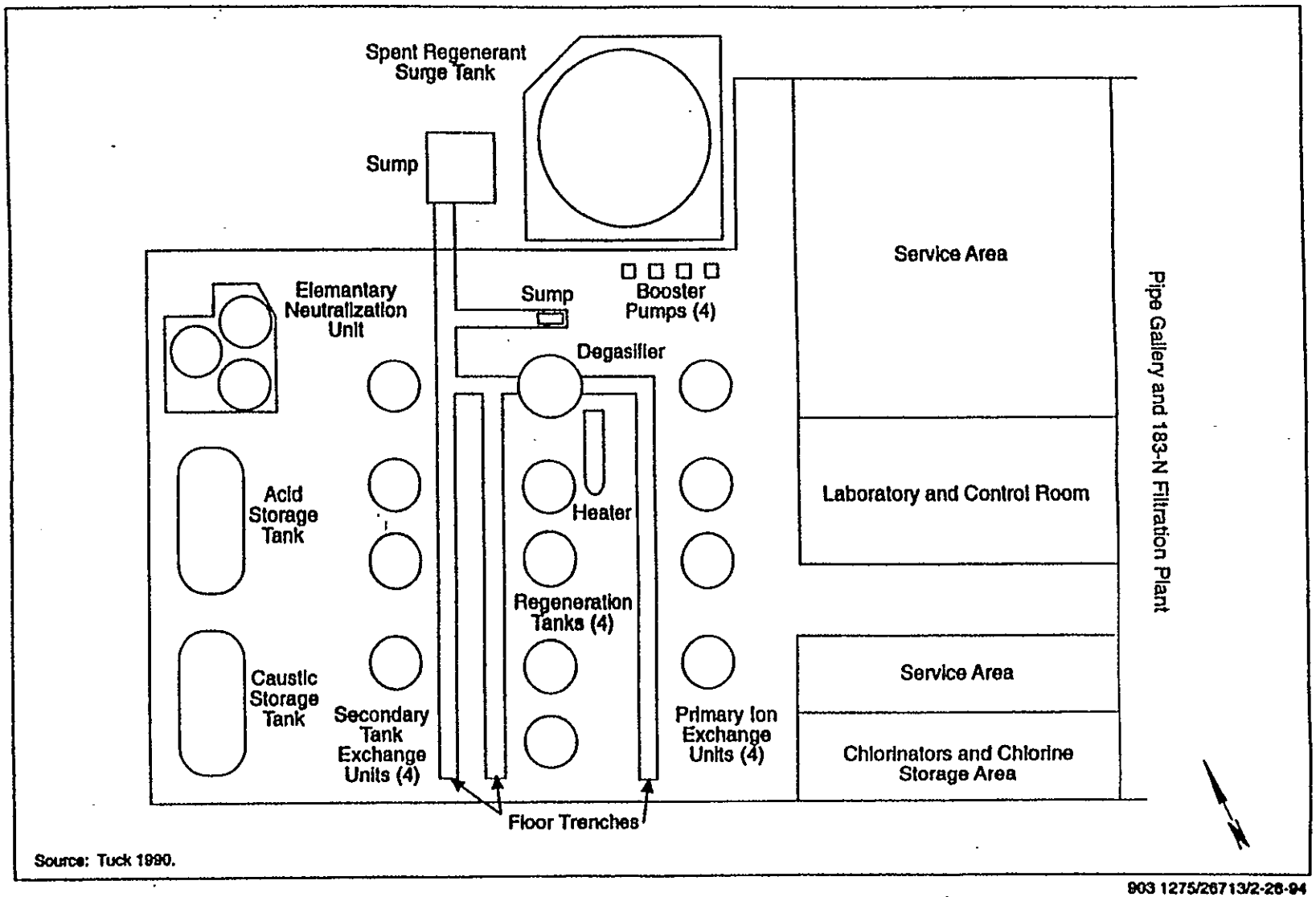

Source: Tuck 1990.

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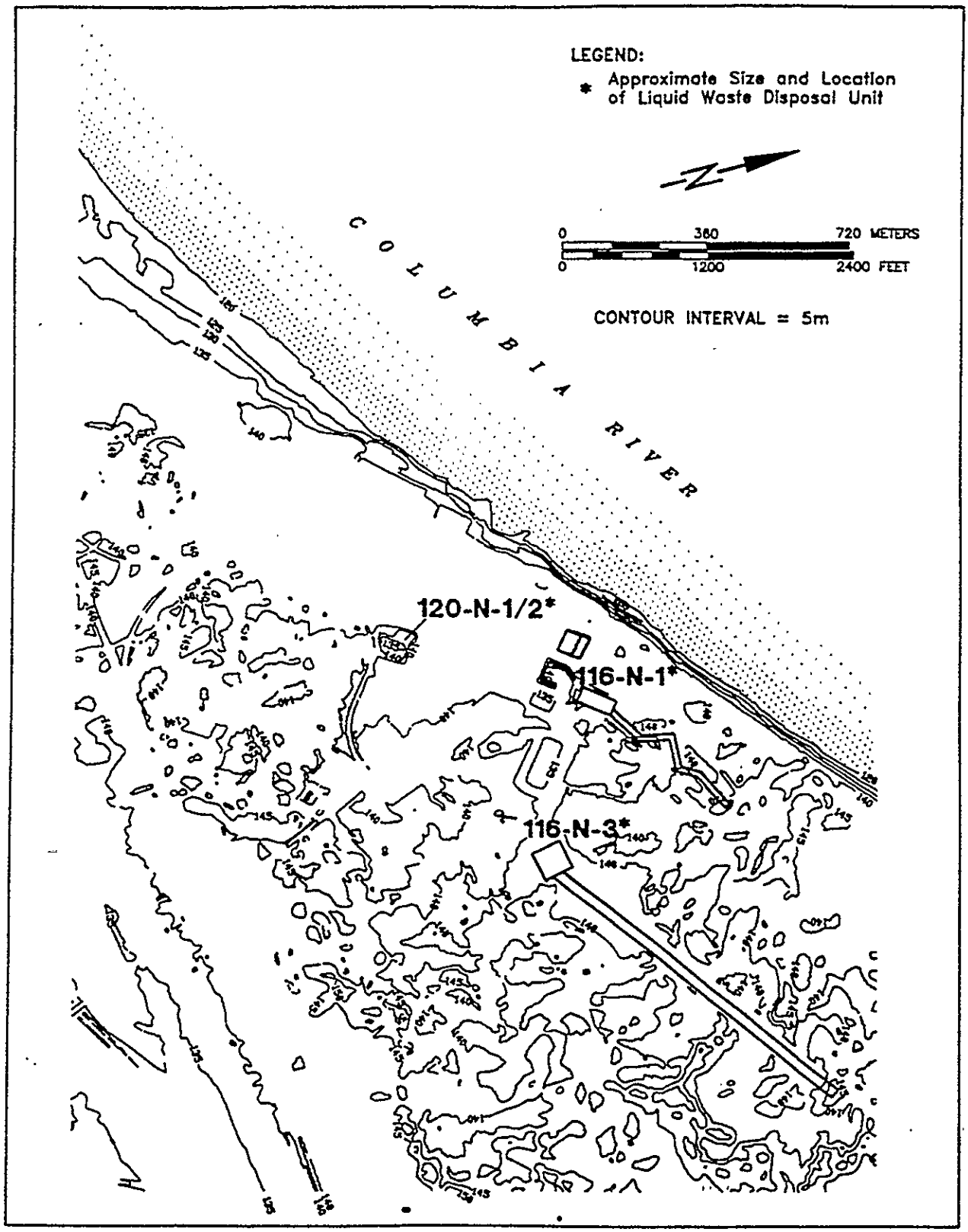
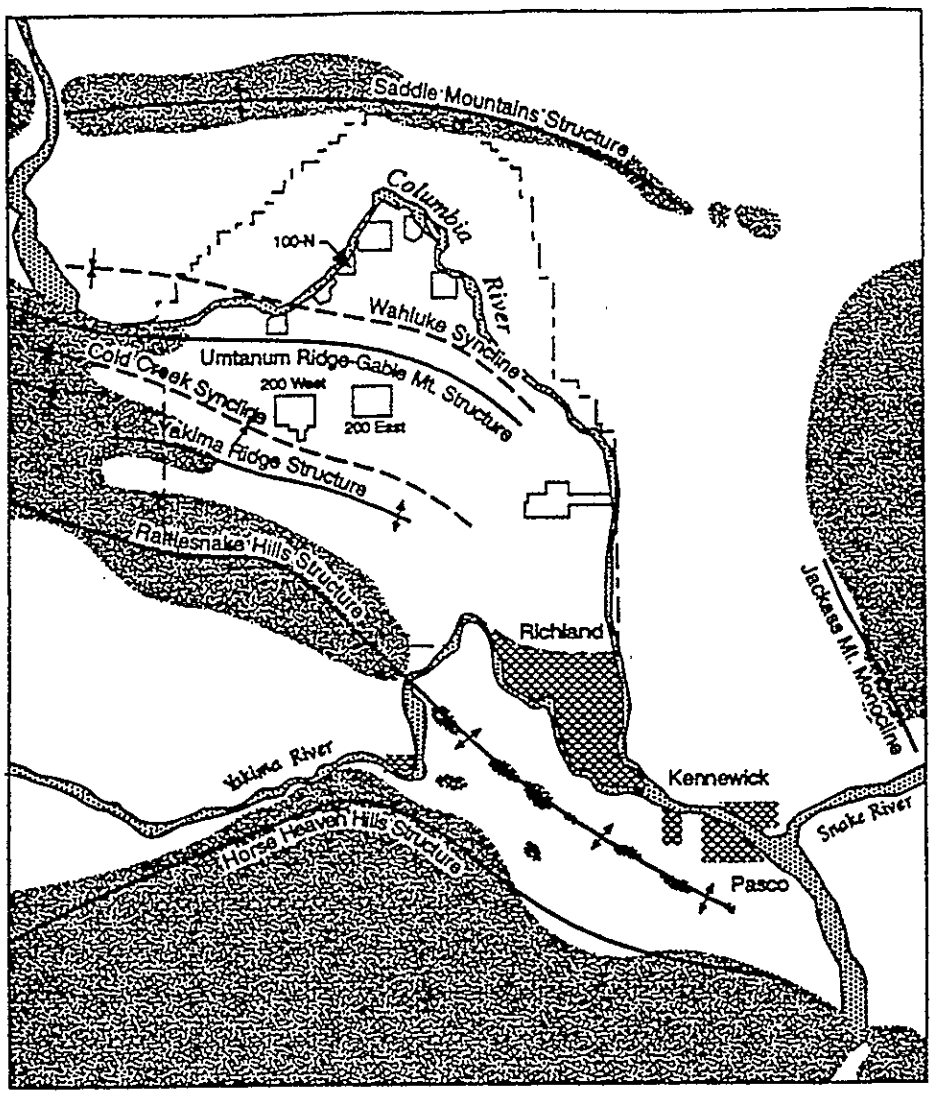
Figure 2-4. General Floor Plan of the 163-N Facility.

Figure 2-5. Topography of the 100 N Area.



9031275\36651 2-28-94 12:24

Figure 2-6. Structural Geology of the Pasco Basin.



LEGEND:

- Generalized Areas of Basalt Outcrop in the Pasco Basin
- Syncline
- Anticline
- Monocline

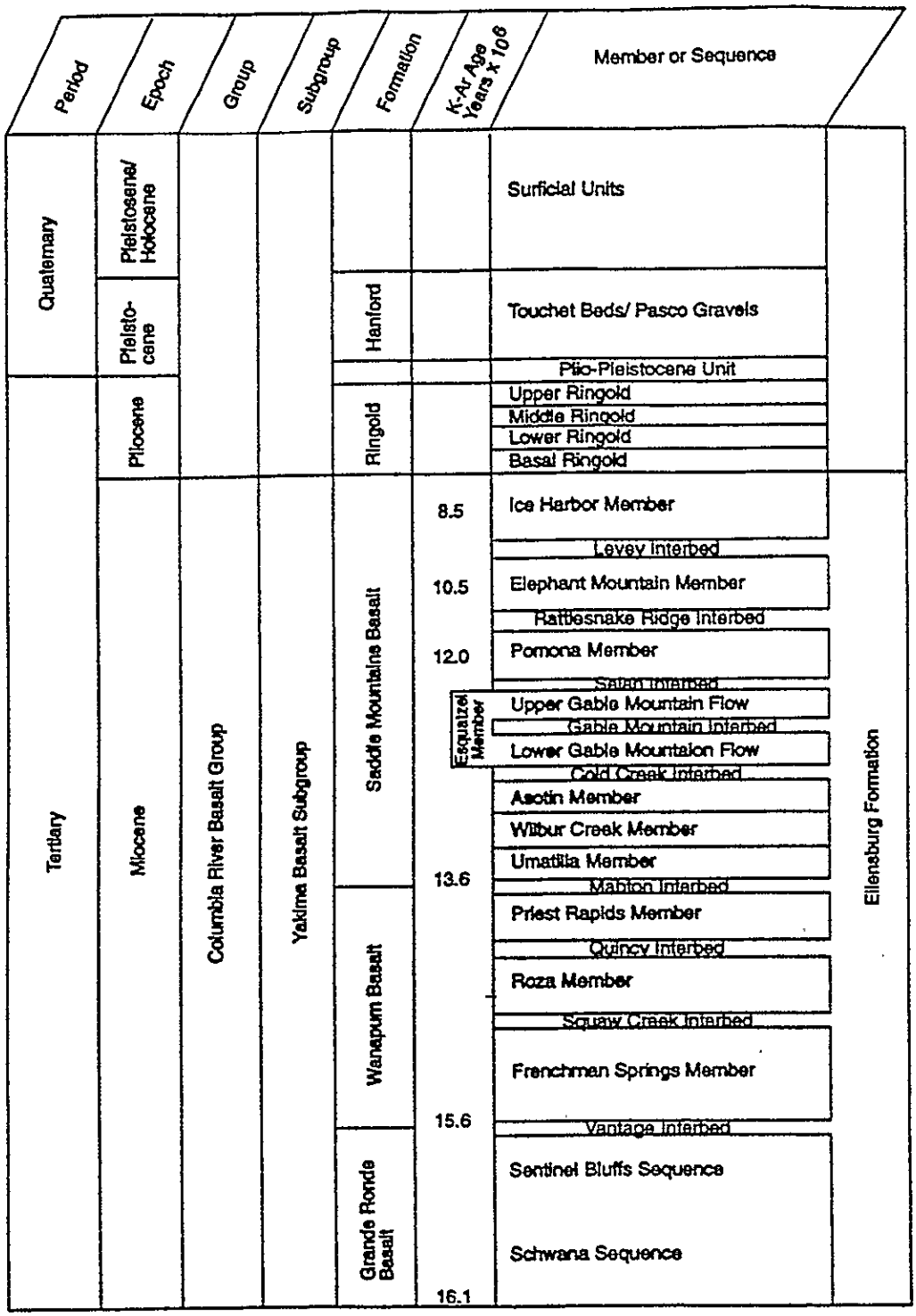
N

0 — 16 KILOMETERS
0 — 10 MILES

Source: Myers et al. 1979.

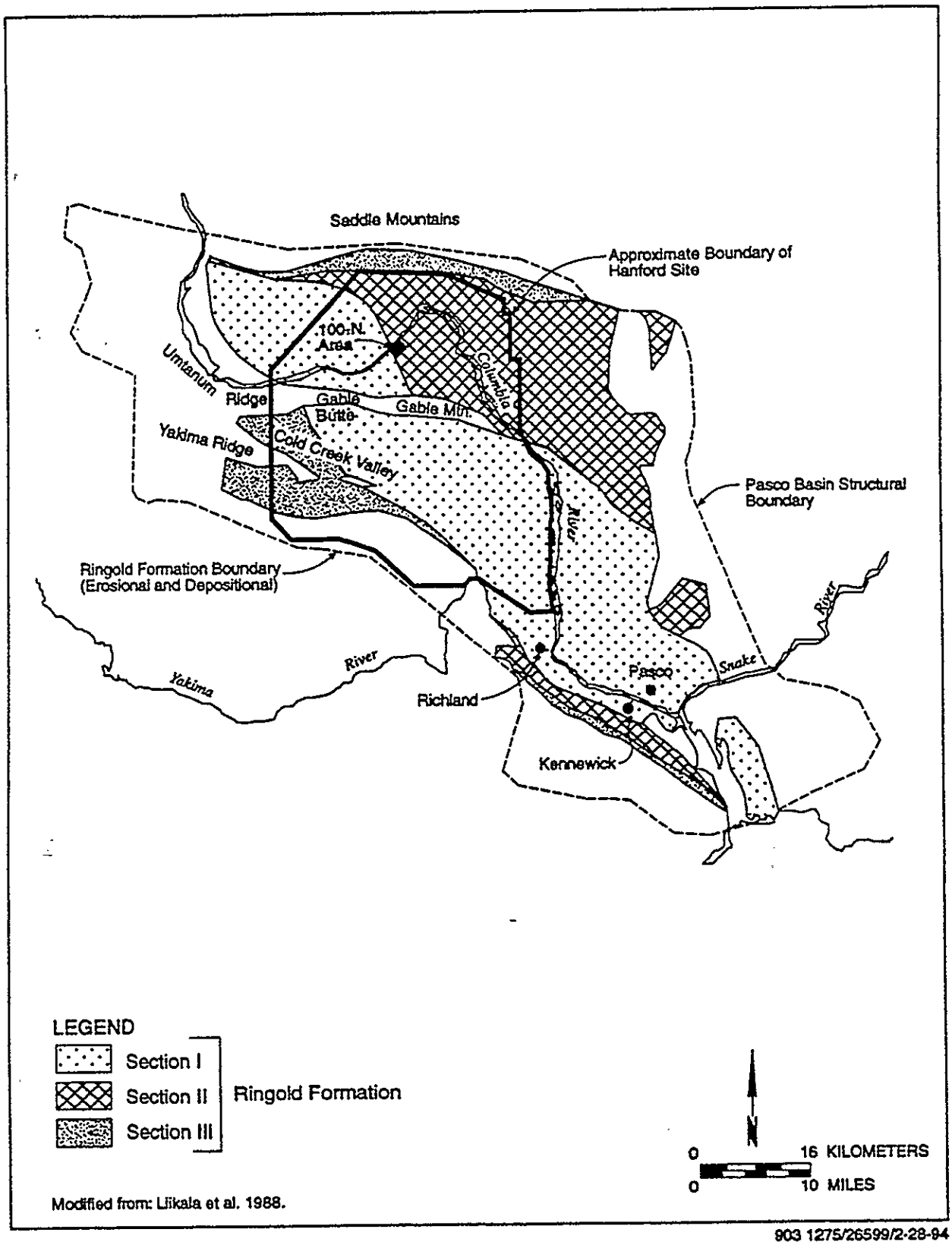
903 1275/26895/2-28-94

Figure 2-7. Stratigraphic Units Present in the Pasco Basin.



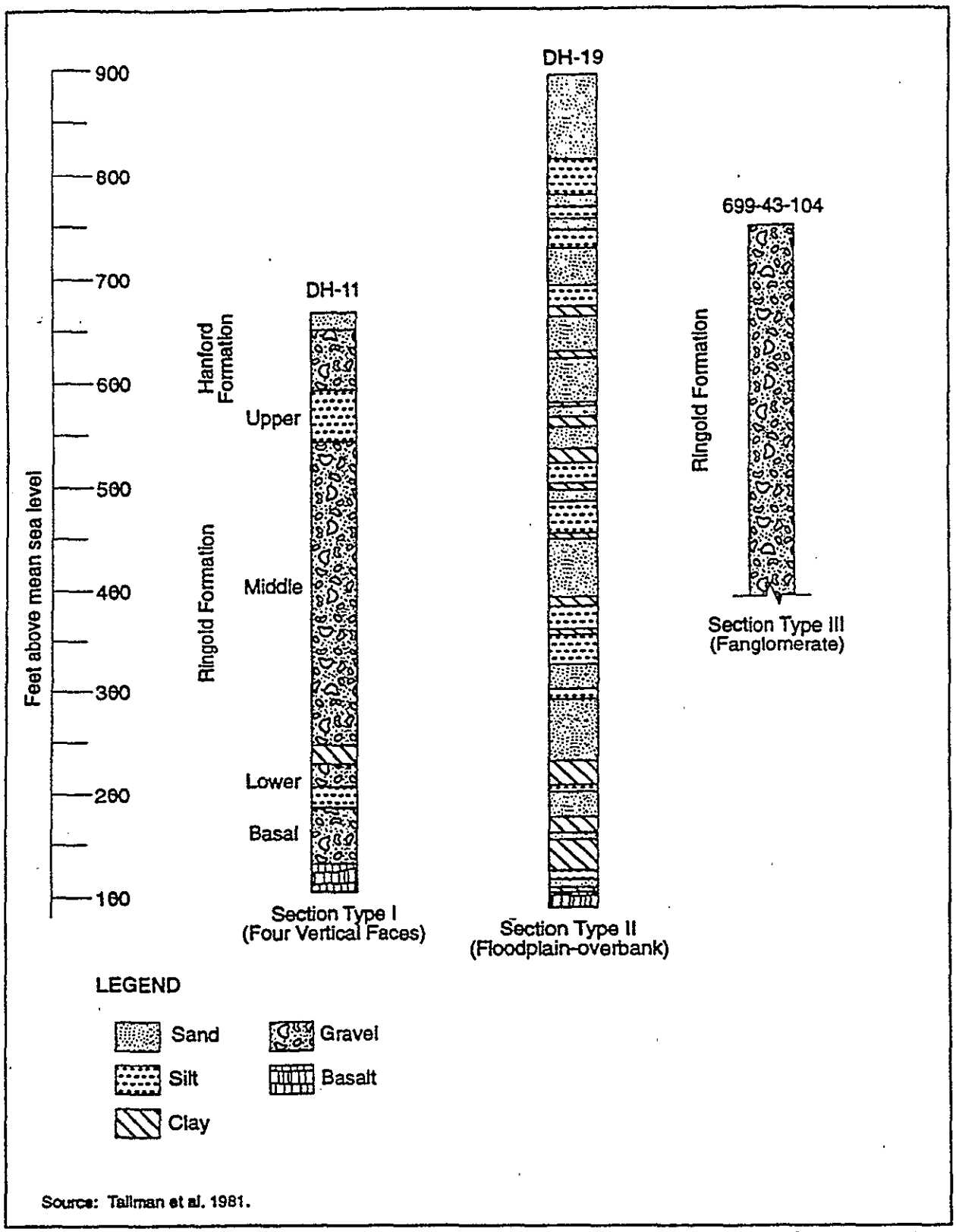
903 1275/26601/2-28-94

Figure 2-8. Distribution of the Ringold Section Types.



903 1275/26599/2-28-94

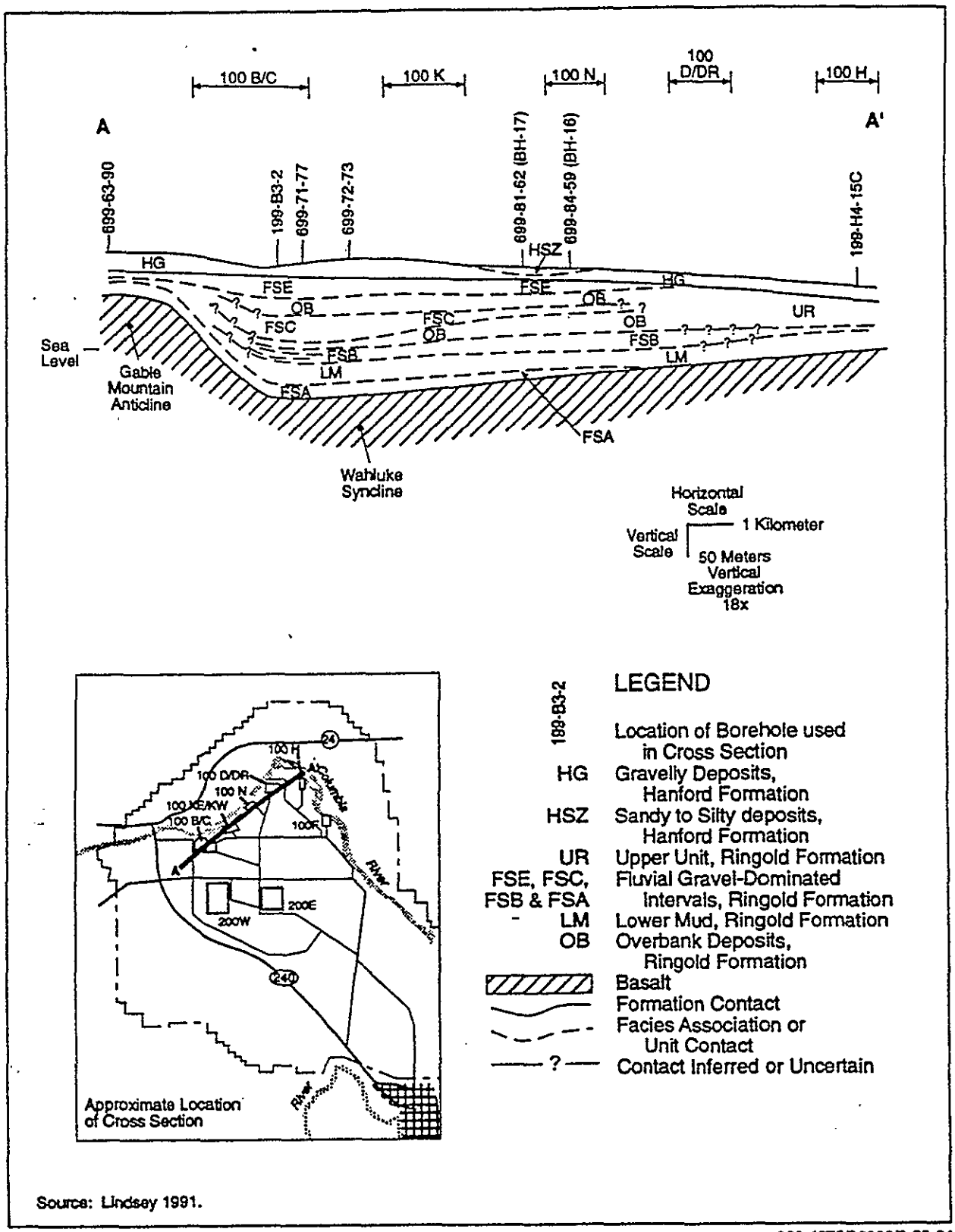
Figure 2-9. Ringold-Type Facies at Hanford Site and Vicinity.



Source: Tallman et al. 1981.

903 1275/26604/2-28-94

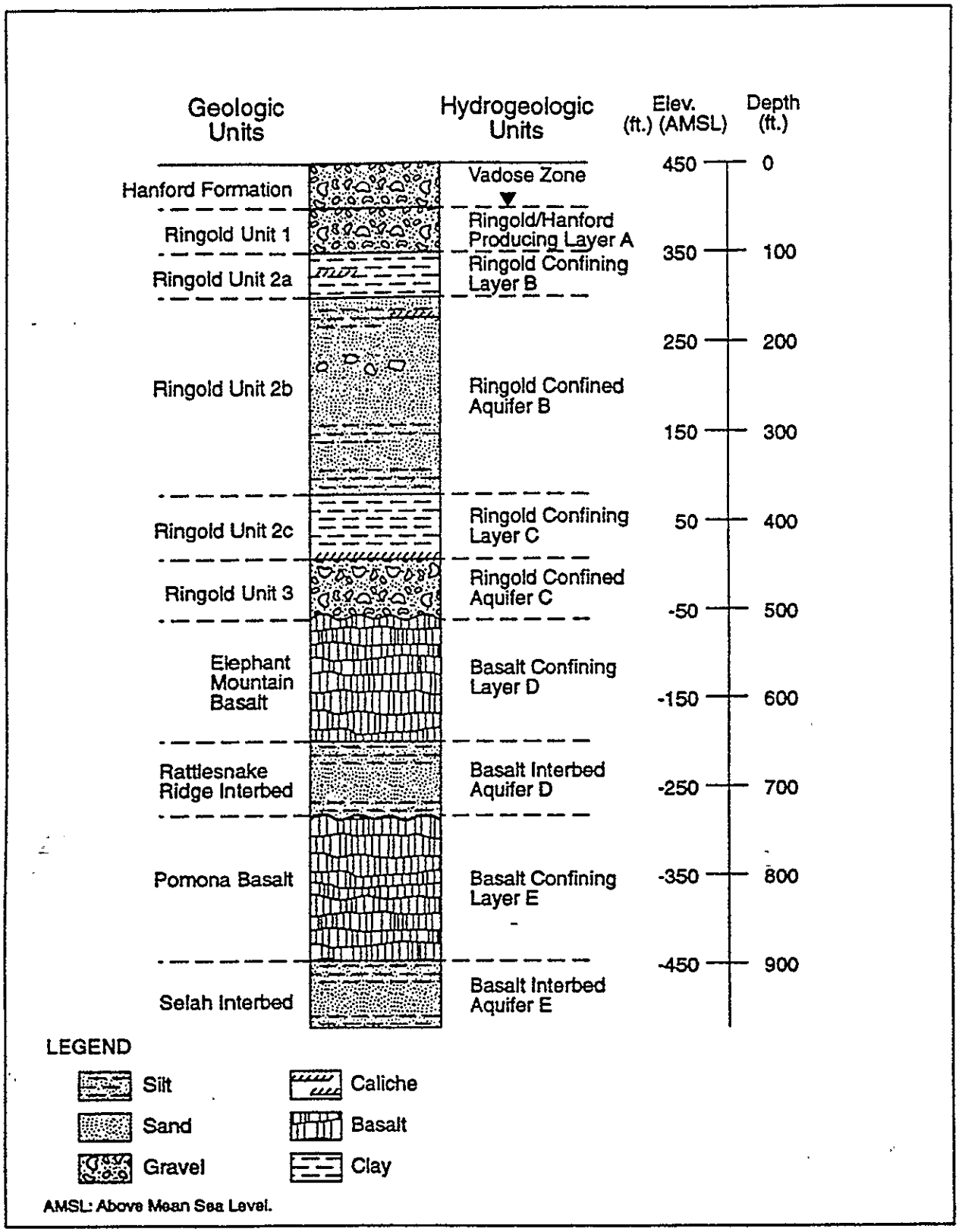
Figure 2-10. Northeast to Southwest Geological Cross Section of the Suprabasalt Sediments Across the 100 Area.



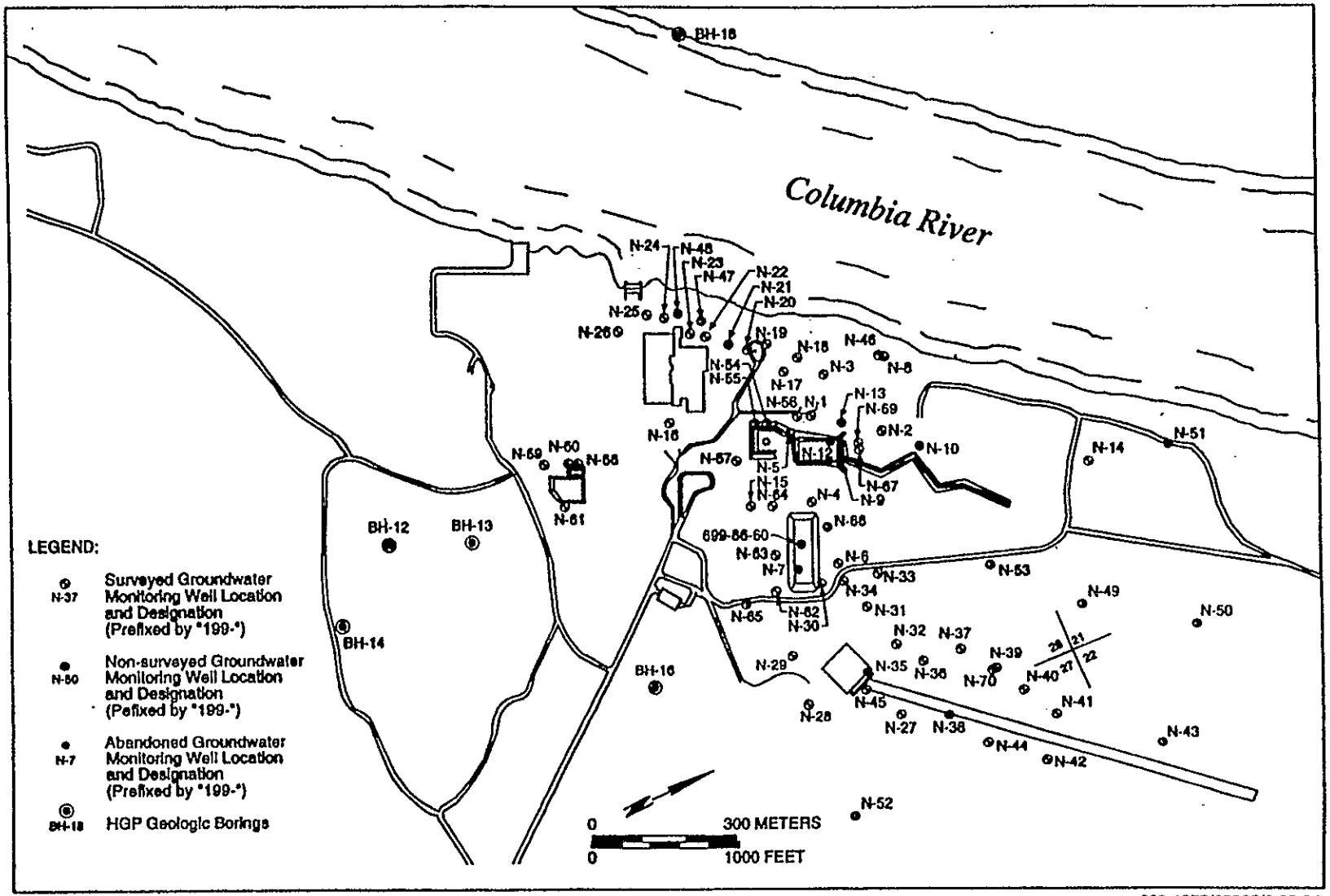
Source: Lindsey 1991.

903-1275/26869/2-28-94

Figure 2-11. Conceptual Geologic and Hydrogeologic Column.

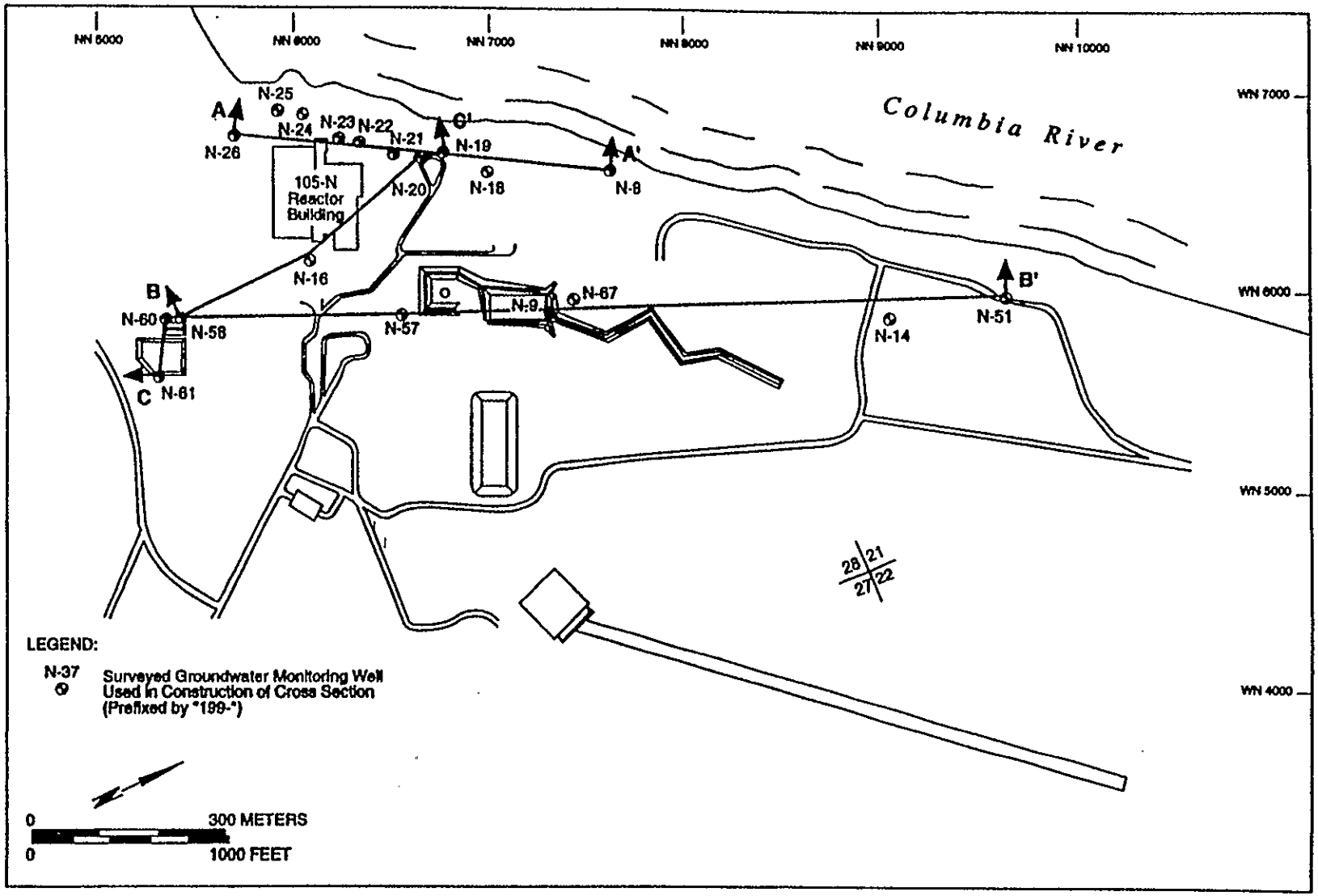


903 1275/26633/2-28-94



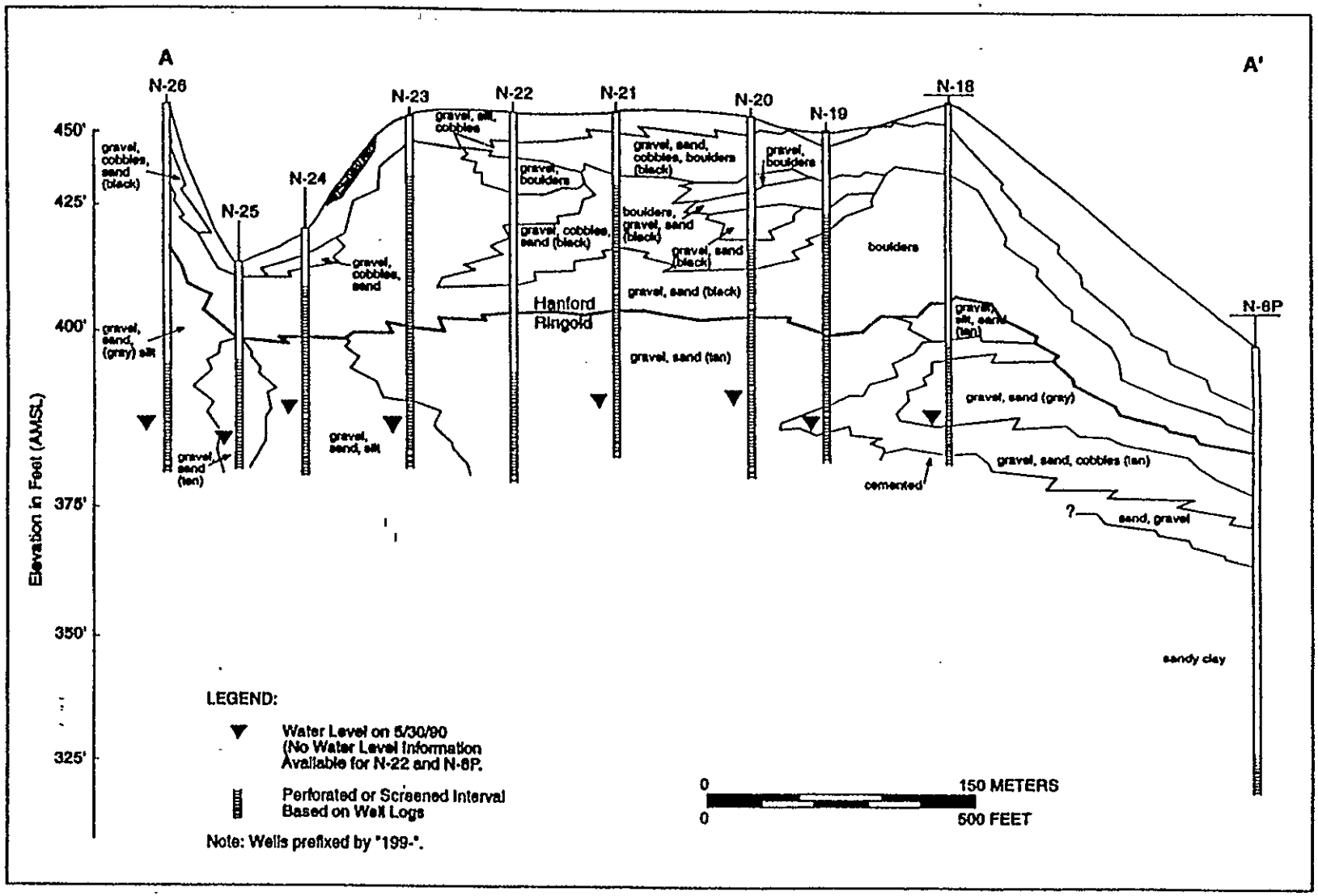
903-1275/26905/2-28-94

Figure 2-12. Location of Monitoring Wells and Geologic Borings in the 100 N Area.



903-1275/26926/2-28-94

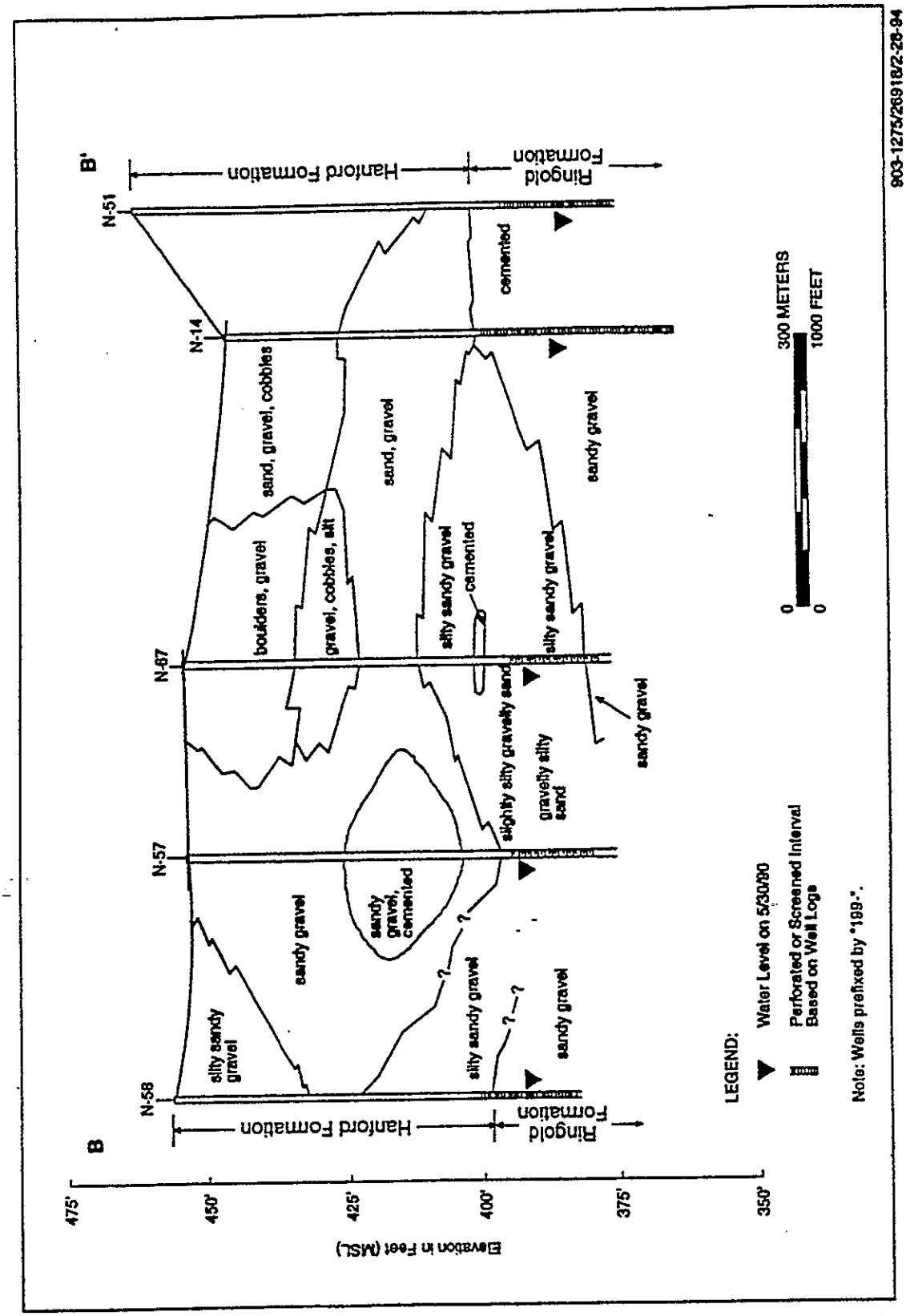
Figure 2-13. Location of Cross Sections A-A', B-B', and C-C'.

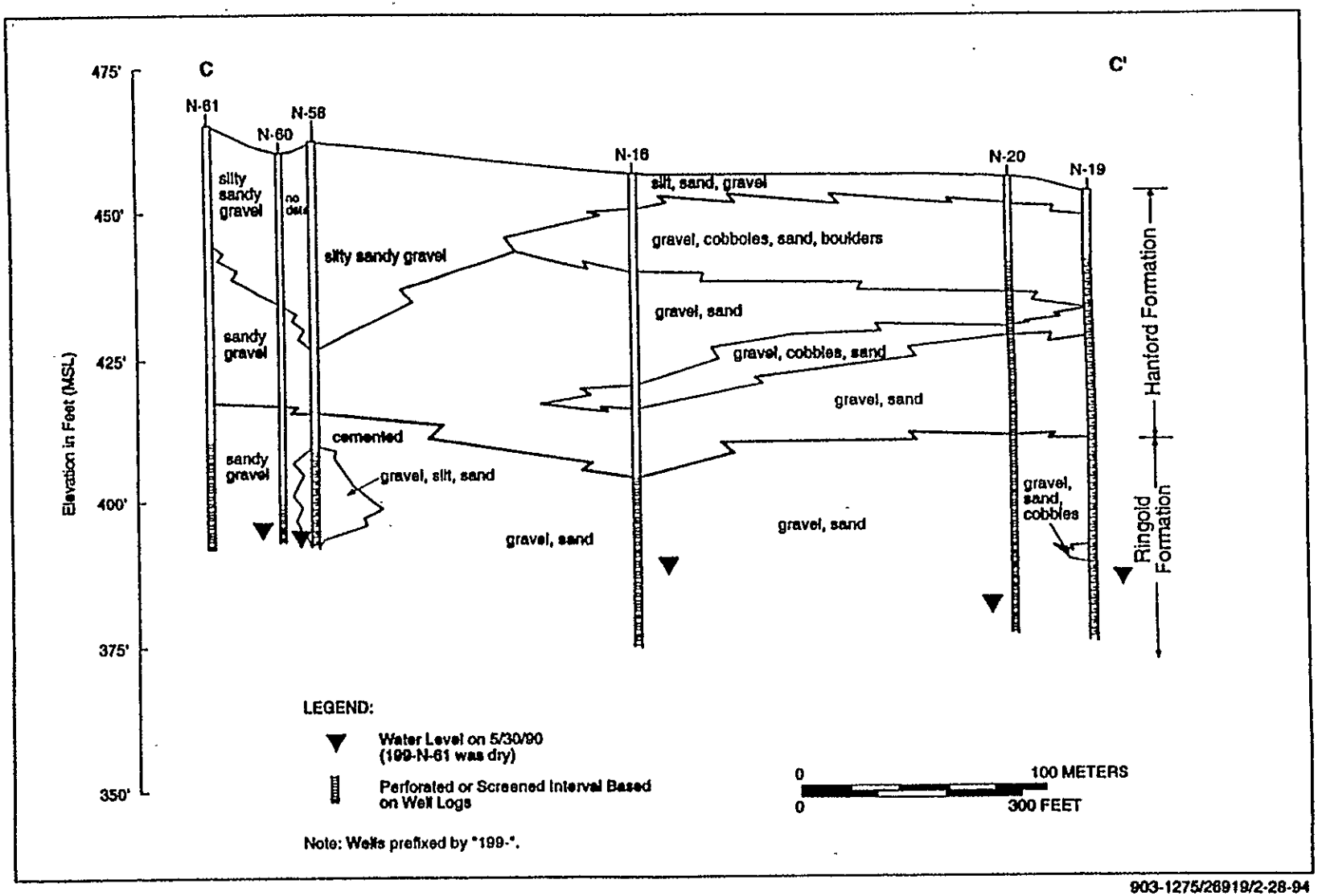


903-1275/26917/2-28-94

Figure 2-14. Cross Section A-A'.

Figure 2-15. Cross Section B-B'.





903-1275/26919/2-28-94

Figure 2-16. Cross Section C-C'.

Figure 2-17. Hanford Site Water Table Map, January 1944.

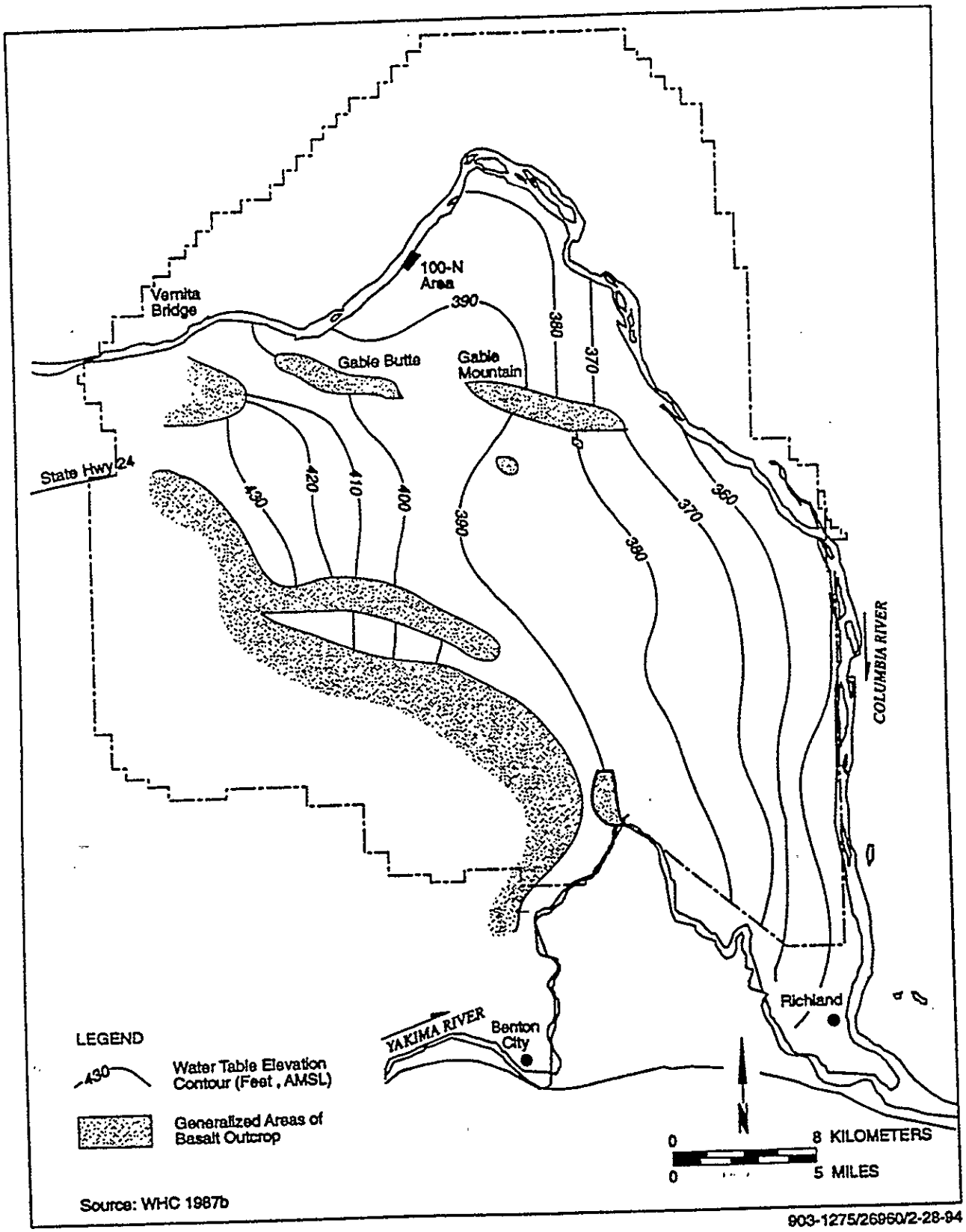
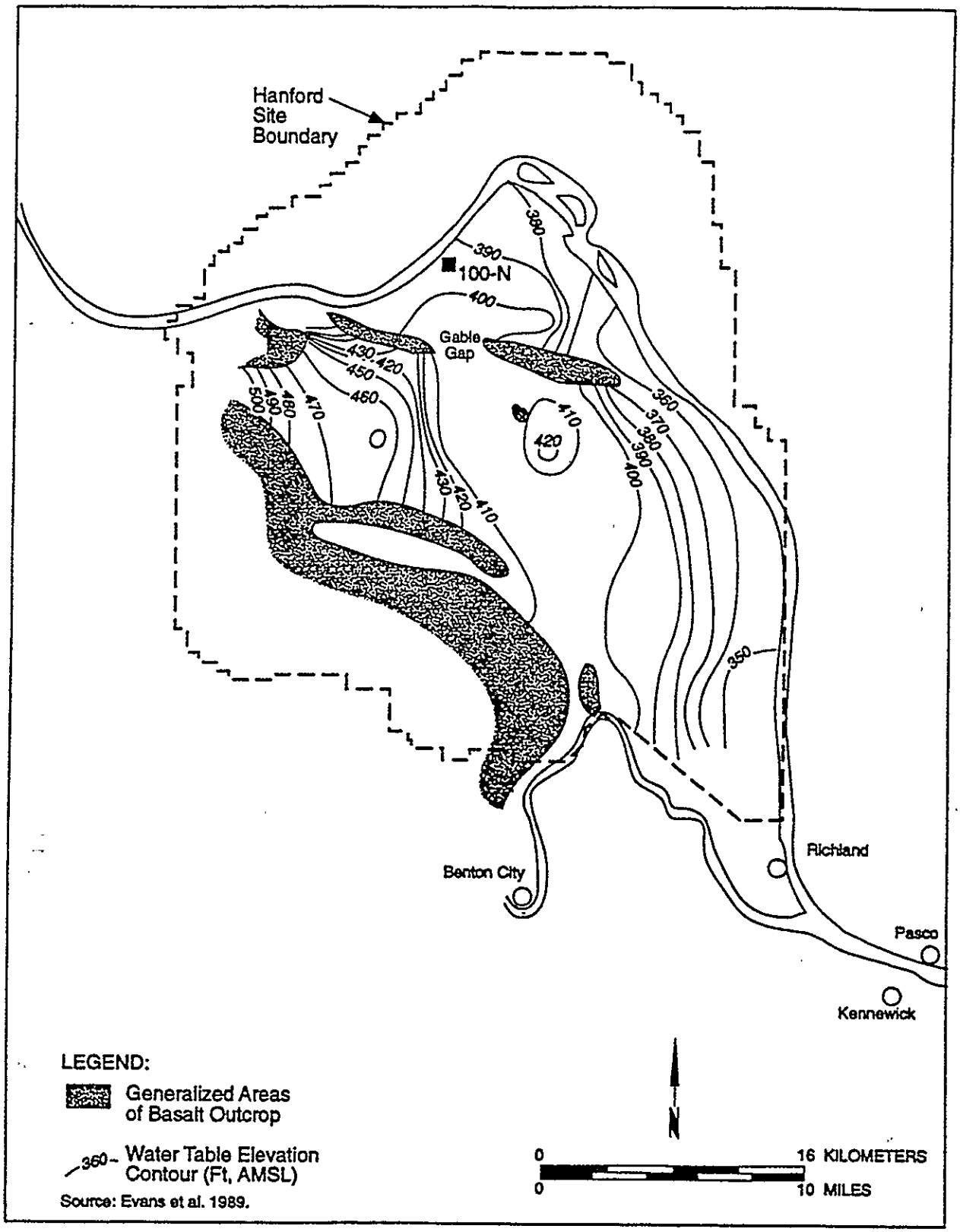


Figure 2-18. Hanford Site Water Table Map, December 1988.



903 1275/26920/2-28-94

Figure 2-19. Water Levels at the 100 N Area, July 1965.

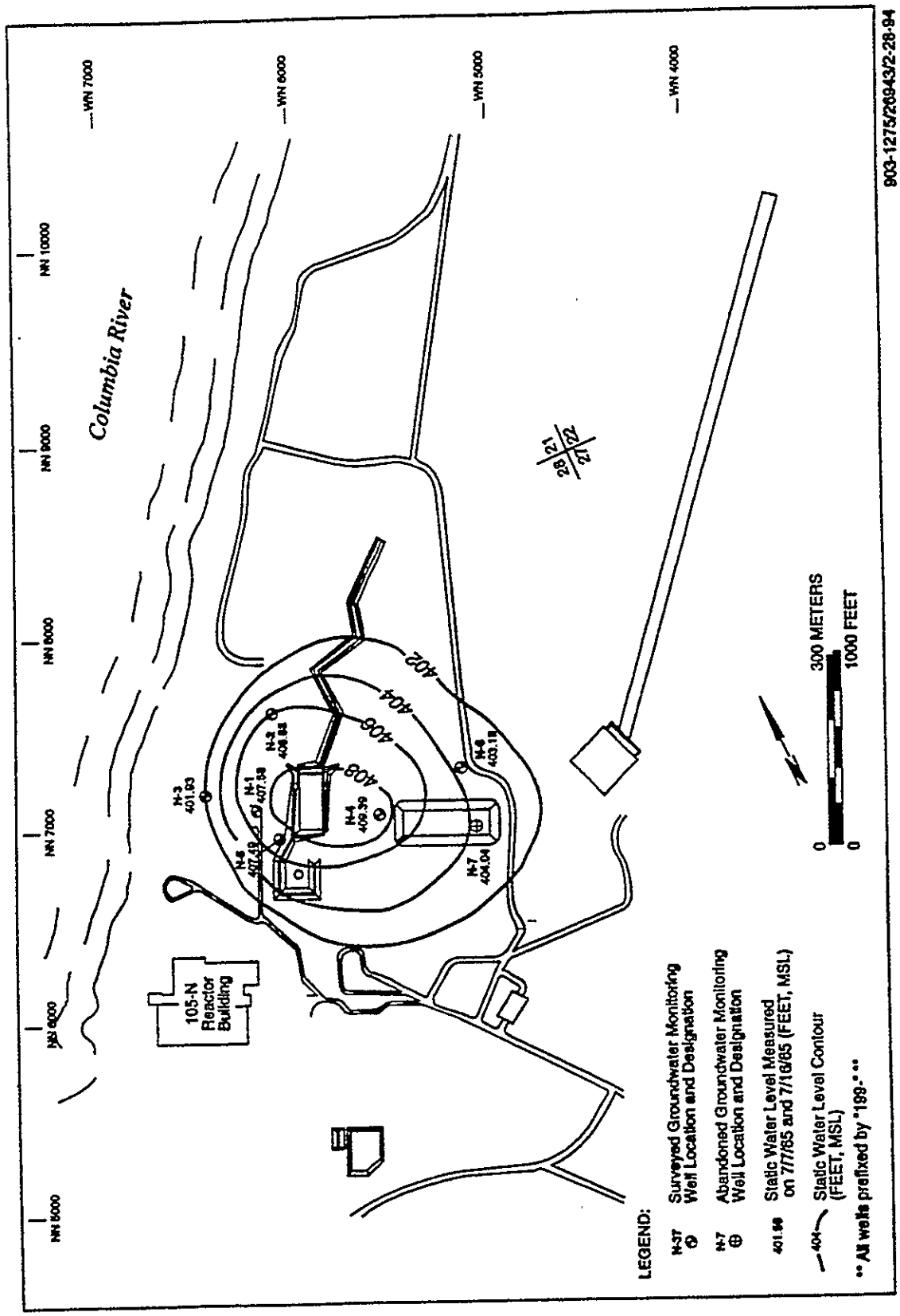


Figure 2-20. Location of the N Springs.

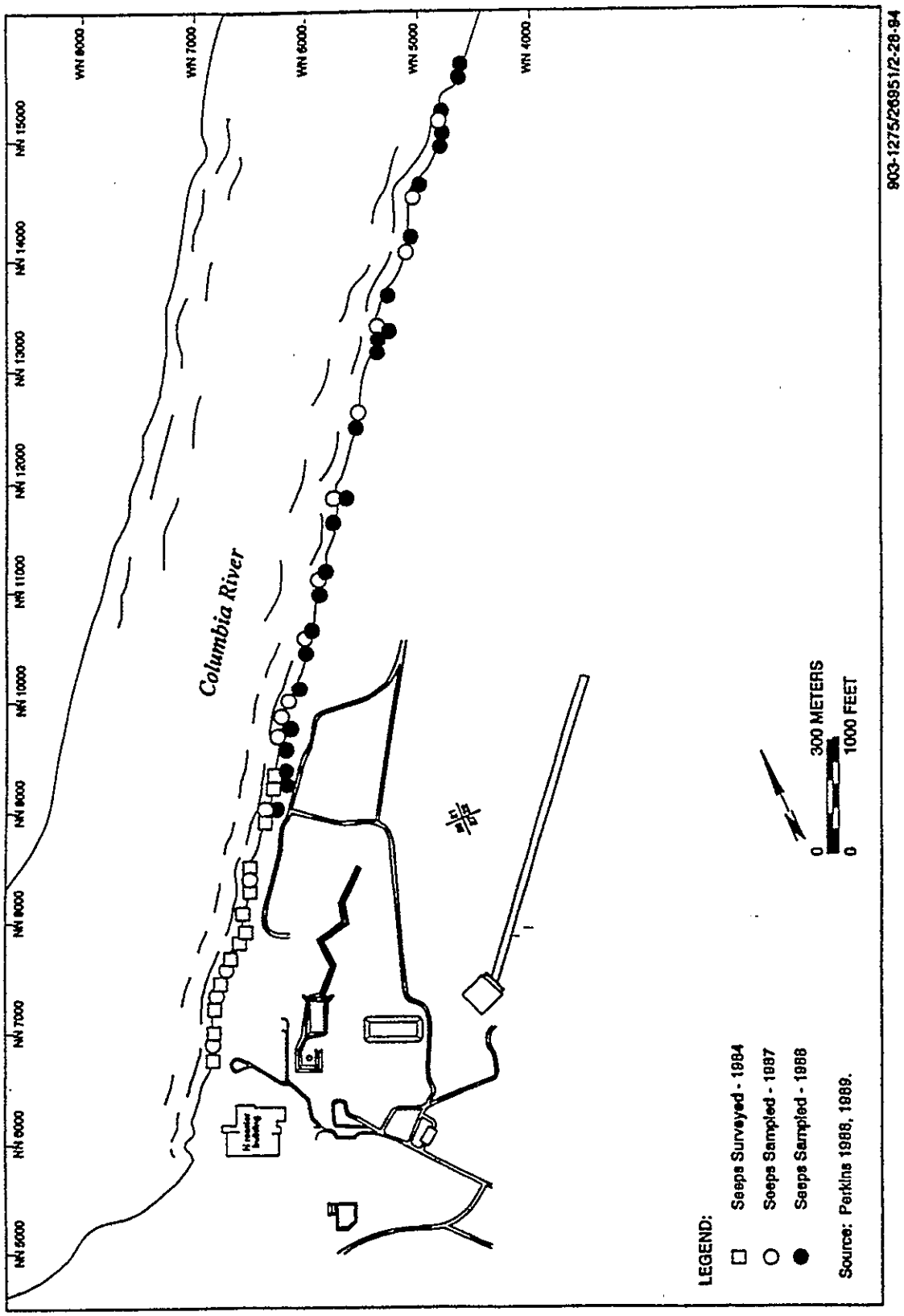


Figure 2-21. Water Levels at the 100 N Area, June 24, 1988.

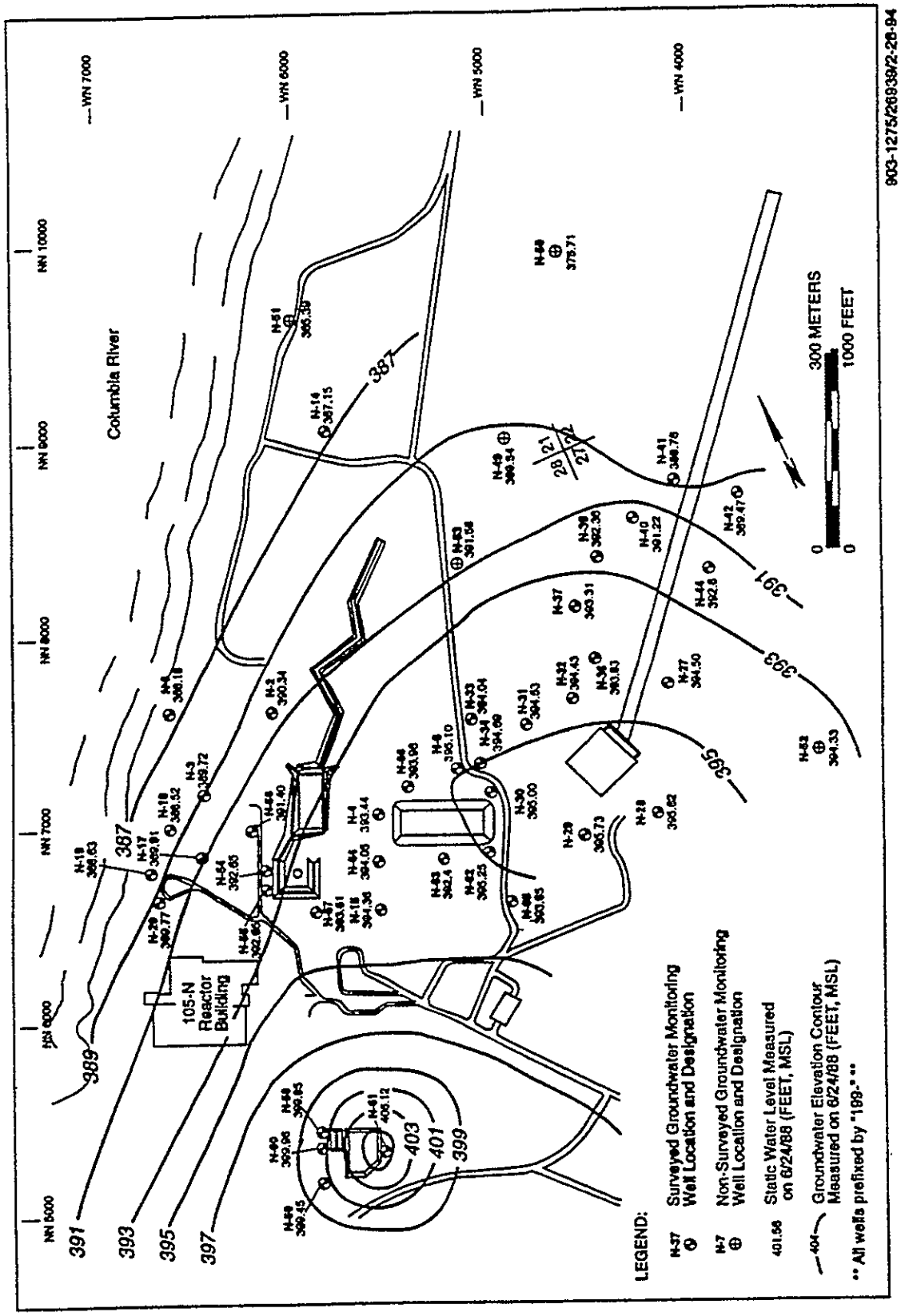


Figure 2-22. Water Levels at 100 N, June 30, 1989.

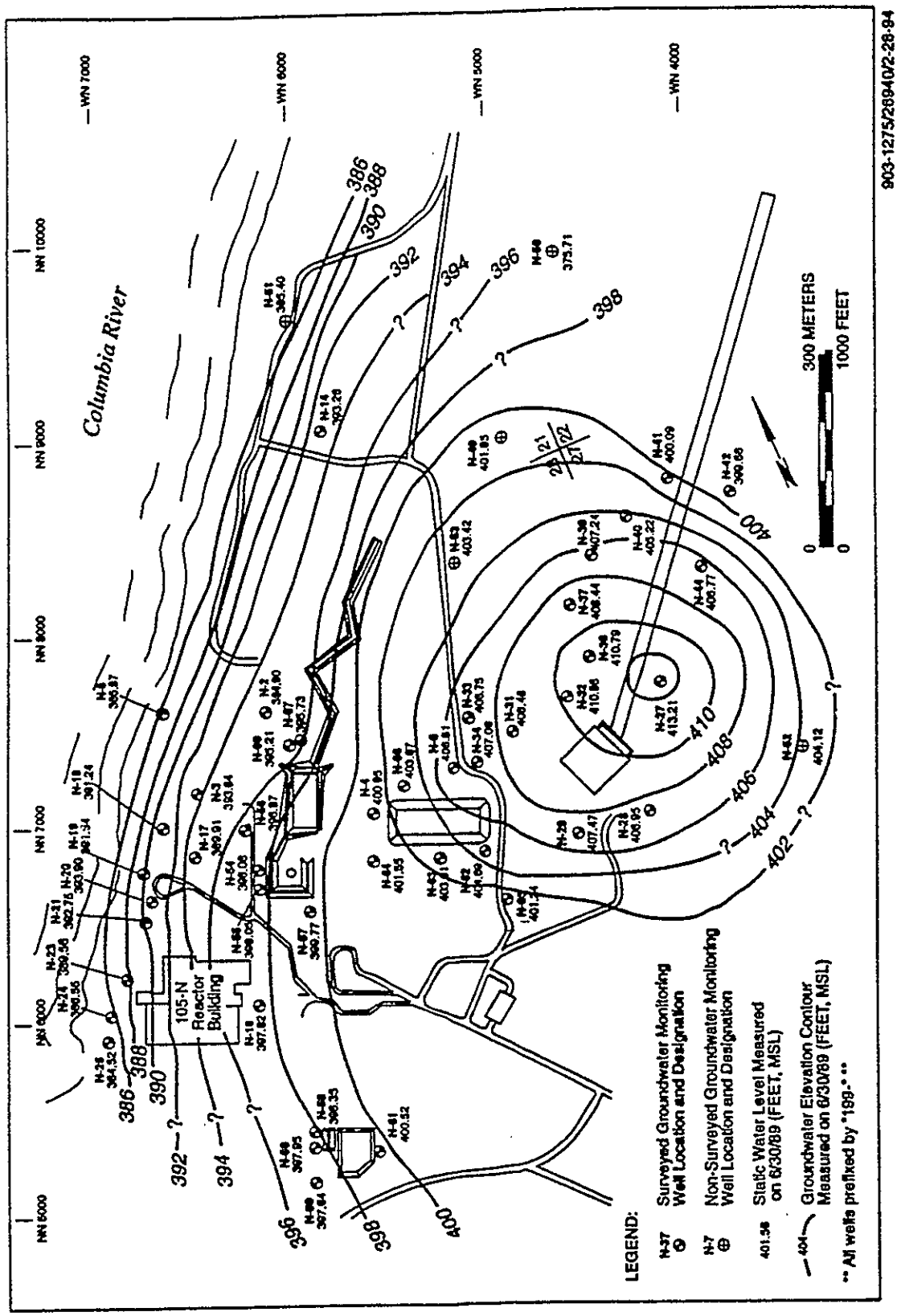


Figure 2-23. Water Levels at the 100 N Area, May 1990.

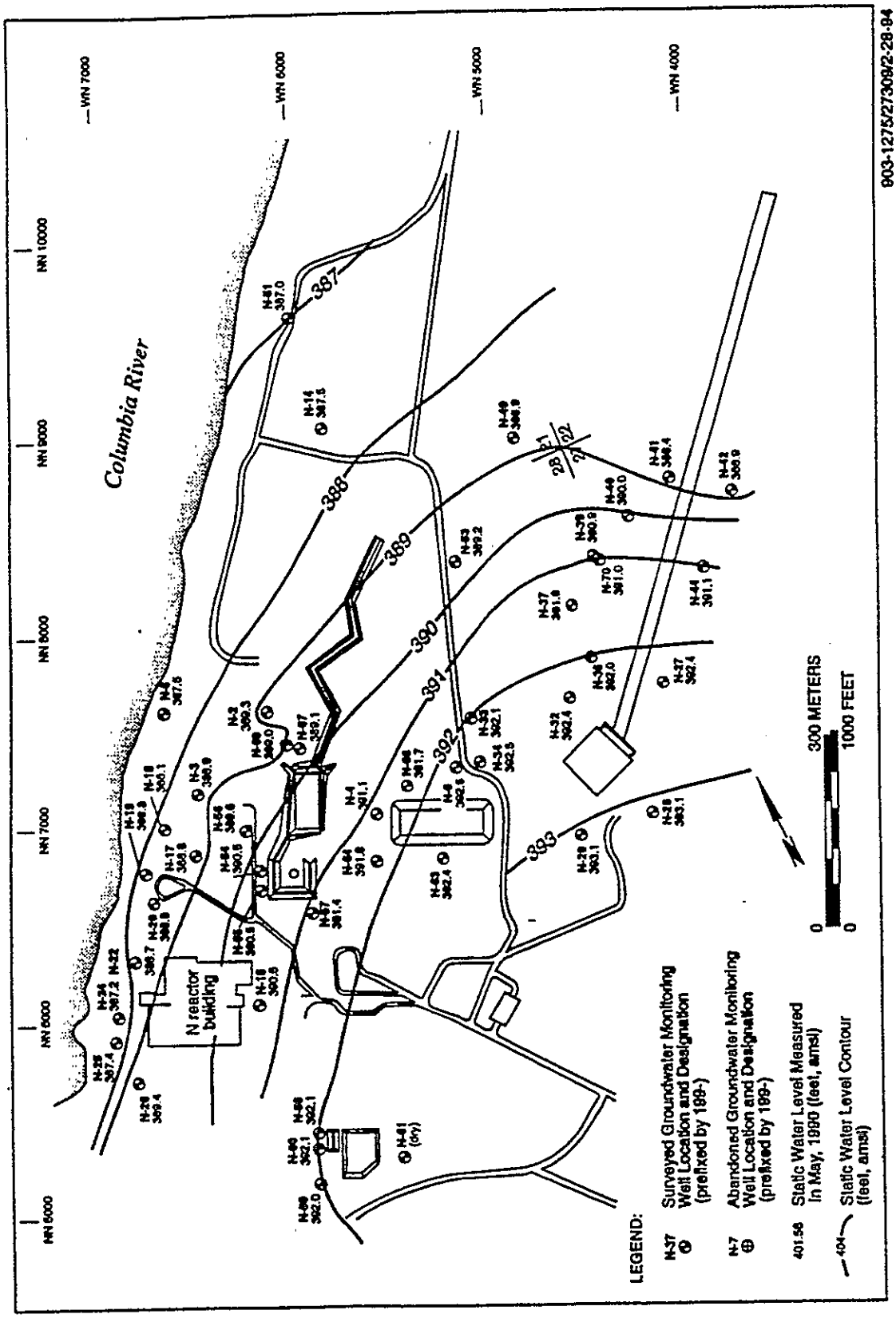
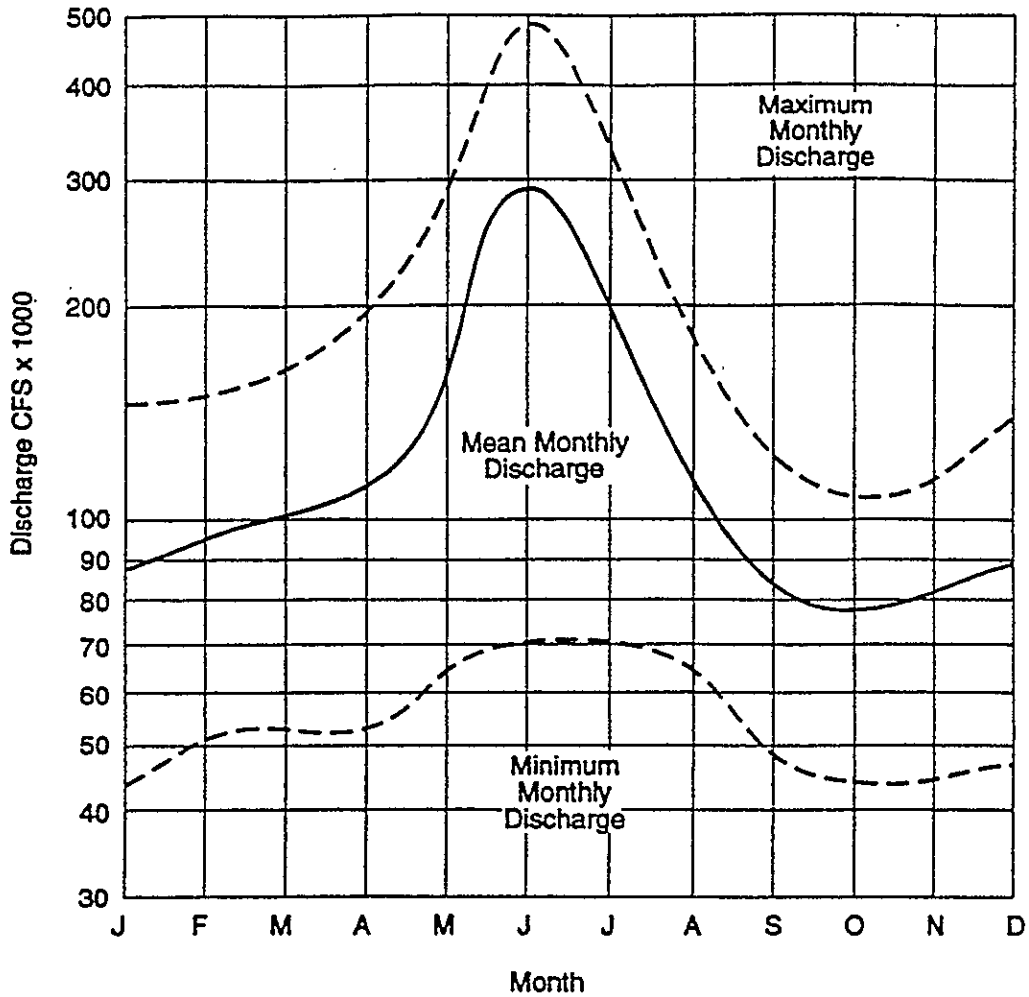


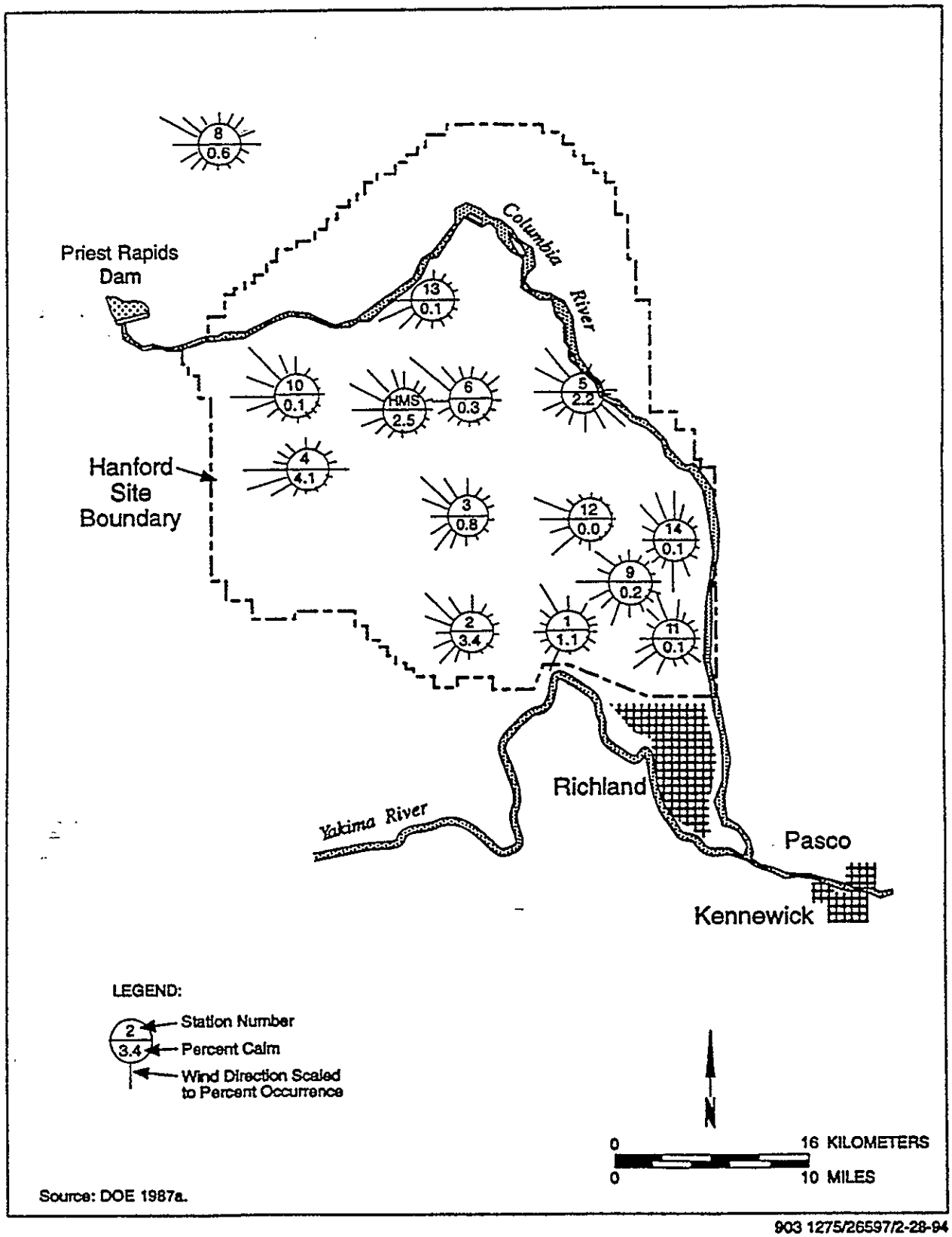
Figure 2-24. Discharge from Priest Rapids Dam, 1960-1977.



Source: Ecker et al 1983.

903 1275/26624/2-28-94

Figure 2-25. Wind Roses for the Hanford Site.



Source: DOE 1987a.

903 1275/26597/2-28-94

Table 2-1. Facilities in the 100 N Area. (page 1 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
105-N (N Reactor)	Reactor building	1963-present	Provides housing for N Reactor and ancillary facilities.	Nonairtight reinforced concrete and steel structure. Houses reactor, fuel storage, reactor work areas, instrumentation room, and transfer area.
107-N	Basin recirculation facility	1983-1990	Contains filtration system used to remove radionuclides from the N Reactor basin water	Reinforced concrete structure. Chemical storage tanks located outside building.
108-N (1106-N)	Chemical unloading facility	1963-1990	Unloading area for trucks and tank cars containing sulfuric acid or sodium hydroxide.	Three aboveground sulfuric acid tanks, one aboveground sodium hydroxide tank and six french drains; five which have been removed.
109-N	Heat exchange building	1963-1990	Provides means for dissipation of reactor process heat.	A reinforced concrete, structural steel building with channeled steel siding. Shares common wall with south wall of N Reactor building. Houses six heat exchanger cells, associated pumps, piping, laboratory, offices and shop areas.
109-NA	Steam and flow building	1963-mid 1980's	Houses hydraulic power-packs used for supplying hydraulic control power to steam values located in the 109-N building.	Steel butler-type building.
116-N	Air stack	1963-present	HEPA filtered exhaust air and gas from the N Reactor ventilation system.	Reinforced concrete stack.
116-N-1 (1301-N)	Crib and trench	1964-1985	Received radioactive effluent from N Reactor and 109-N. Water contained activation and fission products and small quantities of corrosive liquids and laboratory wastes.	Rectangular basin (crib) is 125 ft wide, 290 ft long, 12 ft deep. The bottom is covered with 3 ft of large stones. Extension trench is 1,600 ft long, 50 ft wide, 12 ft deep. Trench is covered by reinforced concrete slabs.
116-N-2 (1310-N, golf ball)	Storage tank	1968-1987	Collection tank for N Reactor primary piping decontamination wastes.	Spherical steel structure with storage capacity of 900,000-gal
116-N-3 (1325-N)	Crib and trench	1983-1993	Receives radioactive activation and fission products and small quantities of corrosive liquids and laboratory chemicals.	Rectangular concrete diversion box (250 x 240 ft), a header box, ~1,200 ft of buried 36-in diameter pipeline, and an extension trench 3,000 ft long, 10 ft wide, 7 ft deep. Crib and trench are covered with precast concrete panels.

Table 2-1. Facilities in the 100 N Area. (page 2 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
116-N-4 (1300-N)	Emergency dump basin	1963-1987	Received steam blowdown from N Reactor steam generators containing low levels of radioactive activation and fission products. Also received water from N Reactor lift station and possible contaminated low point drains.	A steel-lined storage pond with a 1,000,000-gal capacity.
116-N-8 (163-N mixed waste and hazardous waste container storage pad)	Storage pad	1986-present	Drum and containerized storage for mixed and miscellaneous hazardous process chemicals.	A 152 by 60 ft curbed and fenced concrete pad located south of the 163-N building in a three-sided building.
117-N	Exhaust air filter building	1963-present	Filters ventilation air from the confinement zone of the N Reactor building before it is discharged to the atmosphere.	Reinforced concrete structure, almost completely below grade, 4290 ft^2 of enclosed space.
117-NVH	Valve control house	1963-present	Valve house for instrumentation and controls.	Small sheet metal building of approximately 80 ft^2.
118-N-1	Spacer storage silos	1963-present	Used for storage of irradiated fuel spacers from the N Reactor.	The area consists of three silos, two approximately 16 ft in diameter and 20 ft deep and open to the soil. The bottom of the smallest silo is a layer of aluminum filings over the soil. All three silos are covered by concrete caps.
119-N	Air sampling and monitoring	1963-present	Building houses air sampling equipment used for monitoring airborne emissions.	Steel butler-type building.
120-N-1 (1324-NA percolation pond)	Percolation pond	1977-1990	Received corrosive regeneration waste and filter backwash water. Currently receives nonregulated neutralized regeneration water.	Unlined pond, 29,000 ft^2 with a total volume of approximately 2 million gallons.
120-N-2 (1324-N surface impoundment)	Surface impoundment	1986-1988	Received corrosive waste from 163-N building.	Lined pond (1986-1988) with an approximate capacity of 424,000 gal. Prior to 1983, was unlined settling pond. 140 x 75 x 15 ft deep.
120-N-3 (163-N neutralization pit and french drain)	Neutralization pit and french drain	1963-1988	Received corrosive waste from 163-N day storage tanks	Drain pit is 33 x 9 x 8 ft deep.

Table 2-1. Facilities in the 100 N Area. (page 3 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
120-N-4 (1310-N waste oil storage pad, 1310-N nonhazardous waste pad)	1310-N Nonhazardous waste staging area	1985-present	Stores drums and containers of nonradioactive, nonhazardous waste.	Curbed concrete pad 100 x 75 ft, enclosed by chain link fence and locked gates.
120-N-5 (108-N/ 163-N transfer line neutralization pit)	Transfer line neutralization pit	1963-1990	Received corrosive waste for neutralization from transfer line.	Concrete basin lined with polymer concrete.
120-N-6 (108-N acid tank vent french drains)	108-N acid tank vent french drains (five)	1963-1988	Received corrosive waste condensate (sulfuric acid) from tanks and transfer lines in the 108-N building.	No acids or heavy metals were found at site of french drains during characterization in 1987. The five french drains were removed in 1988.
120-N-7 (100 N acid unloading facility french drain)	100 N acid unloading facility french drain	1963-1987	Received corrosive waste (sulfuric acid) generated during acid unloading operations.	Broken vitrified clay pipe and gravel mound at surface.
120-N-8 (163-N sulfuric acid vent french drain)	163-N sulfuric acid vent french drain	1963-1988	Received corrosive waste (sulfuric acid) from 163-N day storage tank.	Gravel- and soil-filled french drain.
124-N-1 (124-N-1 septic tank)	100 N sanitary sewer system no. 1	1963-present	Receives about 1,400 gal per day of sanitary sewage from 163-N/183-N building.	A 2,300-gal storage capacity tank and seepage pit connected to an infiltration area of 200 ft^2
124-N-2 (124-N-2 septic tank)	100 N sanitary sewer system no. 2	1963-present	Receives about 200 gal per day of sanitary sewage from 182-N building.	A 2,300-gal storage capacity tank and seepage pit connected to an infiltration area of 200 ft^2
124-N-3 (124-N-3 septic tank)	100 N sanitary sewer system no. 3	1963-present	Receives about 45 gal per day of sanitary sewage from 107-N building.	A 500-gal capacity cesspool consisting of a buried precast, perforated, concrete pipe resting on 2 ft crushed stone
124-N-4 (124-N-4 septic tank)	100 N sanitary sewer system no. 4	1963-1987	Received about 30,000 gal per day of sanitary sewage from most of the 100 N buildings.	Two septic tanks, with a total capacity of 14,000 gal, connected to a drain field with an infiltration area of 8,900 ft^2
124-N-5 (124-N-5 septic tank)	100 N sanitary sewer system no. 5	1981-1987	Received about 3,800 gal per day of sanitary sewage from 1111-N, 1116-N, 1117-N, 1118-N, 1123-N, 1123-N, 1125-N, and 1131-N buildings and trailers.	A 3,700-gal capacity septic tank connected to a drain field with an infiltration area of 960 ft^2

Table 2-1. Facilities in the 100 N Area. (page 4 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
124-N-6 (124-N-6 septic tank)	100 N sanitary sewer system no. 6	1979-1984	Received unknown amount of sanitary sewage from 1113-N, 1114-N, and 1115-N buildings.	A 2,000-gal capacity septic tank connected to a drain field with an infiltration area of 600 ft^2
124-N-7 (124-N-7 septic tank)	100 N sanitary sewer system no. 7	1984-1987	Received about 5,200 gal per day of sanitary sewage from 1103-N, 1104-N, and 1145-N buildings.	A 7,500-gal capacity septic tank connected to a drain field with an infiltration area of 5,500 ft^2
124-N-8 (124-N-8 septic tank)	100 N sanitary sewer system no. 8	1983-1987	Received 900 gal per day of sanitary sewage from 1132-N, 1133-N, 1134-N, and 1135-N buildings.	A 5,000-gal capacity septic tank connected to a drain field with an infiltration area of 1,650 ft^2
124-N-9 (124-N-9 septic tank)	100 N sanitary sewer system no. 9	1985-present	Receives 2,200 gal per day of sanitary sewage from 1120-N buildings.	Two septic tanks of 3,000-gal capacity connected to a drain field with an infiltration area of 3,500 ft^2
124-N-10 (100 N central sewer system, 124-N-10 sanitary sewer system)	100 N sanitary sewer system no. 10	1987-present	Receives 50,000 gal per day of sanitary sewage from 27 facilities and buildings formerly connected to 100 N sewer systems 4, 5, 6, 7, and 8. Also receives sanitary sewage trucked from the 200 Area.	A three pond sewage lagoon facility, sewer trunk line and other pipelines, two lift stations, manholes, and associated sewer system instrumentation and annunciation systems.
128-N-1 (100 N burning pit)	Burning pit	1963-1989	Used to dispose combustible materials, such as nuisance vegetation, office wastes, tools, hardware, and possibly paints and solvents.	Area located approximately 1,500 ft northeast of 1120-N building, southeast of 116-N-3.
130-N-1 (183-N filter backwash pond)	183-N backwash discharge pond	1983-present	Percolation pond for filter backwash.	Unlined pond.
143-N	Snubber shop	1970's-present	Stored paint, miscellaneous products and small power equipment.	Wood structure.
151-N	250 KV electric substation	1963-present	Supplies electrical power to 100 N Area.	Located north of 120-N-1 percolation pond.
153-N	Switch gear building	1963-present	Houses a transformer/substation.	Block building of approximately 2,300 ft^2.
155-N	BPA switch yard	1968-present	Electrical power line junction and switch yard	Large area containing electrical energy transmission equipment and support building.

Table 2-1. Facilities in the 100 N Area. (page 5 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
163-N	Demineralization plant	1963-1990	Provides demineralized water for reactor primary coolant system.	Reinforced concrete and structural steel, immediately west of 183-N building with which it shares a common wall. 82 x 78 x 40 ft high.
166-N	Oil pump house and storage tank	1963-1990	Fuel oil storage, distribution and control building.	Includes a 1,375,000-gal tank immediately adjacent to the 1715-N Facility and a two-story block building.
181-N	River pump house	1963-1991	Provides raw Columbia River water to various facilities.	Reinforced concrete structures.
181-NE	HGP river pump house	1963-1987	Provides raw Columbia River water to SS facilities.	Reinforced concrete structure.
182-N	High-lift pump house	1963-present	Provides sanitary water for administrative buildings at 100 N.	Reinforced concrete building with channeled steel walls. Houses pumps used to inject demineralized water into cooling systems. 107 x 97 x 20 ft high.
183-N	Water filter plant	1963-present	Provides treated and filtered water for process applications.	Consists of a chemical treatment facility, flocculation basins, filter system, and clearwell storage. 102 x 84 x 20 x high.
184-N Day tanks	Storage tanks	1963-1991	Diesel and black oil storage.	Two 35,000-gal tanks and one 8,000-gal tanks.
184-N	Power house	1963-1990	Provides electrical power for routine and emergency use and process steam.	Reinforced concrete and structural steel building with channeled steel siding. 112 x 96 x 70 ft high.
184-NA, NB, NC	Annex	1963-present	Houses two boilers which provide auxiliary and additional process steam.	Steel butler-type buildings.
185-N	HGP turbine generator building.	1963-1987	Main building which houses turbine generators used for electrical energy production.	This SS facility used surplus N Reactor steam to generate electricity from 1964 to 1987.
1100-N (demolished)	Administration and first aid building	1963-1994	Provided office space for administrative and technical staff.	Building demolished, concrete foundation and floor was 199 x 35 ft.
1101-N to 1105-N, 1107-N, 1109-N to 1111-N (demolished)	Office buildings	1963-1994	Provided office space for administrative and technical staff.	Buildings demolished.
1112-N	Badge house	1983-1991	Security.	Concrete block building with a glass and steel walk through.

Table 2-1. Facilities in the 100 N Area. (page 6 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
1113-N to 1115-N, 1117-N to 1118-N	Office buildings	Early 1980's-present	Provides office space.	Trailers.
1116-N	Simulator building	Early 1980's-present	Control room training.	Trailer.
1119-N	Locker room building	Early 1980's-present	Provides locker space.	Trailer.
1120-N	Warehouse and training building	Early 1980's-present	Provides office space.	Steel butler-type building.
1123-N	Office building	Early 1980's-present	Houses emergency control room	Trailer.
1124-N	Office and records control center	Early 1980's-present	Provides office and storage space.	Trailer.
1125-N, 1126-N	Office buildings	Early 1980's-present	Provides office space.	Trailers.
1127-N	Mobile outage locker room	Early 1980's-present	Provides office space and change room.	Trailer.
1129-N	Special warehouse	Early 1980's-present	Provides storage space.	Trailer.
1130-N	SWP change room building	Early 1980's-present	Used as a changing and storage facility.	Trailer.

Table 2-1. Facilities in the 100 N Area. (page 7 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
1131-N, 1132-N, 1133-N, 1134-N, 1135-N	Mobile office buildings	Early 1980's-present	Provides office space.	Trailers.
1140-N, 1141-N	Restrooms	Early 1980's-present	Provides restroom space.	Trailer.
1142-N	Telephone center	Early 1980's-present	Telecommunications	Trailer.
1143-N, 1143-NA, NB	Paint shop and storage buildings	Early 1980's-present	Provides maintenance space.	Steel butler-type buildings. Paint shop and carpenter shops are approximately 1,450 ft^2 each.
1144-N to 1145-N, 1147-N, 1149-N to 1158-N, 1163-N	Offices	Early 1980's-present	General office space	Trailers.
1304-N	Emergency dump tank	1973-1987	Received emergency blowdown of thermally hot primary reactor coolant water.	1,300,000-gal storage tank located west of N Reactor building.
1312-N	Liquid effluent retention facility	1988-present	Backup to existing containment systems to receive primary cooling water.	HDPE bladder within a lined and bermed impoundment. This facility has never been used.
1313-N	Change and control room	1978-present	Remote instrumentation control for waste transfers to 116-N-2.	Small metal building of approximately 140 ft^2.
1314-N	Liquid waste loadout station	1972-present	Received spent radioactive decontamination from 116-N-2 facility and 107-N facility for transfer to railway tank farms.	Curbed pad with steel butler-type building. Prior to 1976 the site consisted of concrete pad.
1315-N	Diversion system valve house	1963-present	Houses valves which control discharge to the crib.	A 130 ft^2 steel building.
1316-N	Valve house	1963-present	Houses valves which control discharge to cribs.	Small steel building.
1322-N and 1322-NA, NB, NC	Pilot plant treatment facility and sample building	1963-1991	Sample station. Buildings contained automated sampling equipment used to sample the N Springs and radioactive drainlines.	Small steel butler-type building.

Table 2-1. Facilities in the 100 N Area. (page 8 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
1701-N, 1701-NE	Badge house	1963-1984	Security	Trailer.
1702-N	Vehicle inspection	1965-1984	Security	Small portable six by eight foot shed.
1703-N	HGP offices	1965-present	Offices	
1705-N	Instrument and electrical facility	1965-present	Provides space for instrument and electrical shops.	Large steel building with offices and shops
1706-N	Shop area	1965-present	Provide shop and storage space.	Steel butler-type building.
1707-N	Patrol boat storage house	1963-present	Provides storage space.	Metal.
1712-N	Insulation shop	1963-present	Provides maintenance space.	Wood.
1714-N and 1714-NA	Warehouse and receiving facility	1963-present	Provides storage space.	Steel butler-type building.
1715-N	Diesel oil storage tanks	1963-1990	Storage of diesel oil used by pumping systems.	Four 105,000-gal aboveground diesel oil tanks.
1722-N	Decontamination hot shop building	1963-present	Provides decontamination space and area for working with contaminated equipment.	Transite- and steel-sided buildings.
1723-N	Contaminated equipment storage building	1980-present	Provides storage space. Stored contaminated equipment from 1980 to 1984.	In 1984 the area was decontaminated and made into shipping and receiving warehouse.
1734-N	Gas bottle storage	1963-1991	Store pressurized bottles.	Block, transite and steel construction.
1900-N	Water supply tanks	1963-1991	Provides the plants water storage needs.	Steel tanks.
1908-N	Seal well	1963-present	Provides access to the 102-in discharge line for sampling, etc.	Concrete reinforced wier box.
1908-NE	HGP seal well	1963-1990	Provides access to the river discharge for sampling, etc.	Concrete reinforced wier box.

Table 2-1. Facilities in the 100 N Area. (page 9 of 9)

Current Designation (Alias)	Name	Years in Service	Facility Purpose	Facility Description
N-1 to N-30	Craft shops and office buildings	1963-present	Provides office and shop space.	Trailers, wood and steel buildings. Many are in the process of being removed.

HEPA - High efficiency particulate air filter
HGP - Hanford generating plant
HDPE - High density polyethylene
SS - Supply System
SWP - Special work permit

Sources: DOE-RL 1991b, AEC-GE 1964, WHC 1994, Bechtel Hanford Inc. and Westinghouse Hanford Company personnel.

Table 2-2. Overview of Significant Dates for 100 N Area Operation.

Date	Activity
May 13, 1959	Construction of N Reactor begins
September 1963	Construction of Hanford Generating Plant (HGP) begins
October 1963	Construction of N Reactor completed
December 1963	N Reactor achieves initial criticality
November 1964	N Reactor reaches 4,000 MW (thermal)
April 1966	HGP construction completed, electricity production begins
December 1966	N Reactor reaches 800 MW (electrical) (combined with HGP output)
June 1975	N Reactor irradiated fuel storage begins in the 105 KE fuel storage basin
February 1981	N Reactor irradiated fuel storage begins in the 105 KW fuel storage basin
December 12, 1986	N Reactor shutdown for safety upgrades
February 1988	DOE directive to prepare N Reactor for cold standby issued
January 1989	Defueling of N Reactor core begins
April 1989	Defueling of N Reactor core completed
October 1990	Layup completed; cold standby begins
October 1991	N Reactor deactivation/preparation for decontamination and decommissioning (D&D) ordered

Table 2-3. 100 N Area Waste Stream Information. (page 1 of 3)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics	Dates of Operation
Primary Process Systems						
Reactor Decontamination Waste	105-N zone I	Solid	600,000 gal per decon event	Shipped to 200 Area tank farm	Low level*	1968 to 1987
163-N Demineralization Backwash Waste	163-N demineralization water plant	Solid	~400,000 gal/d	Neutralized at 1324-N then discharged to 1324-NA	Corrosive liquid	1963 to 1990
107-N Demineralizer Column Regeneration Waste	107-N	Solid	NA	Neutralized at 107-N tank then shipped to 200 Area tank farm	Low-level radioactive waste, corrosive	1983 to 1990
Solid Waste						
1143-N Paint Shop Wastes	1143-N paint shop	Solid	~55 gal in 2 months	Drum transferred to 116-N-8 storage pad then to 616 bldg	Hazardous waste including MEK, ignitable	1985 to present
Maintenance Shop Contaminated Rags	105-N	Solid	~55 gal in 4 months	Drum transferred to 163-N storage pad then to 616 bldg	Ignitable	1963 to present
105-N Battery Locker Wastes	105-N	Solid	Variable, <100 gal/yr	Acid collected in 13 gal carboys and transferred to 116-N-8, then to 616 bldg	Toxic (cadmium, lead), corrosive	1963 to 1990
Water Quality Lab Wastes	109-N	Solid	300 ml/d when reactor not operating	116-N-8 storage pad then non-rad transferred to 616 bldg	Low-level*, corrosive, toxic (mercury)	1963 to 1989
116-N-8 (163-N Storage Pad)	100 N/K Areas	Solid	1,000 drums can be stored at one time	616 bldg or radioactive retrievable storage units	Hazardous and low-level radioactive waste	1986 to present
1310-N Storage Pad	100 N/K Areas	Solid	200 drums can be stored at one time	NA	Waste oil	1985 to present
Liquid Wastes						
130-N-1 (183-N Filter Backwash)	183-N Filtered Water Plant	Liquid	300,000 to 470,000 gal/d	Filter backwash pond	see Table 3-13	1983 to present
163-N Process Water	163-N	Liquid	200 to 300 gal/m	1324-N/NA	see Tables 3-10 and 3-11	1963 to 1990

Table 2-3. 100 N Area Waste Stream Information. (page 2 of 3)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics	Dates of Operation
Liquid Wastes (Cont.)						
105/109-N Radioactive Liquid Discharges	105/109-N	Liquid	1,300 to 3,000 gal/m	1325-N and 1301-N	Low level*	1963 to 1993
182-N Tank Farm Overflow	182-N	Liquid	4 to 7.2 mgal/d without low lifts; 50 mgal/d with low lifts	Columbia River	Some oil and grease; NPDES permit #WA-000374-3	1963 to 1990
182-N Drain System	182-N	Liquid	0.29 mgal/d without fog spray; 5.4 to 26 mgd with fog spray	Columbia River	Some oil and grease; NPDES permit #WA-000374-3	1963 to 1990
181-N Inlet Screen Backwash	181-N	Liquid	0.31 to 0.48 mgal/d	Columbia River	NPDES permit #WA-000374-3	1963 to 1991
102-in Outfall	105/109-N	Liquid	390 to 610 mgal/d	Columbia River	NPDES permit #WA-000374-3; radioactive constituents	1963 to 1987
N Springs	1325-N and 1301-N (via groundwater)	Liquid	0.96 to 1.4 mgal/d	Columbia River	NPDES permit #WA-000374-3; radioactive constituents	1964 to present
Airborne Emissions						
105/109-N	105/109-N	Gas	210,000 ft^3/m	116-N stack	Radioactive constituents - uses HEPA filter	1963 to present
109-N	zone I	Gas	120,000 ft^3/m	109-N zone I vent	Radioactive constituents	1964 to 1991
109-N	cell 6	Gas	28,000 ft^3/m	109-N cell 6 vent	Radioactive constituents	1964 to 1991
109-N	zone II	Gas	23,000 ft^3/m	105/109-N zone II exhaust fan	Radioactive constituents	1963 to 1991
109-N	zone III	Gas	130,000 ft^3/m	Zone III exhaust fan 10	Radioactive constituents	1963 to 1991
109-N	zone IV	Gas	1,600 ft^3/m	Zone IV exhaust fans 14 and 15	Radioactive constituents	1963 to 1991
105-N Transfer Area	105-N	Gas	28,000 ft^3/m	105-N transfer area exhaust fans	Radioactive constituents	1963 to present

Table 2-3. 100 N Area Waste Stream Information. (page 3 of 3)

Waste Stream	Origin	Type	Volume	Disposal Location	Waste Characteristics	Dates of Operation
Airborne Emissions (Cont.)						
105-N Spacer Decon Facility	105-N	Gas	4,800 ft^3/m	105-N spacer decon facility exhaust fan	Radioactive constituents - uses HEPA filter	1963 to present
105-N 14' Decon Facility	105-N 14'	Gas	6,400 ft^3/m	105-N 14' decon facility exhaust fan	Radioactive constituents - uses HEPA filter	1963 to present
107-N Exhaust	107-N	Gas	7,300 ft^3/m	107-N exhaust vent	Radioactive constituents - uses HEPA filter	1983 to present

gal/m = gallons per minute
gal/d = gallons per day
gal/yr = gallons per year
mgal/d = million gallons per day
ml/d = mililiter per day
ft^3/m = cubic feet per minute
MEK = Methyl ethyl ketone
NA = Not Available.
*At various times these waste streams may have received mixed waste.

Sources: ICF Technology and Ebasco 1988; Westinghouse Hanford Company and Bechtel Hanford Inc. personnel.

Table 2-4. List of Endangered and Threatened Washington State Species Having the Potential to Occur on the Hanford Site. (page 1 of 2)

Endangered Vascular Plants Persistentsepal yellowcress (*Rorippa columbiae*): Known to have a scattered distribution because of specialized habitat requirements or habitat loss; generally occurs in moist to marshy places and is known to inhabit the wetted shoreline of the Hanford Reach of the Columbia River in Benton County.
Threatened Vascular Plants Columbia milk-vetch (*Astragalus columbianus*): Endemic to the area in the immediate vicinity of Priest Rapids Dam, including a portion of Benton County; could occur along the Columbia River in the northwestern portion of the Hanford Site. Eatonella (*Eatonella nivea*): Known to occur along the Columbia River in Grant County; could occur along the river in the northern portion of the Hanford Site. Hoover's desert parsley (*Lomatium tuberosum*): Endemic to south-central Washington, including Benton County; known to inhabit rocky hillsides.
Endangered Birds Aleutian Canada goose (*Branta canadensis leucopareia*): Nests in the Aleutian Islands of Alaska and winters in California; has been occasionally sighted, as a migrant, in Benton County; a potential seasonal user of the Columbia River valley, feeding on grasses, sedges, and berries. American white pelican (*Pelecanus erythrorhynchus*): Winters along the southern Pacific Coast and the Gulf Coast and nests in northern prairie and intermontane lakes; no longer nests in Washington; migrates through eastern Washington; flocks are common in the Columbia Basin during the summer; known to occasionally winter on the Columbia River, foraging on fish, amphibians, and crustaceans and roosting on islands. Peregrine falcon (*Falco peregrinus*): Breeds and winters in eastern Washington, inhabiting open marshes, river shorelines, wide meadows and farmlands; nests on undisturbed cliff faces; an erratic visitor at the Hanford Site, feeding on songbirds, shorebirds, and waterfowl.

Table 2-4. List of Endangered and Threatened Washington State Species Having the Potential to Occur on the Hanford Site. (page 2 of 2)

Endangered Birds (cont.) Sandhill crane (*Grus canadensis*): Inhabits open prairies, grainfields, shallow lakes, marshes, and ponds, nesting in drier grassy and marshy areas; common migrant during the spring and fall in Washington; some known and suspected nesting sites in eastern Washington; unlikely visitor at the Hanford Site. Upland sandpiper (*Bartramia longicauda*): Inhabits ungrazed and lightly grazed prairies, upland meadows, and fields that are usually located near lakes or rivers; breeds in the northern and central portions of North America and winters in South America; uncommon in eastern Washington; a potential migratory visitor at the Hanford Site, feeding on insects, worms, and some vegetation. Western snowy plover (*Charadrius alexandrius*): A coastal species rarely observed in eastern Washington.
Threatened Birds Bald eagle (*Haliaeetus leucocephalus*): A regular winter visitor to the Columbia River, feeding on spawning salmon and perhaps waterfowl and small mammals; roosting areas are known to exist in the 100 Areas of the Hanford Site (roost sites and winter feeding areas constitute critical habitats for this species). Ferruginous hawk (*Buteo regalis*): Inhabits open prairies and sagebrush plains, usually with rocky outcrops or scattered trees, located well away from human disturbance; known to nest in Benton and Franklin counties, with Franklin County possessing the majority of the nests within Washington; known to nest in the Hanford Site on the Arid Lands Ecology Reserve; rarely winters in Washington; known to occasionally forage on small mammals, birds, and reptiles on sagebrush plains in the Hanford Site.
Threatened Mammals Pygmy rabbit (*Sylvilagus idahoensis*): May be extirpated from Washington; inhabits undisturbed areas of sagebrush having soils soft enough in which to dig burrows; once known to exist on the Hanford Site near springs in the Snively Basin, west of the 200 Areas plateau.
Note: State designations are as strict as, or stricter than, federal designations. Information taken from DOE (1987a), Hitchcock and Cronquist (1978), DNR(1987), DOW (1987).

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3.0 INITIAL EVALUATION

This chapter is presented in four sections. The first section lists the known and potential contamination within the 100-NR-1 Operable Unit. The potential corrective action clean-up requirements for the contamination identified by the data review follows. The potential impacts to the public health and the environment are reviewed next, followed by a consideration of the corrective action objectives and alternatives for the types of contamination found.

The information on known and suspected contamination presented in Section 3.1 is based on available data. This information provided input to the preliminary identification of potential contaminant- and location-specific corrective action requirements and the potential impacts to the public health and the environment described in Section 3.2 and 3.3, respectively. Additional data needed for an understanding of the nature and extent of contamination at the operable unit will be collected during the LFI and final RFI. Collection of these additional data, by means of both data compilation and field investigations, is discussed further in Chapter 5.0.

3.1 KNOWN AND SUSPECTED CONTAMINATION

A summary of the known and suspected contaminant sources and the nature and extent of contamination in the various environmental media at the 100-NR-1 Operable Unit is provided below.

To determine the presence or extent of contamination at a site caused by a given event or activity, a summary of background levels of the pollutants must be made. Westinghouse Hanford Company (WHC) proposed a Hanford Sitewide approach to the characterization and use of background data for environmental restoration at the Hanford Site (Hoover and LeGore 1991), and has completed a systematic sampling of the vadose zone (DOE-RL 1994g). The planned evaluation of existing groundwater background data and models (Hoover and LeGore 1991) has been completed, groundwater sampling and analysis is in progress.

It is important when interpreting the data in this section that attention be paid to the amount of radioactive decay that has taken place since the data were gathered. For example, the half-life of tritium is 12.3 yr, approximately the time between 1978 and 1990. Thus, tritium levels would, in 1990, be approximately half their 1978 values. Where possible, the dates for radionuclide inventories have been given, but no attempt has been made to calculate the decayed inventories through the present.

3.1.1 Sources

There are 109 discrete sources of known or potential contamination at the 100 N Area, including eight potential sources at the HGP. Table 3-1 contains brief background information (location, operational dates, waste description, and unit/release description) for identified sources in the 100 N Area.

Sources are placed together into logical groupings, either according to geographical location or process and waste-handling similarities. Figures 3-1 and 3-2 show the locations of source units within the 100 N Area.

All the currently available information for the 100 N Area sources are discussed below. There are no data concerning unplanned releases prior to 1973, but releases probably did occur. All the historical data are being reviewed as part of the source data compilation task discussed in Chapter 5. If additional information becomes available for any of the sources or unplanned releases, the conceptual model will be revised as necessary.

3.1.1.1 1314-N Liquid Waste Loadout Station. This grouping is located at the 1314-N LWLS near the western fence, north of the N Reactor building. The grouping consists of one waste management unit and two unplanned releases which occurred at this unit.

The 1314-N LWLS is a transfer station consisting of numerous valves, pumps, underground and overhead piping and couplings, and underground tanks at the northern end of the 100 N Area, approximately 90 m (300 ft) from the Columbia River. The unit receives liquid radioactive waste from 116-N-2 radioactive chemical waste treatment and storage facility, and the 107-N spent fuel basin recirculation facility. The effluent is transferred into railway tank cars and transported to the 200 Area for processing and disposal (Golder Associates Inc. 1988, DOE-RL 1978).

The 1314-N LWLS has been utilized since 1972, and the shelter building was built in 1978. One valve pit is located in the building and one is outside along the north side of the building.

The dimensions of valve pits and the concrete spill catch basin below the railroad tank car loading point are unknown. Valve pit floors are soil. Two drains in the catch basin connect to a separate catch tank and a 3,800 L (1,000 gal) transfer tank located inside the 1314-N building.

The radioactive effluent piped from the 116-N-2 storage tank was internal decontamination solution from cleaning of the primary coolant loop in the N Reactor and various waste decontamination solutions from small decontamination jobs. Decontamination of the primary loop was done every 3 to 5 years. The radioactive wastewater resulting from this procedure contained phosphoric acid, diethylthiourea, and may have included other agents such as oxalic acid. The wastewater was neutralized in the 116-N-2 facility by the addition of sodium hydroxide solution.

Two unplanned releases associated with the 1314-N LWLS have been documented. The releases are described below:

- September 24, 1973 (UN-100-N-13) - Operations personnel were filling a railroad tank car with waste material from 1314-N when the solution began overflowing from the tank car fittings. The tank car loading pump was turned off. Solution began flowing up through the drain in the catch basin beneath the car, overflowed into the dry well, which also filled and overflowed. The catch basin and dry well are located within the 1314-N building. Approximately 380 L (100 gal) of solution flowed out of the dry well, covering a 6-m by 6-m (20 ft by 20 ft) section of ground inside the radiation zone at the loading station. Total activity in liquid released to ground through the dry well was estimated at 0.011 Ci. Total activity in the 6-m by 6-m (20 ft by 20 ft) area on the ground surface was estimated at 0.015 Ci. An unknown amount of contaminated soil was packaged and shipped to the 200 Area burial ground (UNI 1973, Stenner et al. 1988).

- December 7, 1978 (UN-100-N-26) - The second unplanned release was a 3,800 L (1,000 gal) spill of reactor decontamination solution. The solution backflowed while being pumped into a tank car, and contaminated the valve pit. Most of the solution was pumped back into a tank car. The remaining wastewater was absorbed and sent to the 200 Area burial ground (Stenner et al. 1988).

3.1.1.2 119-N Air Sampling and Monitoring Building. This grouping is located in the vicinity of the 119-N air sampling and monitoring building which is 150 m (500 ft) north of the N Reactor building and directly south of the 1314-N liquid waste loadout facility grouping. The grouping consists of one waste management unit and two unplanned releases listed below. All adjacent to the 119-N building.

1. UN-100-N-14 unplanned release
2. UN-100-N-9 unplanned release
3. 116-N air stack.

3.1.1.2.1 119-N Air Sampling and Monitoring Building Unplanned Releases. The 119-N building houses the equipment used to sample effluent gases and particulates in the adjacent 116-N air stack. One sample collection device used clean water as the coolant for a condenser. The coolant drain pipe was improperly connected (when originally installed) to the nearby 91-cm (36 in) low pressure flush line, which carried irradiated reactor cooling water from the 105-N lift station to the 116-N-1 crib and trench. The improper connection caused the 119-N drain to become pressurized whenever the 105-N lift station pumps were operating. The first unplanned release occurred when 119-N plumbing repairs were being attempted, without knowledge of the improper connection, which was not shown on plans. The second unplanned release occurred during attempts to find the improper connection point. The drain line was eventually disconnected permanently and routed to an earth absorption pit (UNI 1974a).

- August 5, 1974 (UN-100-N-14) - United Nuclear Industries maintenance personnel were working on the 119-N drain system to correct loss of coolant flow in a condensate collection sampler. Upon opening the 5-cm (2 in) diameter drain system to the atmosphere, a backflow from the drain occurred, causing an unplanned release. Intermittent flow was observed from the opened line, until the drain system was reconnected. Approximately 265 L (70 gal) of effluent covering an area of 74 m^2 (800 ft^2) was released to the ground near the 119-N sample building. Total activity was estimated at 0.8 mCi of beta/gamma activity. The contaminated soil area was covered with plastic sheeting and the area barricaded. An unknown amount of soil was excavated and moved to the 200 Area. The area was backfilled with clean soil (UNI 1974b).

- October 14, 1974 (UN-100-N-9) - A 8,300 L (2,200 gal) leak from the same 5-cm (2 in) diameter cooling water drain line connected to the 91-cm (36 in) low pressure flush line occurred when a backhoe hooked onto a buried 5-cm (2 in) valve in the drain line (depth unknown). Contaminated water immediately flowed into the excavation hole around the valve. To facilitate inspection of the valve, excess water was pumped from the hole into a nearby load lugger for temporary storage and the excavation was enlarged. Inspection showed water leaking from the valve bonnet due to the stretching of the valve bonnet bolts. The leak was repaired by replacing the valve bonnet bolts. The excavation site, including the backhoe, was roped off as a radiation zone. Total activity was approximately 4 mCi. An unknown amount of contaminated soil was excavated and removed to the 200 Area burial ground (UNI 1974a).

The 100-NR-1 LFI included chemical and radiological analyses of samples from borehole 199-N-84 drilled to a total depth of 25 ft during November, 1992 (DOE-RL 1994c). The borehole location is shown by Figure 3-3. Figure 3-4 summarizes the geological, analytical, field screening, and geophysical data obtained from borehole 199-N-84. Radionuclide contamination was not expected at this site, therefore only field screening and borehole gamma logging were performed; samples that were collected were not analyzed for radionuclides. Field screening of sediments and the borehole geophysical log did not identify any elevated levels of radioactivity. No inorganic constituents were detected in concentrations above the Hanford Site 95% upper threshold limit (UTL) values. No semi-volatile organic compounds (semi-VOLs), pesticides, or polychlorinated biphenyls (PCBs) were detected. Volatile organic compounds (VOCs) were detected, as listed below:

Volatile organic compounds (μg/kg)	Sample and Sample Interval (ft bls)			
	B07Q83 9.5-11.5	B07Q84 17.5-20	B07Q85 22.5-24	B07Q86 22.4-24
Methylene chloride	2J	ND	2J	ND
Acetone	23	22	22	19

J = Detected value is considered to be an estimate due to quality control deficiencies.
ND = Not detected

3.1.1.2.2 116-N Air Stack. The 116-N air stack functions as the primary air emission point from reactor operations. No discharge records were available for the years 1963 until 1970. Records of discharges of radioactive materials begin in 1971 (Dabrowski 1972). Continuous air sampling was initiated in September 1981.

The radioactive gases detected in emissions from the 116-N stack in 1985 are as follows (Rokkan 1986):

Radionuclide Gases			
H-3	Kr-85m	I-129	I-135
Ar-41	Kr-87	I-131	Xe-133
	Kr-88	I-132	Xe-135
	KrRb-88	I-133	Cs-138

The particulates detected in emissions from the 116-N stack in 1985 are as follows (Rokkan 1986):

Radionuclide Particulates				
Pu-238	Mn-54	As-76	MoTc-99m	BaLa-140
Pu-239/240	Mn-56	Sr-89	Ru-103	CePr-144
Np-239	Fe-59	Sr-90	Ru-106	
Am-241	Co-58	ZrNb-95	Sb-122	
Na-24	Co-60	ZrNb-97	Cs-134	

Additional details regarding air releases are provided in Section 3.1.5. The discharge of radionuclides to the atmosphere was greatly decreased in December 1987, when the N Reactor standdown was initiated.

3.1.1.3 166-N Fuel Unloading and Storage Area. This grouping is located near the 116-N air stack and the 116-N-2 radioactive chemical waste treatment and storage facility and includes the following potential sources:

- fuel oil unloading station
- 166-N tank farm
- UN-100-N-17 unplanned release
- UN-100-N-20 unplanned release
- UN-100-N-24 unplanned release.

3.1.1.3.1 Fuel Oil Unloading Station. The fuel oil unloading station is a concrete-lined containment structure containing 30 cm (12 in) fuel oil supply piping which loads to the No. 6 fuel oil storage tank at the 166-N tank farm. The unit is located east of 1314-N LWLS. Tanker railcars unloaded No. 6 fuel oil at the station and oil was transferred via underground piping to the tank farm. Numerous small, unreported spills have occurred during tanker unloading activities (WHC 1989b).

3.1.1.3.2 166-N Tank Farm. The 166-N tank farm is an earthen-bermed tank farm containing one above ground 5,200,000 L (1,375,000 gal) No. 6 fuel oil tank and four aboveground 400,000 L (105,000 gal) diesel oil storage tanks. The earthen berm has a total containment capacity of 11,500,000 L (3,030,000 gal) (WHC 1989b). The tank farm is located between the 116-N air stack and the 116-N-2 radioactive chemical waste treatment and storage facility. It has been in operation since 1963.

No. 6 fuel oil is unloaded at the fuel oil unloading station from rail tanks and is piped via underground lines to the storage tank. A 20 cm (8 in) underground transfer line runs from the storage tank to the 184-N day tank, where the oil is stored prior to use in the boilers (WHC 1989b).

Diesel oil is unloaded from tanker trucks into the diesel storage tanks. The oil is pumped from the storage tanks via a 10-cm (4 in) underground transfer line to the 184-N day tanks and gravity-fed through a separate 10-cm (4 in) line to the 182-N underground storage tanks (WHC 1989b).

There have been three documented unplanned releases associated with the 166-N tank farm. They are described below:

- August 1966 (UN-100-N-17) - One unplanned release at the unit was caused by the external corrosion of a 10-cm (4 in) supply line between the diesel oil storage tank and the west dike, detected when a discrepancy in the diesel oil inventory was discovered. By that time, 300,000 L (80,000 gal) of diesel oil had been released. The diesel oil drained through the soil to groundwater, then migrated to the Columbia River. A trench was excavated along the riverbank in an attempt to intercept the oil before it could reach the river. Oil exposed in the trench was ignited and burned periodically through 1967 (WHC 1989b). No contaminated soil was removed from the site, and the supply line was repaired in September 1966 (Stenner et al. 1988).

- June 1985 (UN-100-N-20) - External corrosion reportedly caused a leak in a 5-cm (2-in) diesel oil return pipeline within the bermed area containing the four diesel oil tanks. The release of 760 L (200 gal) ran onto the soil (DOE-RL 1991b). The leaking line was excavated, repaired, and backfilled.

- February 1, 1987 (UN-100-N-24) - A leak was caused by external corrosion brought on by a leaking heat transfer line. The leak occurred on the west side of the No. 6 fuel oil tank within the bermed area. The release consisted of an unknown amount of No. 6 fuel oil that ran onto the soil. No cleanup was conducted for this spill. A portion or all of this spill penetrated the soil (DOE-RL 1991b).

The 100-NR-1 LFI included chemical and radiological analyses of samples from borehole 199-N-85 drilled to a total depth of 75 ft during January, 1993 (DOE-RL 1994c). The borehole location is shown by Figure 3-5. Figure 3-6 summarizes the geological, analytical, field screening, and geophysical data obtained from borehole 199-N-85. The concentrations of all VOCs, semi-VOLS, and radionuclides detected in soil samples are listed in Table 3-2. No inorganic constituents were detected in concentrations above the Hanford Site 95% UTL values, and no pesticides or PCBs were detected. The VOCs acetone, benzene, ethylbenzene, xylene, and 2-butanone and the semi-VOLs 2-methylnapthalene, naphthalene,

fluorene, anthracene, phenanthrene, and pyrene were detected predominantly in the 54 ft to 74 ft interval. Toluene and di-n-butylphthalate were found in samples from the 15 ft to 31 ft interval.

Potassium-40, cobalt-60, strontium-90, radium-226, thorium-228, and thorium-232, uranium-233/234, and uranium-238 were detected in the soil samples. The maximum detected radionuclide concentrations did not exceed 1.3 pCi/g, for any isotopes except potassium-40 which ranged from 8.9 to 16 pCi/g. Cobalt-60 and strontium-90 were only found in samples from the 59 ft to 74 ft interval. The other radionuclides occurred essentially in all sample intervals. The gamma ray geophysical logging indicated low levels of cobalt-60 (<1 pCi/g) in the 50 ft to 70 ft interval.

A soil gas survey consisting of a series of probes installed near fuel storage and transfer facilities in the 100-NR-1 Operable Unit was conducted to determine the presence of VOC and petrochemicals in the vicinity of these facilities. The purpose of the survey was to identify of surface and subsurface hydrocarbon contamination that would require further investigation.

Procedures used in the conduct of the survey are contained in the *100-NR-1 Operable Unit Soil-Gas Report* (WHC 1992a). The survey areas included the following four facilities.

- 1715-N diesel oil storage and unloading station
- 166-N fuel oil storage tank
- 166-N pump station
- 1900-N fuel oil unloading trench.

None of the VOCs typically associated with fuel products were detected in any of the soil-gas samples (Table 3-3). The presence of methane and depleted oxygen levels, characteristic of biodegradation, indicates that petroleum products have had sufficient time to biodegrade into other forms. Evidence of petroleum hydrocarbons was detected by field immunoassay tests conducted on drill cuttings obtained during installation of the soil gas sampling points. The elevated levels of total petroleum hydrocarbons (TPH) at the west end of the 1900-N fuel trench, inside the 1715-N tank berm, and at the diesel oil unloading station indicate that soils in these areas are potentially contaminated with petrochemicals.

The soil-gas results also indicate the presence of trace concentrations of perchloroethylene (PCE), a fuel oil additive, in areas where No. 6 fuel oil was unloaded or transferred. Operators and supervisors at 100 N confirmed that this additive was occasionally spilled at the unloading areas. Because these spills were probably small, the resulting contamination is likely limited to the soil in the vicinity of the unloading trench. It is unlikely that these materials have been transported to the underlying groundwater (WHC 1992a).

3.1.1.4 116-N-1 Crib and Trench Grouping. This grouping is located directly east of the 166-N fuel storage area and consists of:

- 116-N-1 crib and trench
- UN-100-N-31 unplanned release
- 1322-N and 1322-NA sampling building
- UN-100-N-8 unplanned release
- UN-100-N-4 unplanned release.

3.1.1.4.1 116-N-1 Crib and Trench. The 116-N-1 crib and trench is a major inactive waste management unit located approximately 300 m (1,000 ft) east of the N Reactor building. The system is commonly referred to as a liquid waste disposal facility. The 116-N-1 crib and trench was used from 1964 until September 1985. This ground disposal facility made use of the natural filtration and ion exchange

properties of soil to remove radioactive material from water. No liquid remains in the crib and trench. The crib is 88 m (290 ft) in length and 38 m (125 ft) in width. The walls of the crib are sloped soil and gravel embankment, and the depth is approximately 3.7 m (12 ft) from floor to ground surface (Diediker and Hall 1985, Gydesen 1986). The crib outline is shown in Figure 3-7.

A zig-zag extension trench, 15 m (50 ft) wide and 3.7 m (12 ft) deep, extends 490 m (1,600 ft) from the crib. The 116-N-1 extension trench was built in 1965 because wastewater volume exceeded the capacity of the crib. A 0.9 m (3 ft) layer of boulders was placed in the crib. Precast concrete cover panels were placed over the trench in 1982 to minimize wildlife access and airborne contamination (Golder Associates Inc. 1988).

The unit was designed to receive radioactive effluent originating in the N Reactor building. Pipelines that discharged directly into the 116-N-1 crib and trench through a 16 m by 3.7 m (52 ft by 12 ft) concrete weir box included an underground 91-cm (36 in) main effluent line from the 105-N lift station and an underground 30-cm (12 in) effluent drainline from the N Reactor basin floor drains, and a 15-cm (6 in) effluent drain line from the 109-N floor drains. Origins of these wastes are presented in Section 2.1.4.1 and at times the waste consisted of water from the primary reactor coolant system, periphery reactor cooling systems and decontamination of these systems.

Cumulative inventories, as of January 1, 1988, for principal radionuclides (Connelly et al. 1991) in effluent discharged to the 116-N-1 crib and trench having half-lives of greater than one year are presented below.

Radionuclide	Half-Life (Yr)	Inventory (Ci)
Co-60	5.3	2,300
Sr-90	28.6	1,900
Ru-106	1	3.7
Cs-134	2.1	12.0
Cs-137	30	2,600
Pu-239	24,000	23

A listing of dangerous waste solutions disposed in the 116-N-1 crib and trench was presented in the *Closure/Post Closure Plan 1301-N Liquid Waste Disposal Facility* (WHC 1987b), and follows. These wastes resulted from decontamination of the primary coolant system and from possible disposal of chemicals to common floor drains that discharged to the crib. The decontamination of the primary coolant system is discussed in Section 2.1.4.1.4.

Compound	Amount, lb/yr
Hydrazine Test Solution	6,100*
Ammonia Test Solution	6,100*
Chloride Test Solution	7,800*
Fluoride Test Solution	3,900*
Sodium dichromate	10,000**
Lead-Acetate Battery Fluid	630***

Compound	Amount, lb/yr
Nickel-Cadmium Battery Fluid	270***
Hydrazine (Injection System)	350

Note: * Reactor cooling water taken for chemical analysis to determine the amount of hydrazine, ammonia, chloride and fluoride in the coolant loop.
** Reportedly used until the mid-1970's.
*** No actual amounts available, but possible because of common floor drains.

Note: Routine monitoring of the influent to 116-N-1 did not reveal detectable levels of these chemicals (WHC 1987b).

The 116-N-1 crib and trench is a dangerous waste disposal facility under RCRA interim status. The DOE has prepared a draft closure and post-closure plan (WHC 1987b) for submittal to Ecology, in accordance with WAC 173-303-610.

The EPA issued a National Pollutant Discharge Elimination System (NPDES) permit for the 116-N-1 facility which required routine monitoring of discharges to the Columbia River via the N Springs. Monitoring data and discussion of the N Springs is provided in the 100-NR-2 Groundwater Operable Unit work plan (DOE-RL 1994a).

One unplanned release (other than systematic releases to the soil and groundwater) is associated with the 116-N-1 crib and trench:

- July 22, 1974 (UN-100-N-31) - While sample lines were being installed in a 15-cm (6 in) steel casing through the berm on the west side of the 116-N-1 crib, the water level in the crib was raised 38 to 46 cm (15 to 18 in) as a result of an emergency dump tank drawdown test being conducted. The increased water level allowed an unplanned release of approximately 3,800 L (1,000 gal) of effluent water to flow through the casing. This release contaminated 190 m^2 (2,000 ft^2) of soil. Sand and fines were used to stabilize soil contamination (Stenner et al. 1988). The extent of remediation instituted is unknown.

Samples of surface sediment were obtained from the bottom of the 116-N-1 trench on August 1, 1985 (Jacques 1986). The samples, about 10 grams each, were collected at several sampling ports on the concrete panels that cover the trench. The samples were analyzed for gamma-emitting radionuclides at an onsite analytical lab. The samples were then shipped to another laboratory for strontium-90 and plutonium analyses. The concentrations of radionuclides, gross alpha, and gross beta (in µCi/g, wet weight), detected in the 116-N-1 trench sediment samples are shown in below:

Sample	Gross Alpha	Gross Beta	Mn-54	Co-60	Sr-90	Cs-137	Ce-144	Pu-238	Pu-239/240
TS-1	0.035	1.9	0.054	1.3	0.093	0.029	<0.087	0.0046	0.026
TS-2	0.028	19.0	0.017	1.1	0.077	0.026	<0.067	0.0029	0.016
TS-3	0.052	13.0	<0.02	1.6	0.21	0.037	<0.084	0.051	0.027
TS-4	0.038	6.5	3	1.2	0.11	0.028	<0.085	0.004	0.023
TS-5	0.034	5.0	0.1	0.95	0.19	0.055	<0.069	0.0039	0.021
TS-6	0.043	10.0	0.056	1.1	0.12	0.068	<0.079	0.0042	0.024
TS-7	0.019	6.0	<0.01	1.3	0.12	0.056	0.05	0.0023	0.014
TS-8	0.018	2.8	8	0.26	0.07	0.022	<0.011	0.0018	0.011
TS-9	0.028	2.3	0.15	0.64	0.11	0.025	<0.063	0.0034	0.020
			0.028						
			0.04						
Average	0.033	7.4	0.064	1.1	0.12	0.038	0.05	0.0036	0.02
S.D.	±0.011	±5.7	±0.046	±0.4	±0.048	±0.017	---	±0.0011	±0.0055

S.D. = standard deviation

A comparison of average radionuclide concentrations (µCi/g, wet weight) detected in 116-N-1 trench sediments from 1975 to 1985 are shown below:

Year	Co-60	Cs-137	Sr-90	Pu-239/240
1975	5.2	1.1	0.0024	0.00098
1976	2.0	0.18	0.027	0.0037
1977	0.71	0.079	0.021	0.0046
1978	5.2	0.22	0.025	0.0052
1979	26.0	0.81	0.042	0.0062
1980	6.4	0.28	0.11	0.04
1981	9.1	0.45	0.15	0.018
1982	15.0	0.66	0.16	0.42
1983	12.0	0.62	0.028	0.0078
1984	22.0	1.2	0.12	0.21
1985	1.1	0.038	0.12	0.02

Annual environmental radiation surveys are conducted at intersecting points of survey grids established around 116-N-1. The survey conducted from April to July 1992 monitored direct radiation levels associated with the disposal facilities. Figure 3-8 shows environmental dose rates detected around 116-N-1 (WHC 1993a).

The 100-NR-1 LFI included chemical and radiological analyses of samples from boreholes 199-N-75, 199-N-76, and 199-N-80 drilled during April to July, 1993 (DOE-RL 1994c). The boreholes are located about 100 to 180 m down-gradient from the 116-N-1 trench, as shown by Figure 3-9. Borehole total depths were 89.6 ft for 199-N-75, 84.5 ft for 199-N-76, and 126.0 ft for 199-N-80. These boreholes were developed as new groundwater monitoring wells. Figures 3-10, 3-11, 3-12 summarize the geological, analytical, field screening, and geophysical data obtained from boreholes 199-N-75, 199-N-76, and 199-N-80, respectively. The concentrations of detected organic constituents and radionuclides and inorganic constituents that exceeded Hanford Site 95% UTL values in samples from boreholes 199-N-75,

199-N-76, and 199-N-80 are presented in Tables 3-4, 3-5, and 3-6 for boreholes 199-N-75, 199-N-76, and 199-N-80, respectively. Cadmium was the only inorganic constituent with concentrations above the Hanford Site 95% UTL values. The VOCs detected, frequency of detection, and maximum and minimum detected concentrations are listed below:

Volatile organic compounds	Detections / Samples / Wells	Maximum / Minimum Concentration (µg/kg)
Acetone	13 / 19 / 3	140J / 16
Carbon disulfide	3 / 19 / 2	8J / 1J
Methylene chloride	13 / 19 / 3	63 / 3J
Toluene	6 / 19 / 3	3J / 2J
2-butanone	1 / 19 / 1	8J
4-methyl-2-pentanone	1 / 19 / 1	7J

J = Detected concentration is an estimated value.

The semi-VOLs detected, frequency of detection, and maximum and minimum detected concentrations are listed below:

Semi-volatile organic compounds	Detections / Samples / Wells	Maximum / Minimum Concentration (µg/kg)
bis(3-ethylhexyl)phthalate	4 / 19 / 3	530J / 61J
Di-n-butylphthalate	10 / 19 / 3	110J / 44J
N-nitrosodiphenylamine	1 / 19 / 1	110J

J = Detected concentration is an estimated value.

Strontium-90 was the principal radionuclide contaminant detected in the three boreholes. It was detected predominantly in the 55 ft to 77 ft bls interval. Strontium-90 concentrations ranged from 2 to 320 pCi/g, as listed in Tables 3-4, 3-5, and 3-6. The distribution of cobalt-60 was similar to that of strontium-90, although the cobalt-60 concentrations were all less than or equal to 2 pCi/g.

3.1.1.4.2 1322-N and 1322-NA Sample Buildings. These buildings contain the liquid effluent waste treatment facility pilot plant. They are located immediately north of the 116-N-2 tank. Building 1322-N contains a drainage tank (UNI 1977). Building 1322-NA contains automatic sequential sampling equipment for the 30-cm (12 in) and 91-cm (36 in) radioactive drainlines and the riverbank springs (UNI 1975a). The dates and nature of operation and details of construction were not reviewed for preparation of this work plan.

Two documented unplanned releases have occurred and are described below:

- May 11, 1975 (UN-100-N-8) - An operator on routine patrol, at 4:00 a.m. noticed a small but steady spray of contaminated water coming from the 91-cm (36 in) radioactive drain return line sampler located near the back of the building. The operator stopped the leak by shutting down the sample pumps. Contaminated water was observed to cover the floor and various pieces of equipment in the rear of the building. Subsequent contamination surveys showed that the water had run out the back door and contaminated approximately 2.3 m^2 (25 ft^2) of ground. The amount of water released was estimated to be 380 L (100 gal). All contaminated areas were roped off, covered with plastic, and identified as a radiation zone. Total activity was estimated to be less

than 0.5 mCi. An unknown amount of the contaminated soil was removed and replaced with clean fill (UNI 1975a, DOE-RL 1991b).

- May 7, 1977 (UN-100-N-4) - A contaminated water leak in the 1322-N and 1322-NA buildings was discovered at 1:00 a.m. An operator on routine patrol found water running out from the doors in the 1322-NA building. He then checked the adjacent 1322-N building and found water spraying out of the top vent on the drainage tank. The sump pump was not operating at the time, and the water left the tank via the vent, backing up the sink drain in 1322-NA building. The water flowed out of the drains and over the 15 cm (6 in) curb onto the ground in front and back of the building. The amount of water released was reported as 5,678 L (1,500 gal) All electrical equipment in the buildings was shut off, preventing further leakage. The contaminated soil outside the front and rear doors, an area of approximately 140 m^2 (1,500 ft^2), was covered with plastic, roped off, and controlled as a radiation zone. Total activity was 0.5 mCi. An unknown amount of contaminated soil was removed and transported to the 200 Area (UNI 1977, DOE-RL 1991b).

The 100-NR-1 LFI included chemical and radiological analyses of six surface soil samples and three soil samples from borehole 199-N-86 (DOE-RL 1994c). Borehole 199-N-86 was drilled to a total depth of 24.5 ft during December, 1992. The borehole location is shown by Figure 3-13. Figure 3-14 summarizes the geological, analytical, field screening, and geophysical data obtained from borehole 199-N-86. The concentrations of all VOCs, semi-VOLS, and radionuclides detected, and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values are in Table 3-7.

Surface soil samples were found to contain nine semi-volatile compounds, the PCB Aroclor 1260, and concentrations of copper, lead, and zinc greater than the Hanford Site 95% UTLs. The semi-VOLS occur primarily in a single sample, which also had elevated levels of all three metals, whereas the PCB was found in all surface soil samples. Potassium-40, cobalt-60, strontium-90, cesium-137, radium-226, thorium-228, and thorium-232, uranium-233/234, uranium-238, plutonium-239/240, and americium-241 were detected in the surface soil samples. The maximum concentrations of cobalt-60 and cesium-137, 7 and 1.5 pCi/g, respectively, and the only detections of plutonium-239/240 and americium-241 occur in the same sample.

Few contaminants were detected in the three samples from borehole 199-N-86; one contained toluene and all contained methylene chloride, although the concentrations were all < 6 μg/kg. No PCBs, pesticides, or inorganic contaminants were found. Potassium-40, cobalt-60, strontium-90, radium-226, thorium-228, and thorium-232, uranium-233/234, and uranium-238 were detected. The spectral gamma ray geophysical log detected an activity of < 10 pCi/g from cobalt-60 in the first 0 to 14 ft interval and an activity of < 10 pCi/g from cesium-137 in the 0 to 7 ft interval.

3.1.1.5 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility. These potential sources listed below are grouped together due to their location at or near the 116-N-2 radioactive chemical waste treatment and storage facility.

- 116-N-2 radioactive chemical waste treatment and storage facility
- UN-100-N-5 unplanned release
- UN-100-N-25 unplanned release
- Spring, 1983 unplanned release
- 124-N-4 septic tank and drainfield.

3.1.1.5.1 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility. The 116-N-2 facility is a waste management unit complex consisting of piping, pumps, a transfer tank commonly referred to as

the silo, and a large treatment and storage tank referred to as the golf ball. The treatment tank is a spherical metal structure with a capacity of 3,400,000 L (900,000 gal). It is partially buried in the ground and surrounded by a 7.6 m (25 ft) high compacted soil radiation barrier on three sides. The unit operated from 1968 until 1987.

The 116-N-2 facility was used to neutralize and temporarily store radioactive waste acid solution used in the internal decontamination of the N Reactor. Chemical wastes from the internal decontamination of the primary loop of the reactor were transferred to the 116-N-2 silo by a 15-cm (6 in) underground transfer line. The silo is a transfer station for materials going into or out of the 116-N-2 storage tank. An additional 3.8-cm (1.5 in) decontamination line enters the silo from the N Reactor building. This line was for transport of small-scale decontamination solutions. According to WHC personnel, decontamination chemical solutions could be transferred to the 116-N-1 crib and trench, if necessary, via a 61-cm (24 in) aboveground transfer line from the 116-N-2 storage tank.

The silo routed the acidic decontamination solutions into the 116-N-2 storage tank for neutralization. The dangerous wastes in the decontamination solution included approximately 80,000 L (21,000 gal) of 70% phosphoric acid and 140 to 180 kg (300 to 400 lb) of diethylthiourea. According to WHC personnel, decontamination of the primary loop of the reactor occurred every 3 to 5 years, resulting in approximately 2,300,000 L (600,000 gal) of solution per decontamination event.

From 1968 until 1972, the neutralized decontamination solution was routed from 116-N-2 directly to tanker trucks parked east of the containment area. According to aerial photos, the area was not paved. Trucks would then take the waste to the 200 Area for disposal. In this time period, two decontamination events occurred. There is no documented evidence of releases in this area but small, incidental releases in the area are expected to have occurred. According to WHC personnel, after 1972, the neutralized decontamination solution from 116-N-2 was sent to the 1314-N liquid waste loadout station.

Three documented unplanned releases associated with the 116-N-2 radioactive chemical waste treatment and storage facility have occurred. These releases are described below:

- June 27, 1972 (UN-100-N-5) - An unplanned release occurred from a leak in the piping between the recirculation pump and the 116-N-2 tank. Evidence indicated that a failure occurred in the underground section of this pipe, causing discharge of approximately 340,000 L (90,000 gal) of radioactive chemical waste to the ground. The low-level radioactive wastewater contained decontamination chemicals used in the decontamination of the N Reactor primary loop. The waste contained 35 Ci of activity, 26 Ci of which were cobalt-60. The pH of the solution was about 9. An unknown amount of contaminated soil was removed and sent to the 200 Area burial ground. The excavation was then backfilled with clean soil (DUN 1972).

- May 15, 1975 (UN-100-N-25) - An unplanned release occurred during transfer of chemical decontamination solution into the 116-N-2 tank. A surge of contaminated water sprayed out an open manhole on the tank. An estimated 1,900 L (500 gal) of primary loop decontamination solution containing phosphoric acid and diethylthiourea was released to the ground inside the radiation zone surrounding the tank. A radiation survey outside the posted zone showed no contamination (UNI 1975b). The extent of remediation conducted is unknown.

- Spring, 1983 - An unplanned release of caustic sodium hydroxide occurred in the Spring of 1983 in association with the reactor decontamination event taking place at that time. According to WHC personnel, a tanker truck was offloading sodium hydroxide to the silo when a fitting came loose and spilled approximately 380 L (100 gal) of liquid to the open soil. No remediation was conducted.

The 100-NR-1 LFI included chemical and radiological analyses of three surface soil samples and four soil samples from borehole 199-N-87 (DOE-RL 1994c). Borehole 199-N-87 was drilled to a total depth of 23.5 ft during December, 1992. The borehole location is shown by Figure 3-15. Figure 3-16 summarizes the geological, analytical, field screening, and geophysical data obtained from borehole 199-N-87. The concentrations of all VOCs, semi-VOLS, PCBs, and radionuclides detected, and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values are in Table 3-8.

Surface soil samples contain four VOCs, ten semi-VOLs, the PCBs Aroclor 1254 and Aroclor 1260, and concentrations of lead greater than the Hanford Site 95% UTLs. Potassium-40, cobalt-60, technetium-99, cesium-137, radium-226, thorium-228, thorium-232, uranium-233/234, uranium-238, plutonium-239/240, and americium-241 were detected in the surface soil samples. The maximum concentrations of cobalt-60 and cesium-137, were 100 pCi/g and 3.8 pCi/g, respectively. Plutonium-239/240 and americium-241 concentrations were < 0.2 pCi/g.

Few contaminants were detected in the three samples from borehole 199-N-87. One sample contained toluene and methylene chloride and had a sulfate concentration greater than the Hanford Site 95% UTL value. Potassium-40, cobalt-60, radium-226, thorium-228, thorium-232, uranium-233/234, and uranium-238 were detected in the borehole surface soil samples. Cobalt-60 was found only in the uppermost sample, collected in the 9 to 11.5 ft interval. The concentration was 4.3 pCi/g. No semi-VOLs, PCBs, or pesticides were detected. The spectral gamma ray geophysical log detected three areas with cobalt-60 activity. At the surface to about 3 ft the maximum activity was 100 pCi/g, in the intervals from about 7 ft to 12 ft and at about 22 ft to 23 ft the activities were < 10 pCi/g.

3.1.1.5.2 124-N-4 Septic Tank and Drainfield. The 124-N-4 septic tank and drainfield is the primary septic system which served the majority of the 100-N buildings from 1963 until 1987. It is located east of the 116-N-2 facility, and consists of two septic tanks (the second tank was installed in 1975) with a total fluid capacity of 53,000 L (14,000 gal). The septic tank effluent drained into a large drainfield. The drainfield is divided into four sections, with a distribution box in each section feeding eight drainlines. The drainfield provided approximately 830 m^2 (8,900 ft^2) of infiltrative surface area. The unit received approximately 110,000 L/day (30,000 gal/day) of sanitary sewage (Gydesen 1985).

There are no documented releases to or from the unit other than sanitary sewage. Surveys have detected radioactive surface contamination at this unit, suggesting possible subsurface contamination. In addition, the close proximity of this unit to the area where tanker trucks were loaded with irradiated, neutralized decontamination solutions from 1968 until 1972 suggests that the possibility of remaining contamination from small, intermittent releases may exist here.

3.1.1.6 116-N-3 Crib and Trench. The 116-N-3 crib and trench waste management unit is located approximately 300 m (1,000 ft) east of the 116-N-1 facility. The unit is also known as the 1325-N liquid waste disposal facility (LWDF). The crib measures 76 m (250 ft) in length and 73 m (240 ft) in width, which provides 5,600 m^2 (60,000 ft^2) of percolation surface. A 914 m (3,000 ft) extension trench was added to augment the operational capacity of the crib. The 116-N-3 facility can hold 23,000,000 L (6,000,000 gal) (Diediker and Hall 1985).

The 116-N-3 crib was constructed as a replacement liquid radioactive waste disposal facility for the 116-N-1 crib and trench and first received N Reactor effluent in 1983. The 116-N-3 trench was put in full service in September 1985 (Diediker and Hall 1985). Between these two dates, both the 116-N-1 and the 116-N-3 facilities were in service. The 116-N-3 trench is 17 m (55 ft) wide, 2 m (7 ft) deep, and is covered by precast concrete panels to prevent access by the local fauna to contaminated water.

The 116-N-3 system consists of a reinforced concrete diversion box tied-in to the 116-N-1 weir box, a reinforced concrete header box that distributed the effluent in the covered 116-N-3 crib, and approximately 366 m (1,200 ft) of 91-cm (36 in) diameter pipe connecting the diversion box to the header box. The 116-N-3 facility, like the 116-N-1 facility, received radioactive liquid effluents from the reactor coolant system, spent fuel storage basin, periphery coolant systems, and various radioactive drain systems located throughout the reactor facility. The origins of these wastes are discussed in Section 2.1.4.1. The average monthly flow rate into the 116-N-3 facility during 1983 through 1986, when the N Reactor was in normal operation, was approximately 5,300 L/min (1,400 gal/min) (Diediker and Hall 1985).

Cumulative inventories, as of January 1, 1988, for principal radionuclides (Connelly et al. 1991) in effluent discharged to the 116-N-3 crib and trench having half-lives of greater than one year are presented below.

Radionuclide	Half-Life (Yr)	Inventory (Ci)
Co-60	5.3	1,140
Sr-90	28.6	210
Ru-106	1	35
Cs-134	2.1	10
Cs-137	30	350
Pu-239	24,000	2.0

Samples of surface sediment were obtained from the bottom of the 116-N-3 crib on August 1, 1985 (Jacques 1986). The samples were analyzed for gamma-emitting radionuclides at an onsite analytical lab. The samples were then shipped to another laboratory for strontium-90 and plutonium analyses. The concentrations of radionuclides, gross alpha, and gross beta (in µCi/g, wet weight), detected in the 116-N-3 crib sediment samples are shown in below:

Sample	Gross Alpha	Gross Beta	Mn-54	Co-60	Sr-90	Cs-137	Ce-144	Pu-238	Pu-239/240
CS-1	0.018	2.3	0.27	1.3	0.088	0.041	0.12	0.002	0.012
CS-2	0.0070	3.1	0.19	0.66	0.026	0.049	0.064	0.00074	0.005
CS-3	0.018	1.6	0.28	1.1	0.089	0.049	0.094	0.002	0.013
CS-4	0.0060	0.83	0.16	0.6	0.027	0.035	0.041	0.00066	0.0043
CS-5	0.0047	0.4	0.052	0.18	0.015	0.013	0.0058	0.00046	0.0028
CS-6	---	---	---	---	---	---	---	---	---
CS-7	0.044	15.0	0.26	1.6	0.2	0.011	<0.1	0.0050	0.03
CS-8	0.026	2.4	0.36	1.7	0.1	0.029	0.1	0.0086	0.056
CS-9	0.018	2.2	0.032	0.14	0.017	0.005	0.015	0.0018	0.012
CS-10	0.012	1.1	0.15	0.52	0.013	0.056	0.067	0.00035	0.0023
CS-11	0.0097	1.5	0.24	0.8	0.012	0.048	0.076	0.0011	0.0069
CS-12	0.0061	0.62	0.17	0.58	0.0058	0.071	0.04	0.00053	0.034
Average	0.015	2.8	0.2	0.83	0.054	0.037	0.062	0.0021	0.013
S.D.	±0.012	±4.1	±0.09 9	±0.53	±0.06	±0.021	±0.031	±0.0025	±0.016

S.D. = standard deviation

Environmental dose rates detected around the 116-N-3 on June 17, 1985 are shown in Figure 3-17. The figure also shows direct radiation levels measured along the length of the 116-N-3 trench. At the time of the survey the 116-N-3 was not receiving liquid effluent from N Reactor. The dose rates were higher near

the 116-N-3 crib. The absence of water from the crib was the major factor contributing to the readings. Water in the crib normally shielded much of the radiation emitted by the contaminated sediments.

An estimate of other wastes annually disposed in the 116-N-3 crib (1984 through 1986) was presented in the *Closure/Post-Closure Plan 1325-N Liquid Waste Disposal Facility* (WHC 1987a) and is presented below. These wastes resulted from decontamination of the primary coolant system, as discussed in Section 2.1.4.1.4. Other wastes may have entered the system due to common floor drains, prior to 1987, when administrative controls were put in place to prevent waste chemical discharges (WHC 1987a).

Compound	Amount, lb/yr
Hydrazine Test Solution	6,100*
Ammonia Test Solution	6,100*
Chloride Test Solution	7,800*
Fluoride Test Solution	3,900*
Lead-Acetate Battery Fluid	120**
Nickel-Cadmium Battery Fluid	80**
Hydrazine (Injection System)	10

* Reactor cooling water taken for chemical analysis to determine the amount of hydrazine, ammonia, chloride and fluoride in the coolant loop.

** No actual amounts available, but possible because of common floor drains.

Note: Routine monitoring of the influent to 116-N-3 did not reveal detectable levels of these chemicals (WHC 1987a).

The 116-N-3 crib and trench managed the same type of N Reactor wastes as the 116-N-1 crib and trench managed. Major discharges to this facility halted in January 1987 and all discharges to the facility ceased in August of 1993. Daily flow volumes were recorded in the N Reactor control room.

The 116-N-3 crib is a dangerous waste disposal facility under RCRA interim status. A closure and post-closure plan has been prepared by DOE (WHC 1987a) for submittal to Ecology, in accordance with WAC 173-303-610.

3.1.1.7 128-N-1 Burning Pit. The 128-N burning pit is located directly east of the 116-N-3 crib and trench grouping. The unit was used primarily for the burning of nonhazardous waste (paper, wood, trash, etc.) generated at the 100 N Area. The amount of waste managed by the unit is unknown. There is no documented evidence of release of dangerous or radioactive wastes from the unit. The unit dimensions have altered in size and its location has shifted during the period of operation (1962 to 1986).

Soil samples were collected from four burn pits in the 100-NR-1 Operable Unit. The sampling locations are designated 128N-FS-1, 128N-FS-2, 128N-FS-3, and 128N-FS-3 and are shown on Figure 3-18. The burn pits 128N-FS-1, 128N-FS-2, and 128N-FS-3 constitute the 128-N-1 burn pit grouping. The HGP burn pit is 128N-FS-4. The samples were collected from disturbed areas. Samples were analyzed for VOCs, heavy metals, TPH, and PCBs using field screening methods.

No VOCs or heavy metals were detected. One sample (128N-FS-3) tested positive for PCBs. The estimated concentration was between 1 and 10 ppm of Aroclor 1248 equivalent. At this same site a pile of

discarded soil was also tested and found to contain TPH concentrations of 100 to 1,000 ppm, but tested negative for PCB (WHC 1993a).

3.1.1.8 181-N River Pumphouse. The 181-N river pumphouse grouping consists of four potential sources which are grouped based on their location at or near the 181-N river pumphouse. The grouping is located between the railroad tracks and the Columbia River and includes the potential sources listed below:

- 260-cm (102 in) outfall (NPDES discharge No. 009)
- April 18, 1986 unplanned release
- 181-N inlet backwash water outfall (NPDES discharge No. 007)
- aboveground waste oil tank.

3.1.1.8.1 260-cm (102 in) Outfall Line. The 260-cm (102 in) outfall line is an NPDES discharge point (Outfall number 009) which disposed raw river water used to cool the secondary cooling water for the N Reactor. The discharge line extends approximately 120 m (400 ft) into the Columbia River and turns upward where water is discharged through a 4 m (13 ft) port (Ecker et al. 1983). From 1982 until 1986, the annual discharge to the river was approximately 570 billion L (150 billion gal) (Rokkan 1987). The unit has released to the Columbia River from 1963 until the present. In addition to recirculated river water, the outfall has discharged wastewater from other sources. The identity and volumes released from these sources will be investigated as a data gap and presented in Table 5-1.

Permitted releases to the river occur on a daily basis. There is one documented unplanned release associated with the unit that violated the NPDES permit conditions.

- On April 18, 1986, a release to the river of regeneration wastewater from the 163-N demineralization plant resulted in a violation of the NPDES pH limits. The NPDES permit requires that the pH of the discharge be > 6.0 and < 9.0. A test was conducted to determine if the concurrent release of acidic cation regeneration wastewater and caustic anion regeneration wastewater would result in a neutral discharge via the 260-cm (102 in) outfall. Sampling of the discharge during the test indicated that neutralization was not occurring as rapidly as necessary. Wastewater was released for about 60 minutes which was below the 6.0 pH limit. The pH then elevated rapidly above the 9.0 limit for about 10 minutes. The amount of wastewater discharged during this 30-minute period is unknown (WHC 1987d).

3.1.1.8.2 Aboveground Waste Oil Tank. An aboveground steel waste oil tank is located at the base of the bluff near the 181-N river pumphouse. The capacity of the tank is 980 L (260 gal). The tank was designed to store waste oil from drip pans used to catch oil from the river pumps. According to WHC personnel, the tank was never used.

3.1.1.8.3 181-N Inlet Screen Backwash Water Outfall. The unit is an NPDES discharge point (Outfall number 007) located at the 181-N river pumphouse, which pumps water from the Columbia River for various 100 N Area processes. The screen removes larger solids from the inlet water prior to use at the 100 N Area. The only NPDES-required parameters are total flow and total suspended solids. The 1987 average total suspended solid concentration was approximately 3.7 mg/L. Approximately 1,300,000 L/day (340,000 gal/day) were discharged from this outfall in 1987 (Rokkan 1988). There are no documented dangerous or radioactive releases from this unit.

3.1.1.9 1304-N Emergency Dump Tank Grouping. The 1304-N emergency dump tank (EDT) grouping consists of two waste management units and six associated unplanned releases. These sources are grouped together due to their close geographical locations and similar waste management. The potential sources in this grouping are:

- 1304-N EDT
- UN-100-N-1 unplanned release
- UN-100-N-29 unplanned release
- UN-100-N-30 unplanned release
- UN-100-N-32 unplanned release
- UN-100-N-2 unplanned release
- UN-100-N-7 unplanned release
- 116-N-4 emergency dump basin (EDB).

3.1.1.9.1 1304-N Emergency Dump Tank. The 1304-N EDT is a 4.9 million L (1.3 million gal) steel, above-ground storage tank. It is located south of the 107-N basin recirculation building and west of the 1300-N EDB. It replaced the EDB as the storage facility used for emergency blowdown of thermally hot, pressurized reactor primary coolant water. The tank maintained constant volume of 2,600,000 L (680,000 gal) of unheated water for quenching of the hot water to prevent it from flashing to steam. Because a small flow of primary coolant was maintained to the EDT to keep interconnecting piping in a thermally warm condition, the quench water normally contained a small inventory of radioactive materials (Perkins 1988). The unit was used from 1973 until reactor shutdown in 1987.

Several documented unplanned releases have been associated with the 1304-N EDT. These releases are described below:

- March 27, 1974 (UN-100-N-1) - The EDT 76-cm (30 in) overflow line developed a leak through a 76-cm (30 in) inflatable pipe flow stoppage device during maintenance operations. In addition, a fill valve on the EDT began leaking at the same time. Approximately 110,000 L (30,000 gal) of irradiated cooling water was spilled on the ground near the tank and flowed over the bank to an area near the 181-N river pumphouse. The spilled material did not reach the river. Analyses of samples taken at the time of the leak indicate that 0.2 Ci was released in the 110,000 L (30,000 gal). Contaminated soil greater than 1,000 cpm was removed and transported to the 200 Area for burial. The remaining contaminated soil was stabilized in place using 10 to 15 cm (4 to 6 in) of clean soil (UNI 1974c).

- April 23, 1974 (UN-100-N-29) - A faulty check valve in the EDT bypass line allowed approximately 380 L (100 gal) of irradiated primary coolant water to leak to the ground. The water ran out from under a concrete ground cover on the slope above the tank and covered an approximate area of 1.2 m by 9.1 m (4 ft by 30 ft). A sample of the mud and water yielded a reading of 5,000 cpm. Approximately 0.1 Ci of radioactive material, mostly manganese-56 and sodium-24 was released. The contaminated soil was removed for disposal (UNI 1974d).

- July 27, 1974 (UN-100-N-30) - During the filling of the EDT in preparation for a drawdown test of the system, the EDT overflowed through a vacuum breaker vent in the top of the tank. Approximately 9,500 L (2,500 gal) of water spilled to the ground around the tank and contaminated an area of approximately 230 m^2 (2,500 ft^2) to a maximum of 500 cpm. No water reached the river. Sands and fines were used to stabilize the soil contamination. It is unknown if the contaminated soil was removed (UNI 1974e).

- September 16, 1974 (UN-100-N-32) - A repeat of the April 23, 1974 incident occurred due to a faulty check valve. Approximately 1,900 to 3,800 L (500 to 1,000 gal) of irradiated primary coolant water spilled down the slope from the metal culvert housing the check valve and contaminated soil by the south and east walls of the tank. A sample of the mud yielded a reading of 20,000 cpm. Two days later, an evaporated sample was analyzed and indicated that < 10 mCi of radioactive material remained in the ground. An unknown amount of contaminated soil was

removed and disposed. The remaining contaminated soil was stabilized in place using clean fill (UNI 1974f).

- February 19, 1980 (UN-100-N-2) - A leak in the 2.5-cm (1 in) FLV 858 valve body relief line occurred. The FLV 858 valve is on the 81-cm (32 in) low pressure flush line between the 109-N heat exchanger building and the EDT. Approximately 95,000 to 110,000 L (25,000 to 30,000 gal) of irradiated water leaked to the ground. Most of the water in the area was transferred with a portable pump to the EDB. Based on sample analysis it is estimated that less than 1 Ci of beta/gamma radioactivity was released to the ground. An unknown amount of contaminated soil was removed and disposed. The remaining contaminated soil was stabilized in place using clean fill (UNI 1980).

- April 29, 1985 (UN-100-N-7) - Approximately 1,900,000 L (504,000 gal) of irradiated water was released to the soil from a leak in the 25-cm (10 in) drain line between the N Reactor building and the EDT. The cause of the leak is unknown. Approximately 32 m^3 (1,130 ft^3) of contaminated soil was removed and disposed. Groundwater monitoring wells were sampled until concentrations of iodine-131 returned to background levels (DOE-RL 1991b).

3.1.1.9.2 116-N-4 Emergency Dump Basin. The 116-N-4 EDB is a liquid effluent storage basin that was originally designed to receive emergency cooling water from the N Reactor. It is located northwest of the 109-N building. The unit is a concrete basin with a welded steel liner (Jacques 1985), and is approximately 40 m (130 ft) long by 24 m (80 ft) wide by 4.6 m (15 ft) deep and has a storage capacity of 3,800,000 L (1,000,000 gal) (DOE-RL 1991b).

The EDB was constructed in 1963 to receive "single pass" radioactive emergency cooling water. In the late 1960s, the unit was determined to be insufficient for its original use. The basin did not have the capacity needed to contain the volume of coolant used during an emergency cooling operation. It was replaced by the 1304-N EDT in 1973. From 1973 until 1987, the EDB received contaminated liquid effluent generated during the periodic blowdown of N Reactor's 12 steam generators located in the 109-N building. This condensate contained low levels of radioactive contamination. Contents of the unit were sampled on a monthly basis from 1978 to 1985. Table 3-9 shows the average annual concentrations by radionuclide in the unit (Jacques 1985). At various times, the EDB also received radioactive wastes from the N Reactor lift station. Since the N Reactor shutdown in 1987, water has been maintained in the EDB (approximately 2,800,000 L [750,000 gal]) so that the bottom sludge layer will not become exposed. Subsequent drying of the sludge could expose receptors to airborne exposure to contaminated particulate matter. According to WHC personnel, filtered river water has been added as needed to maintain the water level. Documentation of the amount of water added to the EDB has not been maintained. There are no documented releases associated with the unit.

3.1.1.10 118-N-1 Spacer Storage Silos. The 118-N-1 spacer storage silo grouping consists of three waste management units and three unplanned releases associated with the spacer storage silos. These potential sources located in the vicinity of the spacer storage silos and include:

- 118-N-1 spacer storage silos
- UN-100-N-3 unplanned release
- UN-100-N-12 unplanned release
- 124-N-3 septic system
- 105-N lift station underground storage tank
- Corridor 22 unplanned release.

3.1.1.10.1 118-N-1 Spacer Storage Silos. The three 118-N-1 spacer storage silos were used for the temporary storage of irradiated fuel spacers. The steel spacers came in immediate contact with the fuel rods in the N Reactor. The silos, approximately 4.9 m (16 ft) in diameter by 6 m (20 ft) deep, are located north of the N Reactor building. The three silo floors are open to the soil. The bottom of silo Number 1 consists of packed aluminum filings, but it is not sealed. The silos have approximately one-half to one meter thick concrete caps covered with soil (DOE-RL 1991b).

Releases occurred from 1963 until 1987 when spacers were placed in or removed from the silos. Spacers were deposited in the silos through the buried spacer transfer line. The reinforced plastic spacer transfer line connected the N Reactor fuel storage basin, where the spent spacers were placed in water after use, and the silos. The depth of the line is variable. There was no secondary containment surrounding the line. Small amounts of irradiated water passed through the line with the spacers and was deposited in the silos. In addition, water was sprayed over the spacers during removal from the top of the silos to eliminate the potential airborne release of radionuclides. In recent years, paint was used as a fixative when spacers were transferred from the silos. According to WHC personnel, the silos currently contain dry irradiated spacers. The volume of water that reached the soil either through the bottom of the silos or the exposed soil around the silos is unknown.

Two documented releases to the ground have been associated with the spacer storage silos and associated piping:

- March 8, 1978 (UN-100-N-3) - A leak was detected in the spacer transfer line. The first indication of the leak was the appearance of a 1.2-m (4 ft) diameter by 76-cm (30 in) deep sinkhole between the 105-N lift station and the spacer storage silos. Excavation of the sinkhole area revealed a crack in the 7.6-cm (3 in) reinforced plastic pipe approximately 3.4 m (11 ft) below grade. It is estimated that approximately 1,400,000 L (360,000 gal) of irradiated N Reactor fuel storage basin water entered the ground. Estimated radionuclide releases to the soil were: cobalt-60 (70 mCi); strontium-90 (80 mCi); cesium-137 (250 mCi); cerium/praseodymium-144 (140 mCi); and, plutonium-239 (0.4 mCi).

  An unknown amount of soil was removed and disposed at the 200 Area burial ground (UNI 1978).

- February 27, 1979 (UN-100-N-12) - A leak similar to the March 8, 1978 release occurred. A 0.6 m by 0.9 m by 46-cm (2 ft by 3 ft by 18 in) sinkhole was discovered at the backfilled location of the previous leak. The pressure of the transport of spacers within the line apparently caused a rupture. An estimated 950,000 L (250,000 gal) of irradiated N Reactor fuel storage basin water was released to the ground. Estimated radionuclide releases to the soil were: cobalt-60 (190 mCi); strontium-90 (126 mCi); cesium-137 (396 mCi); cerium/praseodymium-144 (34 mCi); and, plutonium-239/240 (0.57 mCi).

  The plastic pipe was replaced with a stainless steel pipe (UNI 1979). It is unknown if the contaminated soil was removed or covered.

3.1.1.10.2 124-N-3 Septic Tank. The 124-N-3 septic system is a cesspool that served the 107-N building from 1982 to the present. The unit served two to three employees working at the 107-N building as well as temporary construction workers in the area and is designed to only receive sanitary sewage. The cesspool includes a 1,900 L (500 gal) precast concrete tank, perforated tile pipe, and solid cover with 0.6 m (2 ft) of crushed stone below the tank. The estimated daily flow was 170 L/day (45 gal/day) (Gydesen 1985). There is no documented information regarding disposal of any other wastes to the unit.

3.1.1.10.3 105-N Lift Station Underground Storage Tank. The 105-N lift station underground storage tank was a 19,000 L (5,000 gal), single-wall carbon steel tank used for storage of diesel oil (DOE-RL 1989a). The tank had no cathodic or interior protection and was approximately 11 to 15 years old before being removed in December 1990. Soil sampling indicated that the site is not contaminated with petroleum derivatives.

3.1.1.10.4 Corridor 22 Unplanned Release. In 1983 or 1984 several hundred liters of radioactively-contaminated water were reportedly spilled outside the Corridor 22 doorway in the N Reactor building. Scrub water from the fission product filter trap reportedly overflowed and was discharged to the ground. The concrete was reportedly painted over and an indeterminate amount of soil was removed.

3.1.1.11 182-N Underground Storage Tank Area. This grouping consists of the three 182-N underground storage tanks located south of the N Reactor building.

Three underground diesel storage tanks were located on the north side of the 182-N high lift pumphouse. These were identified as 182-N-1-DT, 182-N-2-DT, and 182-N-3-DT. All tanks were single-wall carbon steel and each was between 38,000 to 72,000 L (10,000 to 19,000 gal) in capacity. They were approximately 16 to 20 years old and had no cathodic or interior protection (DOE-RL 1989a). There is no documented information regarding releases from the tanks. The three tanks were pumped dry and removed in December 1990. Soil sampling indicates that the valve area is contaminated and scheduled for remediation under the underground storage tank program.

3.1.1.12 N Reactor Spent Fuel Storage Basin. The N Reactor spent fuel storage basin is a concrete containment basin for the storage of spent fuel elements, irradiated spacers, and other fuel handling equipment. Underwater transfer carts moved the irradiated fuel elements to the storage basin where they were stored in the temporary storage baskets. Baskets were emptied and fuel elements placed in storage canisters, sorted by enrichment and discharge dates. The filled canisters were moved by bridge cranes to storage cubicles, formed by a lattice of boron concrete walls. The storage basin began operation in 1963 and ceased storing irradiated nuclear fuel in 1989 when all fuel was transferred to the 100 K fuel storage basins. However the basin remains filled with water for purposes of shielding and radiological contamination control.

Two releases associated with the N Reactor fuel storage basin and its drainage system have been documented. These releases are described below.

- May 13, 1975 (UN-100-N-10) - A leak of irradiated water to the ground occurred on May 13, 1975 during preparation for the removal of a check valve from the Zone I gravity drain line to the 105-N lift station. Whirley pumps were used to remove water from the lift station during the shutdown of the lift station pumps and draining of the 91-cm (36 in) radioactive drain line. The water was to be pumped to the EDB during this process. During the drawdown test of the Whirley pump system, approximately 380 L (100 gal) leaked to the ground through a loose hose fitting between the pumps and the EDB. The exact location of the spill is not documented. Approximately 9 m^2 (100 ft^2) of soil was contaminated with 1 mCi of mixed fission and activation products. The area was surrounded with a small dirt dam and covered with plastic to minimize spreading of the contamination. An unknown amount of contaminated soil was removed and disposed (UNI 1975c).

- February 28, 1986 (UN-100-N-35) - Routine sampling of 100 N Area groundwater monitoring wells revealed elevated levels of iodine-131. Testing showed the leak to be basin water. Investigation showed water leaking through an expansion joint 8.5 m (28 ft) below ground level. Water was leaking to the lift station and through an expansion joint to the ground. The leaking

only occurred when the basin water level was high and water flowed out the overflow weirs. The leaking weir was located and the leak was determined to be coming from a cleanout valve. The weir and drain line were grouted and sealed on December 5, 1986.

3.1.1.13 Outer Refuse Area. The outer refuse area grouping consists of three waste management units located near the southern periphery of 100 N Area. These three potential sources have been grouped together because of their isolated location and are identified below. The information for this grouping was obtained from HGP personnel.

- HGP burn pit
- grass dump
- construction debris dump.

3.1.1.13.1 HGP Burn Pit. The HGP burn pit is an area of open ground previously used to burn paper, wood, and probably trash. It is unknown if solvents were burned at this site, although barrels containing hazardous oil were found at the site. The burn pit was last used by HGP on June 1, 1989.

Soil samples were collected from four burn pits in the 100-NR-1 Operable Unit. The sampling locations are designated 128N-FS-1, 128N-FS-2, 128N-FS-3, and 128N-FS-3 and are shown on Figure 3-18. The burn pits 128N-FS-1, 128N-FS-2, and 128N-FS-3 constitute the 128-N-1 burn pit grouping. The HGP burn pit is 128N-FS-4. The samples were collected from disturbed areas. Samples were analyzed for VOCs, heavy metals, TPH, and PCBs using field screening methods. Soil tested at 128N-FS-4 contained less than detectable concentrations of VOCs, heavy metals, TPH, and PCBs.

3.1.1.13.2 Grass Dump. The grass dump is an area of open ground used as a grass dump over an unknown period of time. It is unknown if other wastes have been placed in the unit.

3.1.1.13.3 Construction Debris Dump. The construction debris dump was used by the J.A. Jones Construction Company during past construction work at the 100 N Area. Debris dumped at the site consisted of dirt, rocks, asphalt, concrete, metal, and wood. No hazardous or radioactive waste disposal has been documented. A practice at the 100 N Area has been to survey materials for radioactivity before disposal. According to WHC personnel, materials disposed here were surveyed for radioactivity and released (no radiation was detected prior to disposal).

3.1.1.14 182-N High Lift Pumphouse. The 182-N high lift pumphouse grouping consists of four potential sources within the area surrounding the 182-N high lift pumphouse. The grouping includes the water supply tank farm and extends to the Columbia River. The following potential sources are located in this area:

- 124-N-2 septic tank
- 182-N tank farm overflow (NPDES Outfall No. 005)
- 182-N drain outfall (NPDES Outfall No. 006)
- February 6, 1987 unplanned release.

3.1.1.14.1 124-N-2 Septic Tank. The septic tank and seepage pit making up sewer system II are located southeast of the 182-N building and were installed in 1963 (Gydesen 1985). The system is still operating and only receives sanitary sewage (DOE-RL 1991b). The seepage pit for this system provides about 19 m^2 (200 ft^2) of infiltration surface area and 8,540 L (2,256 gal) of fluid storage. In 1985, the system served 10 personnel and the calculated daily flow was 760 L/day (200 gal/day) (Gydesen 1985). No remedial activities have taken place.

3.1.1.14.2 182-N Tank Farm Overflow. This unit is a NPDES-permitted discharge point (Outfall No. 005) to the Columbia River. It contains drainage (water) from the 182-N tank farm area. The area discharges to the river by a 91-cm (36 in) raw water return line. The discharge point is located 90 m (300 ft) upstream of 181-N. In 1987, the average daily discharge to the river via this point was 10 million L (2.7 million gal) (Rokkan 1988). Currently, discharges from this point are minimal. The startup date for the discharge was 1964. There are no documented dangerous or radioactive releases to the river via this discharge point.

3.1.1.14.3 182-N Drain System. This unit is a NPDES-permitted discharge point (Outfall No. 006) to the Columbia River. Drainage from the 182-N high lift pumphouse is discharged to the river by a 107-cm (42 in) raw water return line. The discharge point is 30 m (100 ft) upstream of 181-N. In 1987, the average daily discharge to the river via this point was 1,000,000 L (270,000 gal) (Rokkan 1988). The startup date for the discharge was 1964. It is currently in use. Raw and filter water from pump seal leakage is discharged from this point. Westinghouse Hanford Company personnel have indicated that small quantities of low-level radionuclides have been released from reactor emergency core cooling system pump seals and discharged to the river. The identity of the low-level radionuclides released will be investigated as a data gap and presented in Table 5-1.

3.1.1.14.4 Oil Release to the Columbia River. On February 6, 1987, approximately 19 L (5 gal) of turbine oil was discharged to the Columbia River through the 182-N tank farm raw water return line. A small (pin-hole size) leak in a lube oil line in the No. 2 drive turbine allowed oil to enter the secondary steam system. Steam condensate from this system returns to the 100-N steam condensate system that drains to the river. The leak in the lube line was repaired (Rokkan 1988).

3.1.1.15 Acid/Caustic Storage and Transport System. The acid/caustic storage and transport system grouping includes all of the process units, waste management units unplanned releases, and pipelines associated with the storage and transport of acids and caustics used in the 163-N demineralization plant. Due to its location, the 163-N septic tank is also included in this grouping. Potential sources are listed below:

- 108-N chemical unloading facility
- 120-N-7 unloading station french drain
- 120-N-6 sulfuric acid tank french drains
- 108-N neutralization pit
- UN-100-N-15 unplanned release
- UN-100-N-33 unplanned release
- December 26, 1987 unplanned release
- 120-N-5 acid/caustic trench and neutralization unit
- UN-100-N-34 unplanned release
- August 7, 1987 unplanned release
- September 2, 1987 unplanned release
- November 9, 1987 unplanned release
- 120-N-3 neutralization pit and french drain
- 120-N-8 sulfuric acid day tank french drain
- regeneration waste transport system
- June 14, 1986 unplanned release
- June 30, 1986 unplanned release
- 124-N-1 septic tank.

3.1.1.15.1 108-N Chemical Unloading Facility. The 108-N chemical unloading facility was used for storage, and transfer of 93% sulfuric acid and 50% sodium hydroxide solutions received by railroad tank

car or tank truck (Chien 1989). The 120-N-7 unloading station french drain was used for containment of small releases from the overhead transfer boom. The french drain was used from 1963 until March 1987 (DOE-RL 1991b). The french drain was 0.9 m (3 ft) in diameter by 1.2 m (4 ft) deep and consisted of a clay pipe filled with lime. Recent inspections indicate the french drain is still present.

There are three 38,000 L (10,000 gal) above-ground steel sulfuric acid storage tanks and one 290,000 L (76,800 gal) sodium hydroxide tank located at the 108-N facility. The tanks began operating in 1964. Adjacent to the sulfuric acid tanks are five 120-N-6 sulfuric acid tank french drains where tank overflows were vented. The french drains are approximately 0.6 m (2 ft) in diameter and consist of a clay pipe packed with lime. The french drains operated from 1963 until March 1987 (DOE-RL 1991b). Recent inspections indicate that this french drain has been removed. The acid transfer system uses a 3,800 L (1,000 gal) steel transfer tank of unknown construction located in a pit west of the 108-N building. The tank is filled with acid via gravity flow from the storage tanks. Air pressure is used to transfer the acid by way of piping through the trench to the 163-N day tank. There are no french drains associated with the sodium hydroxide tank. Transfer pumps located in the 108-N building were used to transfer the sodium hydroxide directly to the 163-N day tank from the storage tank via piping through the trench (Chien 1989).

The brick-lined 108-N neutralization pit is located outside the 108-N building. This facility received drainage from the 108-N floor drains and from the acid transfer tank. The pit was used to manually neutralize waste acid. The neutralized waste was sent via a water jet pump to the 183-N facility where it was then discharged to the river through the 260-cm (102 in) outfall line. The unit has been in operation since 1963. According to WHC personnel, the unit is 1.8 m (6 ft) wide by 1.2 m (4 ft) long by 1.8 m (6 ft) deep. The brick lining has been replaced on at least one occasion. Currently, the unit contains water, apparently from wash down of facilities at shut down in 1990.

Various small, intermittent spills have occurred over the years at the 108-N facility that were associated with unloading and transfer operations. Several larger documented spills are described below:

- March 20, 1981 (UN-100-N-15) - Sulfuric acid and rinsewater were spilled inside the 108-N building. The unknown amount of liquid was transferred to the acid tank french drains for neutralization. The transfer line developed a leak and released acid solution to the ground. The affected area was estimated to be < 4.6 m^2 (50 ft^2) (DOE-RL 1991b). Remedial measures instituted were not documented.

- November 9, 1981 (UN-100-N-33) - Approximately 3,800 L (1,000 gal) of sulfuric acid were spilled during transfer from a rail car to an acid storage tank (DOE-RL 1991b). No remedial measures were taken.

- December 26, 1987 - Approximately 38 L (10 gal) of sodium hydroxide were spilled to the ground during transfer from a rail car to the caustic storage tank. Difficulties during the transfer prompted the operator to disconnect the transfer line and set it on the ground while investigating the problem. At that time the sodium hydroxide leaked from the transfer line. The spill was cleaned up on December 31, 1987 (WHC 1989c). The extent of remediation is unknown.

3.1.1.15.2 120-N-5 Acid/Caustic Transfer Trench and Neutralization Unit. The unit is a polymer concrete-lined neutralization pit and acid/caustic transfer trench between the 163-N demineralization plant and the 108-N chemical unloading facility. The neutralization unit consists of two containment vaults - one for sulfuric acid and one for sodium hydroxide. Each containment vault is approximately 1.8 m (6 ft) long by 1.8 m (6 ft) wide by 3 m (10 ft) deep. The trench, containing both acid and caustic piping, slopes toward the neutralization unit so that spills can be contained within the vaults. The polymer concrete

lining was installed in parts of the trench in 1986. According to personnel, the unit consisted of unsealed concrete from 1963 to 1986.

Intermittent small releases have occurred over the years. In January 1976, the pit sealed itself and liquid backed up to the piping level, subsequently corroding the caustic and acid lines (DOE-RL 1991b). Several documented releases associated with the unit have occurred. These releases are described below:

- May 12, 1980 (UN-100-N-34) - During the weekly transfer of sulfuric acid from the 108-N storage tank to the 163-N day tank, a rupture in the pipeline occurred. Approximately 13,000 L (3,400 gal) of sulfuric acid spilled into the containment vault and overflowed to the ground. The acid in the containment vault was neutralized with 50% sodium hydroxide and pumped to the clearwell overflow (located south of the unit). The unknown amount of acid that overflowed to the ground was neutralized with soda ash and liquid sodium hydroxide (DOE-RL 1991b). No further remediation has been documented.

- August 7, 1987 - Water was found leaking outside the 163-N building north wall to an area of the trench that had not been treated with polymer cement due to clearance restrictions. Sulfuric acid had corroded away exposed concrete (WHC 1987e). The extent of contamination, amount of sulfuric acid released, and the extent of remediation is unknown.

- September 2, 1987 - During caustic transfer from the 108-N caustic storage tank to the 163-N caustic day tank, a leak was noted in the piping and caustic collected in the trench. Transfer was stopped and the pipeline patched (WHC 1987f). The amount of caustic released into the trench is unknown and there is no documentation that caustic reached the soil.

- November 9, 1987 - A leak of approximately 760 L (200 gal) of sulfuric acid occurred during transfer operations. This was cleaned up at the time. On December 4, 1987, it was noticed that the trench was open to the soil at the location where the leak occurred. This open area was found to be a dry well installed in 1986 during upgrading of the trench. The dry well was installed for steam trap drainage, not for containment of acid spills. An estimated 57 to 114 L (15 to 30 gal) of sulfuric acid was released to the ground (WHC 1987g). An unknown amount of contaminated soil was removed.

3.1.1.15.3 120-N-3 (163-N) Neutralization Pit and French Drain. The unit is a french drain and vault located immediately west of the 163-N demineralization plant. The unit was constructed in 1963 and is still in place (DOE-RL 1991b). It served as a spill containment unit for the two 38,000 L (10,000 gal) acid and caustic day tanks located immediately inside the 163-N building. A drain in the tank area leads to the unit. The vault is approximately 2.4 m by 7.6 m (8 ft by 25 ft) in size and approximately 2.4 m (8 ft) deep. The walls of the vault are constructed of concrete and the floor is unlined, earthen material. Located in the vault is a 1.2 to 1.8 m (4 to 6 ft) diameter french drain made of clay. The depth of the french drain is unknown. No liquid is currently present in the pit and french drain.

Small, intermittent releases of sulfuric acid or sodium hydroxide occurred during transfer operations to or from the 163-N day tanks (DOE-RL 1991b). No releases other than the small releases have been documented.

3.1.1.15.4 120-N-8 Day Tank Vent French Drain. The unit is a french drain used to receive overflow of sulfuric acid from the 163-N demineralization plant sulfuric acid day tank. The unit is 1.2 to 1.8 m (4 to 6 ft) in diameter and consists of a clay pipe filled with lime to neutralize any sulfuric acid releases. It is located on the north side of the 163-N building. The unit was installed in 1963 and taken out of service on May 13, 1988 (DOE-RL 1991b). No liquid is currently present in the french drain.

The unit received unknown amounts of intermittent sulfuric acid discharges. Each discharge is estimated to have averaged less than 3.8 L (1 gal) of liquid (DOE-RL 1991b). There are no specific documented releases associated with the unit.

3.1.1.15.5 Regeneration Waste Transport System. The regeneration waste transport system includes the storage and piping systems which managed spent regeneration effluent (either acid, caustic or neutralized) from the 163-N demineralization plant and routed this effluent to the 120-N-1 and 120-N-2 ponds. The system took on various configurations from 1977 until 1990. Prior to 1977, the spent regeneration waste was discharged to the Columbia River (Krug 1989).

From 1977 until 1983, regeneration effluents flowed through lined concrete trenches, 0.3 m (1 ft) deep by 0.6 m (2 ft) wide, in the 163-N demineralization plant. The trenches were covered with a metal grating. The trenches carried the effluent to a sump located near the northwest corner of the 163-N building and sump pumps delivered the effluent to an underground 20-cm (8 in) epoxy resin waste transfer line. The waste transfer line historically carried the acid and/or caustic regeneration effluent as well as filter backwash water effluent from the 183-N water filter plant approximately 400 m (1,300 ft) to the north and south settling ponds and subsequently the 120-N-1 percolation pond (WHC 1987c). Figure 3-19 shows the regeneration waste transfer system configuration from 1977 until 1983.

In 1983, the piping was modified to deliver the acid and/or caustic effluent from 163-N directly to the 120-N-1 percolation pond, bypassing the now closed settling ponds. In addition, the filter backwash water was no longer combined with the regeneration effluent, but was piped to the new 130-N-1 filter backwash discharge pond. The regeneration waste transport system operated in this configuration from 1983 until 1986 (WHC 1987c). Figure 3-20 shows the design of this system for that time period.

In 1986, the 120-N-2 surface impoundment was put into service. At that time, the acid and/or caustic regeneration effluent was routed directly to this unit, where the effluent was neutralized. The neutralized effluent was then piped to the 120-N-1 (1324-NA) percolation pond (WHC 1987c). Figure 3-21 shows the design of the regeneration waste transport system between 1986 and 1988.

In 1988, an ENU was installed within the 163-N demineralization plant. At that time, the 120-N-2 surface impoundment was taken out of service. From 1988 until 1990, spent regeneration effluent was routed via the same trenches mentioned previously to the spent regeneration surge tank, located on the north exterior of 163-N building. The tank discharged to the ENU. After adding the proper amount of acid or caustic solution, the contents were mechanically agitated. When the pH was within the range of 4.0 to 11.0, the neutralized effluent was piped via the 20-cm (8 in) waste transfer line to the 120-N-1 percolation pond (Tuck 1990).

Westinghouse Hanford Company personnel have indicated that low levels of radionuclides have been found in the piping. Based on analyses of piping scale, the material was determined to be naturally occurring thorium found in alum used during the water purification processes.

There have been two documented releases associated with the regeneration waste transport system. These releases are described below.

- June 14, 1986 - A leak was detected in the waste transport pipe while wastes from the anion and cation regeneration process were being routed to 120-N-2 surface impoundment. Once the leak was discovered, regeneration processes were shut down. A sample was collected at the point of the leak and found to have a pH of 1.4. It was estimated that approximately 25,000 L (6,500 gal) of acidic regeneration waste had leaked to the ground and formed a pond in an area south and east of the 163-N/183-N buildings. Caustic regeneration waste was pumped through the line and

allowed to leak into the acidic pond to neutralize the spilled material. Several hours elapsed until the pH of the spilled material reached 6.9. The neutralized liquid was then pumped to the 260-cm (102 in) outfall line and released to the Columbia River. An unknown amount of soil around the leak was excavated and disposed. The pipe was repaired (UNI 1986a).

- June 30, 1986 - Approximately 3,800 L (1,000 gal) of acidic (pH of 1.1) cation regeneration waste spilled to the ground in the area of sump No. 1 when a temporary transport line became dislodged from the sump. When this was discovered, the regeneration process was stopped and the hose placed back in the sump and secured. The pH was adjusted by adding 82 kg (180 lb) of caustic soda (soda ash) to the spilled waste. The soil was sampled and the pH was 10.1, therefore no further remediation was conducted (UNI 1986b).

3.1.1.15.6 124-N-1 Septic Tank. The septic tank and seepage pit making up sewer system I are located south of the 163-N building and were installed in 1963 (Gydesen 1985); the system is still operating (DOE-RL 1991b). This unit receives sanitary sewage. It was originally designed to serve only personnel in the 163-N/183-N building. The seepage pit for this system provides about 19 m^2 (200 ft^2) of infiltration surface area and 8,540 L (2,256 gal) of fluid storage. In about 1982, two bathroom utility trailers were hooked up to this sewer system to serve the personnel in the 1127-N and 1128-N buildings. In 1985, the unit served 50 personnel and calculated daily flow was 5,400 L/day (1,420 gal/day) (Gydesen 1985). These utility trailers and the 1127-N and 1128-N buildings have been removed from the area. There are no documented dangerous or radioactive releases associated with the unit.

3.1.1.16 116-N-8 Hazardous and Mixed Waste Storage Area. The 116-N-8 hazardous and mixed waste storage area is a concrete-paved waste container storage pad. The pad is curbed and surrounded by a wire mesh fence. The pad is 18 m by 46 m (60 ft by 152 ft) in size. It is located inside the double-fenced reactor area at the southern corner of the fence. The pad is covered by a roof and walled on two sides. The unit has been in operation since December 1986 (DOE-RL 1991b).

Drums and containers stored in this area may contain mixed or hazardous wastes (DOE-RL 1991b). Hazardous or mixed wastes from satellite collection areas within the 100 N Area and from other points of generation at the retired 100 K Areas are stored at the unit (ICF Technology, Inc. and Ebasco Services, Inc. 1988). Prior to 1986, the area was used as a maintenance storage area. There are no documented dangerous or radioactive releases from the unit.

3.1.1.17 184-N Plant Service Power House, Tanks, and Piping System. This area is distinguished by the significant number of hydrocarbon product releases. Potential sources are listed below:

- 184-N plant service power house
- 184-N day tank area
- UN-100-N-19 unplanned release
- UN-100-N-21 unplanned release
- October 9, 1987 unplanned release
- 166-N-184-N piping (not shown in Figure 3-2)
- UN-101-N-18 unplanned release
- UN-100-N-22 unplanned release
- UN-100-N-23 unplanned release
- October 14, 1987 unplanned release
- April 26, 1989 unplanned release.

3.1.1.17.1 184-N Plant Service Power House. The 184-N plant service power house consists of three boilers located in the 184-N building and the 184-N annex. The boiler system provides oil-fired

boiler-generated steam to the main steam supply system during reactor startup and shutdown periods (WHC 1989a). The 184-N stack released a variety of constituents to the air from 1963 until 1987. Known chemicals in stack emissions include sulfur dioxide, nitrogen oxide, sulfur trioxide, carbon monoxide, aldehydes, hydrocarbons, and particulates. The steam piping system in the 184-N facility is contaminated with low-level radioactivity as a result of leaks that developed in the primary reactor cooling system. Contaminated steam piping is identified and labeled.

3.1.1.17.2 184-N Day Tank Area. The 184-N plant service power house has three above ground oil day tanks located outside the building on the north side. These include two 130,000 L (35,000 gal) No. 6 (Bunker C) fuel oil day tanks and one 30,000 L (8,000 gal) diesel oil day tank. The day tanks are surrounded by a concrete retaining wall (WHC 1989b).

Several documented unplanned releases are associated with the 184-N day tank Area. These are described below.

- April 1984 (UN-100-N-19) - Approximately 7,600 L (2,000 gal) of No. 6 fuel oil spilled to the ground when the day tank overflowed during filling. All of the fuel oil was contained within the surrounding retaining walls and did not penetrate the hard sand floor of the containment structure. The waste oil was removed and disposed (WHC 1989b).

- April 25, 1986 (UN-100-N-21) - Approximately 3,000 L (800 gal) of diesel oil was released to the ground when the day tank overflowed during filling. This was attributed to a failure of the tank-level annunciator. The annunciator was repaired and the oil removed from the tank impoundment area. Groundwater monitoring wells were sampled and no oil was detected (WHC 1989b).

- October 9, 1987 - The diesel oil day tank overflowed during filling operations due to a level indicator which was not reading the correct oil level. The unknown amount of oil was cleaned up (WHC 1987h).

3.1.1.17.3 166-N - 184-N Piping. The 184-N fuel oil day tanks are connected to the oil storage tank at 166-N by an 20-cm (8 in) underground supply line. The 184-N diesel oil day tank is connected to the storage tanks at 166-N by a 10-cm (4 in) underground supply line (WHC 1989b). Several unplanned releases from the pipelines have been documented. They are described below:

- August 1973 (UN-100-N-18) - A leak caused by external corrosion occurred in the 10-cm (4 in) diesel oil supply line between the 166-N storage tanks and the day tank. The leak was detected by a pressure test after approximately 760 L (200 gal) of diesel oil had been spilled to the ground (WHC 1989b). The line was excavated and repaired (DOE-RL 1991b). There is no documentation regarding the specific location of the leak or removal of contaminated soil.

- June 23, 1986 (UN-100-N-22) - External corrosion of the diesel oil supply line caused a 3,800 L (1,000 gal) leak of diesel oil just outside the 184-N tank area. The line was excavated and rerouted. Only the contaminated soil which was removed during the repair of the line was disposed of. No other soil remediation was performed. Groundwater monitoring well 199-N-16 was sampled and oil was detected in July 1986. Well 199-N-16 is located approximately 9 m (30 ft) west of the 184-N building. An unknown amount of residual oil was recovered from the groundwater through well 199-N-16 (WHC 1989b).

- January 10, 1987 (UN-100-N-23) - External corrosion caused a leak in the diesel oil supply line. Approximately 760 L (200 gal) of diesel oil were released to the soil. The line was isolated,

excavated, and repaired. Groundwater monitoring well 199-N-16 was sampled and oil found. Residual oil was recovered from the well (WHC 1989b). There is no documentation regarding soil remediation that occurred.

- October 14, 1987 - An unknown amount of fuel oil leaked from a loose pipe fitting at the 184-N annex. Oil was being transferred from the day tank to the No. 2 boiler. Oil was contained in the 184-N annex drain trench and cleaned up (Tallent 1988).

- April 26, 1989 - The diesel oil supply pipeline developed leaks in three places between 166-N and the 184-N day tanks. The specific cause of the leak was unknown. A minimum of 1,100 L (300 gal) of diesel oil was released to the soil along the pipeline. Monitoring wells 199-N-16 and 199-N-17 were sampled (WHC 1990b). Westinghouse Hanford Company personnel indicated that oil was detected in these samples. A total of 46 drums and eight dump trucks of contaminated soil were removed.

3.1.1.18 Decontamination Drainline Leak. This small area is distinguished from the surrounding source unit areas due to a mixed waste leak from the 3.8-cm (1.5 in) decontamination drainline connecting the N Reactor building to the 116-N-2 radioactive chemical waste storage facility. Decontamination of the N Reactor occurred every 3 to 5 years. The decontamination solution generally contained phosphoric acid and diethylthiourea, but small-scale decontaminations occurred which contained a variety of cleaning solutions. Generally, the 3.8-cm (1.5 in) chemical decontamination waste drainline transported these smaller-scale decontamination solutions to the 116-N-2 facility.

On September 10, 1985, a leak of radiologically contaminated water occurred at four locations along the decontamination waste drain line between the N Reactor building and 116-N-2 facility (UN-100-N-6). This occurred near the N-29 craft shop. Approximately 6,800 L (1,800 gal) of irradiated water was released. The water contained a total estimated 0.2 Ci of cobalt-60, 0.04 Ci of manganese-54, 0.003 Ci of ruthenium-103, and 0.003 Ci of cesium-137. Approximately 17 m^3 (590 ft^3) of contaminated soil reading between 7,000 and 25,000 cpm was removed and drummed for disposal. No documented sampling was conducted at the base of the excavation. The area was backfilled with clean fill (DOE-RL 1991b).

3.1.1.19 120-N-4 Storage Area. This grouping consists of two potential sources in an area southwest of the 116-N-2 radioactive chemical waste treatment and storage facility. These potential sources are the 120-N-4 nonhazardous and nonradioactive storage area and the 1716-N service station underground storage tanks.

3.1.1.19.1 120-N-4 Storage Area. The unit is currently used as a nonhazardous and/or low level radioactive waste storage pad. It is a 30 m by 23 m (100 ft by 75 ft) curbed concrete pad located immediately southwest of the berm surrounding the 116-N-2 radioactive chemical waste treatment and storage facility. The unit has been in its current configuration since November 1985.

Prior to 1985, the unit was unpaved and used as a laydown yard for radioactively-contaminated equipment as well as for storage of radioactively-contaminated oils. Information regarding types and amounts of wastes stored in this area is unavailable. Aerial photographs prior to 1985 indicate storage of unknown materials in the area immediately southeast of the current pad. There are no documented releases to the soil from this unit.

3.1.1.19.2 1716-N Service Station Underground Storage Tanks. Two underground storage tanks were located at the 1716-N service station, located south of the 120-N-4 nonhazardous and nonradioactive storage area. The tanks are identified as 100-N-SS-27 and 100-N-SS-28. Both tanks contained unleaded gasoline. Tank 100-N-SS-27 had a capacity of 11,000 L (3,000 gal) and tank 100-N-SS-28 had a capacity

of 7,600 L (2,000 gal). The tanks were constructed of single-wall carbon steel and neither had cathodic or interior protection. Tank 100-N-SS-27 was installed in 1967 and Tank 100-N-SS-28 was installed in 1976 (DOE-RL 1989a). Tank 100-N-SS-27 was removed in December 1990 and 100-N-SS-28 was removed in July 1991. Soil sampling indicates that the tanks have leaked and remediation is planned as part of the underground storage tank program.

3.1.1.20 Regeneration/Filter Backwash Waste Disposal Area. The regeneration/filter backwash waste disposal area grouping includes those units which have received corrosive regeneration wastes from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant. There are five potential sources in this area, including:

- 120-N-1 percolation pond
- south settling pond
- 120-N-2 surface impoundment
- 130-N-1 filter backwash discharge pond
- 1143-N paint shop.

The 1143-N paint shop is included in this area since it is located in close proximity to the 120-N-1 and 120-N-2 facilities.

3.1.1.20.1 120-N-1 Percolation Pond. The 120-N-1 percolation pond is a large unlined pond located approximately 910 m (3,000 ft) southeast of the N Reactor building. The pond was placed in service in August 1977, and was used to treat corrosive regeneration effluent from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant. The effluent was treated in the 120-N-1 percolation pond by the alternate addition of acidic cation column regeneration effluent and alkaline anion column regeneration effluent. This alternate addition of low and high pH effluent served to neutralize the effluents. The 120-N-1 percolation pond also made use of the buffering capacity and calcareous nature of the soil underlying the pond to neutralize these corrosive wastes. Treated effluents were first transferred to the north and south settling ponds located directly west of the percolation pond. These settling ponds were used to settle out the solids in the filter backwash water waste stream. The settling ponds were removed from service in early 1983. The 120-N-1 percolation pond managed an average of 600,000 L/day (160,000 gal/day) of corrosive regeneration effluent and 1,100,000 L/day (300,000 gal/day) of filter backwash water (WHC 1987c). Figure 3-22 shows the configuration of the 120-N-1 percolation pond area from 1977 to 1983. Tables 3-10 and 3-11 show representative analyses of cation and anion regeneration effluent cycles, respectively, which were discharged to 120-N-1. Table 3-12 shows representative analyses of the filter backwash effluent discharged to 120-N-1. The frequency of these analyses is not known.

Westinghouse Hanford Company personnel indicated that low levels of naturally occurring thorium was present in the water purification chemical, alum, and may have been disposed in this unit. This radionuclide has been found in the water treatment plant piping.

In the spring of 1983, the 120-N-1 percolation pond was enlarged from a bottom area of 850 m^2 (9,200 ft^2) with a volume of approximately 4,500,000 L (1,200,000 gal) to a bottom area of 2,700 m (29,000 ft^2). This enlarged pond was designed to contain up to 11,000,000 L (3,000,000 gal) of corrosive wastes from the regeneration of ion exchange columns in the 163-N demineralization plant. The filter backwash water was routed to the 130-N-1 filter backwash disposal pond at this time, and the south settling pond was backfilled to grade (WHC 1987c). The entire bottom area of the 120-N-1 pond has not been covered with wastes since its enlargement.

Use of the 120-N-1 percolation pond to treat dangerous wastes was discontinued by May 13, 1986 when the 120-N-2 surface impoundment was put into service to treat the corrosive regeneration effluents. The

120-N-2 surface impoundment is a double-lined pond with a leachate collection system which was used to neutralize the wastes prior to their discharge to the 120-N-1 percolation pond (WHC 1987c). This unit was used from 1986 until 1988, when it was replaced by the ENU located at the 163-N demineralization plant. The 120-N-1 percolation pond continued to receive neutralized regeneration effluent from 1986 until 1993. The enlarged 120-N-1 percolation pond and the 120-N-2 surface impoundment are shown in Figure 3-23.

The 100-NR-1 LFI included the sampling and analysis of surface soils and sediment from a test pit at the 120-N-1 percolation pond (DOE-RL 1994c). Fourteen samples were collected from the test pit at 5 ft intervals from the surface to a total excavated depth of 70 ft. Data were also obtained from the 103 ft deep boring 199-N-77, located downgradient but nearby to assess potential contamination from the 120-N-1 and 120-N-2 sites, and the former site of the south settling pond. The test pit and borehole locations are shown in Figure 3-24. Figures 3-25 and 3-26 are summary diagrams for the test pit and borehole 199-N-77, respectively.

The concentrations of all VOCs and semi-VOLs detected and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values in the surface soil and test pit samples are shown in Table 3-13. Benzene, toluene, chloroform, and methylene chloride were detected. All had concentrations < 8 μg/kg. The semi-VOLs, di-n-butylphthalate and bis(2-ethylhexyl)phthalate, were detected. The maximum concentrations were 90 and 58 μg/kg, respectively. Concentrations of copper and zinc lead greater than Hanford Site 95% UTL values were detected in one surface soil sample. Because radionuclide contamination was not expected at this site, samples from 199-N-77 were not analyzed for radionuclides. Field screening pit did not identify any elevated levels of radioactivity.

The concentrations of all VOCs and semi-VOLs detected and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values in the sediment samples from borehole 199-N-77 are listed below:

Analytes	Sample and Sample Interval (ft bls)				
	B06848 23-25	B06850 38-40	B06851 50-52	B06854 63-65	B06852 70-72
Volatile organic compounds (µg/kg)					
Acetone	11J	7J	10J	8J	26J
Semi-volatile organic compounds (µg/kg)					
bis(2-ethylhexyl)phthalate	160J	180J	-	-	-
Metals (mg/kg)					
Copper	34.9	<	<	<	<

A = All detected concentrations of organic compounds are shown, only inorganic constituents that exceed the Hanford Site 95% UTL values are shown (DOE-RL 1994g).
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
< = Concentration less than Hanford Site 95% UTL value of 28.2 mg/kg for copper (DOE-RL 1994g).

Because radionuclide contamination was not expected at this site, samples from 199-N-77 were not analyzed for radionuclides. Field screening pit did not indentify any elevated levels of radioactivity. The spectral gamma ray geophysical log did not detect any man-made radionuclides in borehole 199-N-77.

3.1.1.20.2 South Settling Pond. The south settling pond, in conjunction with the north settling pond, received corrosive regeneration effluent and process and cooling water from the 163-N demineralization plant and filter backwash water from the 183-N filtered water plant from 1977 until 1983. Volumes of effluent to these ponds is the same as for the 120-N-1 percolation pond. Representative analyses of effluents discharged to the south settling pond are presented in Tables 3-10, 3-11, and 3-12. Additional information regarding contaminants possibly contained in the 163-N demineralization plant waste waters is presented in Tuck (1990). Westinghouse Hanford Company personnel, have indicated that low levels of naturally occurring thorium may be present in the pond as a result of using alum in the water treatment process.

The south settling pond was a rectangular, unlined basin constructed below grade. The dimensions of the pond were approximately 34 m by 15 m (110 ft by 50 ft) at grade; the sides sloped to a bottom measuring approximately 21 m by 3 m (70 ft by 10 ft). Depth is estimated to have been approximately 4.6 m (15 ft). After settling out of solids primarily from the filter backwash effluent, the contents of the south settling ponds were transferred to the 120-N-1 percolation pond. Between 1983 and 1986, the North and south settling ponds were closed. The regeneration effluent was then discharged directly to the 120-N-1 percolation pond and the filter backwash effluent was then discharged to the 130-N-1 filter backwash disposal pond. The south settling pond was backfilled.

The LFI (DOE-RL 1994c) at the former site of the south settling pond included the sampling and analysis of surface soil and sediment from the 78 ft deep borehole 199-N-88 and geophysical logging of the boring. Data were obtained from the 103 ft deep boring 199-N-77, located downgradient but nearby these sites to assess potential contamination from the site. Data from borehole 199-N-77 are summarized in Section 3.1.20.1. The borehole locations are shown in Figure 3-24. Figure 3-27 is a summary diagram for borehole 199-N-88.

The concentrations of all VOCs and semi-VOLs detected and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values in sediment samples from borehole 199-N-88 at the site of the former south settling pond are shown in Table 3-14. Methylene chloride, acetone, and toluene were detected. The maximum detected concentration of these VOCs was 54 μg/kg of acetone. Di-n-butylphthalate, bis(2-ethlyhexyl)phthalate, and diethylphthalate were the only semi-VOLs detected. The concentrations ranged from 84 to 170 μg/kg. A concentration of manganese that exceeds the Hanford site 95% UTL value was found in one sample. Because radionuclide contamination was not expected at this site, samples from 199-N-88 were not analyzed for radionuclides. Field screening did not indentify any elevated levels of radioactivity. The spectral gamma ray geophysical log did not detect any man-made radionuclides.

3.1.1.20.3 120-N-2 Surface Impoundment. The 120-N-2 surface impoundment was constructed and placed in service in 1986 at the site of the unlined north settling pond and operated until 1988. It is located approximately 910 m (3,000 ft) southeast of the N Reactor building (WHC 1986). The operating history for the north settling pond is the same as the south settling pond, described in the previous section.

The 120-N-2 unit is a double-lined surface impoundment with leak detection equipment. The unit is approximately 43 m by 23 m (140 ft by 75 ft) at grade sloping to 24 m by 4.6 m (80 ft by 15 ft) at approximately 4.6 m (15 ft) below grade. The impoundment was designed to contain a volume of 1,600,000 L (424,000 gal) (WHC 1986). Figure 3-28 shows the physical design of the unit. No leaks have been detected from this unit.

Acid and caustic regeneration effluent from the 163-N demineralization plant was neutralized in the 120-N-2 surface impoundment. Approximately 1,630,000 L/day (430,000 gal/day) were neutralized (Krug, 1989). Tables 3-10 and 3-11 show representative analyses of cation and anion regeneration effluents, respectively. The caustic anion regeneration effluent was generally neutralized in the surface impoundment by the addition of the acidic cation regeneration effluent. Acid cation regeneration effluent was thus similarly neutralized by the addition of caustic anion regeneration effluent. Once neutralization was complete, the neutralized effluent was discharged to the 120-N-1 percolation pond via a 30-cm (12 in) drainline and 30-cm (12 in) overflow line (WHC 1986). In 1988, the 120-N-2 surface impoundment was taken out of service and replaced by the ENU located at the 163-N demineralization plant.

The LFI at (DOE-RL 1994c) the 120-N-2 surface impoundment included the sampling and analysis of sediment from the 78 ft deep boreholes 199-N-89 and the geophysical logging of the boring. Data were also obtained from the 103 ft deep boring 199-N-77, located downgradient but nearby these sites to assess potential contamination from these sites. Data from borehole 199-N-77 are summarized in Section 3.1.20.1. The borehole locations are shown in Figure 3-24. Figure 3-29 is a summary diagram for borehole 199-N-89.

The concentrations of all VOCs and semi-VOLs detected and inorganic constituents with concentrations greater than the Hanford Site 95% UTL values in sediment samples from borehole 199-N-89 at the 120-N-2 percolation pond are shown in Table 3-15. Methylene chloride, 2-butanone, 2-hexanone, toluene, xylene, acetone, and chloroform were detected. The maximum detected concentration of these VOCs was 23 μg/kg of acetone. Di-n-butylphthalate, bis(2-ethlyhexyl)phthalate, and diethylphthalate were the only semi-VOLs detected. Di-n-butylphthalate was detected in all samples collected in the 10 ft to 71 ft interval. The concentration ranged from 68 to 230 μg/kg. The other semi-VOLs were detected only once. Concentrations of cadmium and copper that exceed the Hanford site 95% UTL values were found in one sample. Because radionuclide contamination was not expected at this site, samples from 199-N-89 were not analyzed for radionuclides. Field screening did not indentify any elevated levels of radioactivity. The spectral gamma ray geophysical log did not detect any man-made radionuclides.

3.1.1.20.4 Filter Backwash Discharge Pond. The 130-N-1 filter backwash discharge pond is a percolation pond used for disposal of effluents generated during backwash of the filters in the 183-N filtered water plant. The pond is a natural basin, marsh-like in appearance, located about 0.8 km (0.5 mi) southeast of the N Reactor building.

The filter backwash discharge pond was placed in service in early 1983 following reconstruction of the 120-N-1 percolation pond, which was formerly used for disposal of the backwash effluent. The pond is fed via a 25- to 30-cm (10 to 12 in) buried line from the 183-N filtered water plant. Approximately 1,100,000 L/day (300,000 gal/day) of backwash effluent were disposed at the unit. The 183-N filter backwash effluent has a neutral pH and contains low concentrations of several anions and cations (Krug 1989). Aluminum sulfate (alum) is used as a flocculent and polyacrylamide is used as a filter aid/coagulant in filtered water production (Greager 1979). Analysis of the filter backwash effluent indicates that it does not contain any listed dangerous wastes or dangerous waste sources, or exhibit any dangerous waste characteristics or criteria (Krug 1989). Table 3-12 shows representative analyses of the filter backwash effluent. There are no data on the characteristics of the pond sediments or pond water, and there is no documentation of any hazardous wastes or materials at this site.

3.1.1.20.5 1143-N Paint Shop. The 1143-N paint shop has three waste management units; a water scrubber for paint overspray, a 210 L (55 gal) solvent accumulation drum, and an associated outdoor sandblasting area, the 1143-N blast yard.

Paint wastes were collected, drummed, and transferred off-site for disposal. Overspray collected by the water curtain filtration system was collected, sampled and disposed of in the paint shop wash basin after analysis showed it was nonhazardous. The blast yard manages paint chips and spent garnet sand. There is no documentation or evidence of releases from this unit. These waste management units are still active and no remedial activities have taken place.

3.1.1.21 Office Septic Tank Area. The four septic systems listed below are shown in Figure 3-1. The only known waste managed by these units is sanitary sewage. There is no documented information that any other wastes were released into the septic systems or evidence that remedial activities were performed.

- 124-N-5 septic tank
- 124-N-6 septic tank
- 124-N-7 septic tank
- 124-N-8 septic tank.

3.1.1.21.1 124-N-5 Septic Tank. The septic tank and drainfield making up sewer system V are located south of building 1117-N and were installed in 1981 (Gydesen 1985); the system was taken out of service in February 1987 (DOE-RL 1991b). The septic tank has a fluid capacity of 14,000 L (3,677 gal) and a drainfield providing approximately 90 m^2 (960 ft^2) of infiltrative surface area. Fill dirt was placed over the drainfield to a depth of 0.6 m (2 ft) or more in the early 1980s. Sewer system V served buildings 1111-N, 1116-N, 1117-N, 1118-N, 1123-N, 1124-N, 1125-N, and 1131-N. In 1985, the unit served 210 personnel and the calculated daily flow was 140,000 L/day (3,780 gal/day) (Gydesen 1985). The sewer system is still in place and it is unknown if residual liquid is present. The number of personnel at the 100 N Area has declined since 1987.

3.1.1.21.2 124-N-6 Septic Tank. The septic tank and drainfield making up sewer system VI are located south of Building 1113-N and were installed in 1979-80 (Gydesen 1985); the system was taken out of service in February 1987 (DOE-RL 1991b). This unit received sanitary sewage. The septic tank has a fluid capacity of 7,600 L (2,000 gal) and the drainfield has an infiltrative surface area of 74 m^2 (800 ft^2) (Gydesen 1985). This system is directly hooked up to sewer system VII just upstream of the septic tank. Sewer system VI served buildings 1113-N, 1114-N, and 1115-N. In 1984, irreparable damage was done to the septic tank; it was pumped out and the system was abandoned (Gydesen 1985).

3.1.1.21.3 124-N-7 Septic Tank. The septic tank and drainfield making up sewer system VII are located south of building 1115-N under the high-voltage power lines and were installed in 1984 (Gydesen 1985); the system was taken out of service in February 1987 (DOE-RL 1991b). This unit received sanitary sewage. The septic tank has a fluid capacity of 28,000 L (7,500 gal). Sewer system VII served buildings 1103-N, 1104-N, and 1145-N. In 1985, the unit served 290 personnel and the calculated daily flow was 20,000 L/day (5,220 gal/day) (Gydesen 1985). The sewer system is still in place and it is unknown if residual liquid is present.

3.1.1.21.4 124-N-8 Septic Tank. The septic tank and drainfield making up sewer system VIII are located south of building 1134-N and were installed in 1983. This unit received sanitary sewage. The septic tank has a fluid capacity of 19,000 L (5,000 gal) and the drainfield has an infiltrative surface area of 150 m^2 (1,650 ft^2). Sewer system VIII served buildings 1132-N, 1133-N, 1134-N, and 1135-N. In 1985, the unit served 51 personnel and the calculated daily flow was 3,500 L/day (915 gal/day) (Gydesen 1985). The sewer system is still in place but is no longer in use. It was replaced by the 124-N-10 sewer system in 1987.

3.1.1.22 N-17 Paint Shop. This grouping includes the entire craft shop area.

Paints, solvents, and oils are used at the N-17 paint shop. The N-17 paint shop has two waste accumulation drums, one for waste paint and the other for waste oil. There is also an associated sandblasting area. The paint shop is located about 300 m (1,000 ft) east of the N Reactor facility. This unit is presently active.

An air compressor located east of the paint shop has leaked nonhazardous lubrication oil over the years; the surrounding soil is oil-stained. The extent of contamination is unknown. Six drums of contaminated soil were removed.

3.1.1.23 124-N-9 Septic Tank. The septic tank and drainfield making up the 129-N-9 sewer system are located northeast of building 1120-N and were installed in 1985. The septic tank has a fluid capacity of 11,000 L (3,000 gal) and the drainfield has an infiltrative surface area of 325 m^2 (3,500 ft^2). This unit receives 8,300 L/day (2,200 gal/day) of sanitary sewage (DOE-RL 1991b). There is no documented information regarding disposal of any other wastes to the unit. The sewer system is still in place. No documented remedial activities have taken place.

3.1.1.24 100-N Sewer System. This grouping includes the recently constructed centralized 124-N-10 sewer system for the 100 N Area and an unplanned release (UN-100-N-11). Both potential sources are located approximately 1.6 km (1 mi) east of 100-N Reactor building.

3.1.1.24.1 124-N-10 Sewer System. The 100-N sewer system was constructed to replace five existing 100 N Area sewer systems which had technically failed and required upgrade or replacement before unnecessary inconvenience or potential health hazard was incurred. The system includes a three-pond lagoon facility, a sewer trunk line and other pipelines, two lift stations, new manholes, and associated sewer system instrumentation and annunciation capability. The five sewer systems that were replaced include (Hughes 1985):

- sewer system IV, which served the 105-N, 109-N, 184-N, 1100-N, 1101-N, 1102-N, 1107-N, 1112-N, 1119-N, and 1126-N buildings and contractor construction buildings
- sewer system V, which served the 1111-N, 1116-N, 1117-N, 1118-N, 1123-N, 1124-N, 1125-N, and 1131-N buildings
- sewer system VI, which served the 1113-N, 1114-N, and 1115-N buildings and was abandoned
- sewer system VII, which served the 1103-N and 1104-N buildings, and 1113-N, 1114-N, 1115-N, and 1146-N buildings (1152-N, 1153-N, and 1154-N buildings were also connected to this system)
- sewer system VIII, which served the 1132-N, 1133-N, 1134-N, and 1135-N buildings.

This unit has been operational since February 1987 and receives 190,000 L/day (50,000 gal/day) of sanitary sewage (DOE-RL 1991b). There is no documented information regarding disposal of any other wastes to the unit other than sanitary sewage routinely trucked there from the 200 Area. The central sewer system is still in place. No remedial activities have taken place.

3.1.1.24.2 UN-100-N-11 Unplanned Release. On October 2, 1975, a radioactively contaminated 230 kg (500 lb) valve bonnet fell from a truck onto the road and into the adjacent field (DOE-RL 1991b). This occurred at the corner of Route 4 North and the 100 N Area access road. Cleanup consisted of removal and disposal of 6.1 m^3 (8 yd^3) of contaminated soil and asphalt.

3.1.1.25 Hanford Generating Plant Area Sources. The HGP Area was operated by the SS. Pursuant to Change Number C-93-08 to Appendix C of the Tri-Party Agreement (Ecology et al. 1994b), DOE has assumed responsibility for regulatory compliance and the lead for cleanup actions under the Tri-Party Agreement. Operations at the HGP centered around building 185-N, the turbine generator building, where electrical power was produced. The EPA RCRA facility assessment (RFA) (EPA 1992) identified 11 solid waste management units (SWMUs) at the facility, which are listed below:

- HGP transformer yard - SWMU-1
- HGP building oil storage - SWMU-2
- HGP building floor drains, sumps, and all piping to settling pond and outfall - SWMU-3
- HGP turbine oil filter unit - SWMU-4
- HGP Tile field - SWMU-5
- HGP Settling pond - SWMU-6
- HGP outfall - SWMU-7
- HGP maintenance garage - SWMU-8
- HGP building septic systems (2) and maintenance garage french drain - SWMU-9
- HGP disposal and storage area - SWMU-10
- HGP burn pit - SWMU-11.

There are eight potential source units at the HGP, including:

- HGP diesel oil storage tank
- HGP outfall
- HGP settling pond
- HGP tile field
- HGP transformer yard
- HGP disposal and storage area (bone yard)
- HGP septic tanks (2) and
- HGP maintenance garage french drain.

The HGP building oil storage area (SWMU-2) and the HGP turbine oil filter unit (SWMU-4) are not considered potential source units since both were identified by the RFA (EPA 1992) as requiring no further action at this time. The HGP gasoline storage tank has been removed from the ground with verification that no contamination remains, therefore, it is not considered a potential source unit.

3.1.1.25.1 HGP Diesel Oil Storage Tank. The 76,000-L (20,000-gal) underground storage tank located on the east side of the 185-N turbine generation building, and contains diesel oil used for heating. The tank Levelometer was read each working day, in addition, monthly dip tests are performed. There is no indication of leaks and no documented remedial activities have taken place.

3.1.1.25.2 HGP Outfall. Columbia River water is used to cool the closed-loop condenser water in 185-N turbine generation building. The intake for the river water is located at the 181-NE the river pumphouse building, and the outfall is located about 60 m (200 ft) further downstream at the 1908-NE seal well building. The outfall is permitted under NPDES Discharge Permit No. WA 002487-2 issued on March 10, 1980. Discharge from the HGP to the Columbia River was terminated on March 14, 1988, after the N Reactor was placed in layup status. No documented remedial activities have taken place.

3.1.1.25.3 HGP Settling Pond. The HGP settling pond is located near the 1908-NE seal well building. Design details of the pond are unknown. Condenser pit and service water sumps, demineralizer backwash, roof and parking lot runoff, all discharge to the settling pond. An oil spill occurred on January 2, 1987 and was contained by the pond. Cleaned up was performed by United Nuclear and J.A. Jones companies in early February 1987 . Further information on the spill is unavailable. The HGP tile field is located to the east and upslope from the settling pond and may discharge sanitary sewage and waste from the lab drains into the pond. Other than the oil spill cleanup, no documented remedial activities have taken place. The piping from the HGP building drains (SWMU-3) will be addressed with the settling pond (SWMU-6).

3.1.1.25.4 HGP Tile Field. The HGP tile field is located west of the 185-N building and east and upslope from the HGP settling pond. The HGP sanitary sewer and lab drains discharge to the tile field. Specific lab waste information is unknown. No documented remedial activities have taken place.

3.1.1.25.5 HGP Transformer Yard. The HGP transformer yard is located along the west side of the 185-NE building. Electrical transformers are stored on a gravel pad. According to site representatives, PCBs have never been used in the transformers. Oil stains are visible where transformers were located in the storage yard. Stains average approximately 0.8 m^2 (1 yd^2). No remedial activities have taken place.

3.1.1.25.6 HGP Disposal and Storage Area (Bone Yard). The HGP bone yard is located west of the southwest corner of the 155-N switch yard and across the railroad tracks. The bone yard is an area of open ground where scrap metal and equipment are stored. The soil in the bone yard is oil-stained and garnet grit from sandblasting is also present. No documented remedial activities have taken place.

3.1.1.25.7 HGP Gasoline Storage Tanks. The HGP gasoline storage tanks were located north of the 185-N building. The 3,800-L (1,000-gal) underground leaded gasoline tank was installed in 1965. No design details for the tank are available. The tank was removed on October 12, 1989. A site assessment was completed and no contamination was found. A 3,800-L (1,000-gal) unleaded gasoline underground storage tank was removed with verification that no contamination remains.

3.1.1.25.8 HGP Septic Tanks and Maintenance Garage French Drain. Two septic tanks and a french drain are located in the eastern portion of the HGP area. The tanks were installed in 1965, one was removed from service in 1989. The septic tanks served the field office building and gate house. The french drain served the maintenance garage. These wastewater disposal units received sanitary sewage and wash water.

3.1.2 Soil

As previously described, a number of potential sources of contamination have been identified at the 100 N Area. This section discusses known and suspected contaminant occurrence in the soil column as a result of releases from these sources.

3.1.2.1 Background Soil Quality. Soils near the 120-N-1/120-N-2 area have been sampled and analyzed. These data indicate that the soils contain metals, with low levels of radionuclides, volatiles, and no semivolatiles. Analytical results for these samples may be compared to regional and Hanford site wide

soil samples to evaluate soil quality at this site. Soil samples were collected from a location south of the 120-N-1 surface impoundment and were taken from 0.3 m (1 ft) below the surface of a 3-m (10 ft) deep trench (Chou 1989).

Results of total metals and nonmetal analyses for soil samples analyzed are presented in Tables 3-16 and 3-17, respectively. Analyses for radionuclides indicate that most are below detection limit, except for beta, uranium, potassium-40, lead-212, and lead-214 (see Table 3-18). Results of total metals analysis and metals analysis using extraction test procedures as indicated, are presented in Table 3-19. A few of the samples were analyzed for volatile organics and volatiles were detected in each of the samples, even though holding times were exceeded. Acetone was detected in five samples ranging from <0.007 to 0.032 mg/kg, 1,3-dichlorobenzene was detected at 0.003 mg/kg in one sample, and diethylether was detected in two samples at 0.018 and 0.028 mg/kg. No semi-VOLs were detected above the detection limit.

Several anomalies in the sampling data have been identified, including the mentioned exceedance of holding times that resulted from inconsistencies in the chain of custody/sample request forms. While the results for anions and cations were questionable in some instances, the overall quality control (QC) data were acceptable (Chou 1989).

Additional sitewide background data is also available, and maybe applicable to the 100 N Area (DOE-RL 1994g). Surface soil samples are collected periodically at a number of locations to determine the extent of contamination both on and off the Hanford Site as part of the Hanford Environmental Monitoring Program (Jaquish and Bryce 1990). These samples may be of limited use because they do not provide subsurface soil data, are only analyzed for a limited range of radionuclides, and are purposely located in areas where radionuclide levels are most easily detected. Onsite samples are collected at locations adjacent to major operating facilities, whereas off-site samples are collected around the Hanford Site perimeter, generally in a downwind direction. Because of their intentional proximity to operating facilities, Hanford Site samples may not be regarded as providing an adequate background concentration reference. Data from twelve Hanford Site sampling stations have been used for the purposes of this work plan, the locations are:

- 1.6 km (1 mi) northeast of the 100 N Area
- 1.6 km (1 mi) east of the 100 N Area
- the 100 Area fire station
- the 200 East Area, north central
- east of the 200 East Area
- the 200 East Area, southeast
- southwest of the 100 B/C cribs
- south of the 200 East Area
- east of the 200 West Area
- 3.2 km (2 mi) south of the 200 West Area
- southeast of the Fast Flux Test Facility
- north of the 300 Area.

Data from both onsite and off-site samples collected in 1989 are presented in Table 3-20. All soil sampling locations are shown on Figure 3-30. No background soil data have been developed for nonradioactive inorganic contaminants such as nitrate, sulfate and chromium.

Results of the characterization of the natural chemical composition of Hanford Site soil samples are presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analyses* (DOE-RL 1994g). This characterization is based on the chemical analysis of inorganic constituents from 170 samples. The characterization included an analysis of physical properties and factors that might affect the

natural soil chemical composition, as determined by regulatory protocols. Hanford Site soils have not been characterized sufficiently to establish the natural concentrations of the following types of constituents: VOCs, semi-VOLs, pesticides and PCBs, and radionuclides.

Table 3-21 presents the lognormal distribution 95th percentile of the data for a lognormal distribution and the 95% confidence limit of the 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1994g). The 95% confidence limit of the 95th percentile of the data distribution, abbreviated as the 95% UTL is one way to define threshold levels.

3.1.2.2 Surface Soil Contamination. Surface soil samples have been collected from various locations in the 116-N-1 and 116-N-3 areas since 1975. From 1975 to 1980, soil samples were collected at unspecified locations within the 116-N-1 trench. Analytical data from these samples indicate that strontium-90 and plutonium-239/240 concentrations increased during this time period, while cobalt-60 and cesium-137 values varied yearly (Greager 1980).

Beginning in 1980, soil sampling was conducted annually in the 100 N Area as part of the Environmental Surveillance Program. In 1980, nine surface soil samples were collected in areas both north and south of the 116-N-1 crib and trench and nine surface soil samples were collected within the trench. Results of these analyses are presented in Table 3-22. Concentrations in the trench can be seen to be at least 100,000 times higher than in the adjacent soil surface (Greager 1980).

Relatively consistent surface soil sampling locations were established in 1981, which were then sampled annually. Additional sampling locations were added periodically (i.e., addition of sampling locations south of 116-N-1 upon activation of the 116-N-3 crib and trench). The sample location map is presented in Figure 3-31. It must be emphasized that each location may not have been sampled each year, and some sample collection locations were not consistent from year to year. The average concentration of select radionuclides over the entire soil sampling area between 1980 and 1988 is presented in Table 3-23. The concentrations of most of the constituents have decreased since 1980. Additionally, sediments within the 116-N-1 and 116-N-3 cribs have been sampled under the Environmental Surveillance Program. Data from all sampling programs indicate the presence of radionuclides in the surface soils.

A radiological characterization of the 116-N-1 facility was conducted in 1989 and 1990 to determine if the source of the elevated environmental exposure rates along the shoreline of the Columbia River in the vicinity of 116-N-1 is due to skyshine (Brown and Perkins 1991). Skyshine results from contaminated sediments that emit gamma photons which are scattered downward due to interaction with the atmospheric constituents. The study measured radiation along the shoreline of the Columbia River and compared the observed measurements with skyshine model predictions. Based on this comparison, the radiation along the shoreline was determine to be from skyshine resulting from the sediments of 116-N-1. The study then looked at different combinations of trench coverings to reduce the dosage along the river and concluded that two or three sections of the trench would have to be covered to reduce the shoreline dose to below 100 mrem/yr.

Pesticides are routinely applied to various locations on the site for vegetation control. In general, no pesticide contamination is expected to occur onsite, however source samples will include analysis for selected pesticides as outlined in the QAPjP.

3.1.2.3 Vadose Zone Soil Contamination. In addition to surface soil analyses, soil samples were collected within the vadose zone as part of a 1982 research project by Robertson et al. (1984). Three wells were installed at varying distances from the 116-N-1 crib and trench, and soils from the borings were analyzed. The locations of these wells are shown in Figure 2-12. Well 199-N-9 was installed 30 m (100 ft) from the trench, while wells 199-N-12 and 199-N-13 were installed 46 and 73 m (150 and 240 ft)

from the trench, respectively. Depth to groundwater varied from 16 to 18 m (53 to 59 ft). Boreholes were logged using gamma-ray logging tools to assess the occurrence of radionuclides in the borehole (Robertson et al. 1984).

Data from these logs indicate that very low concentrations of radionuclides such as cobalt-60, cesium-137, antimony-125, and ruthenium-106 were present in soils from well 199-N-9 above the water table, although the concentration increases markedly in soils at the water table. Wells 199-N-12 and 199-N-13 are more distant from the trench and had lower radionuclide concentrations in the unsaturated zone, but also had elevated concentrations at the water table (within the saturated zone). These data indicate that extensive lateral migration of contaminants from the trench within the unsaturated zone is not apparent in these borings (Robertson et al. 1984). Mechanisms which control the lateral migration of contaminants through the unsaturated zone include dispersion, diffusion, capillary flow, migration through a low permeability zone due to increased moisture content and perched water, and the adsorption capacity of the soil.

Because these wells were installed between the trench and the springs, they could be used to assess the chemical speciation of wastewater as it migrates from the trench to the springs. While this is more specific to the groundwater pathway, this study also sheds light upon the retention of specific radionuclides that could also occur in the vadose zone. These studies indicate that as the trench water percolates into the soil and moves downward to the water table and on to the springs, selective removal of the cationic and particulate radionuclides occurs, with the more mobile anionic and nonionic species transmitted with groundwater essentially unattenuated (or with low attenuation). For example, cesium-137 is the least mobile of the radionuclides in this study; while 16,100 pCi/L were present in trench water (all as a soluble cation), no cesium-137 was detected in either the wells or springs, indicating that this radionuclide was probably bound in the soil column. On the other hand, 50% of the iodine-131 in trench water was present as a soluble anion, and this species was relatively mobile in groundwater (present in both the wells and springs), and did not sorb readily as an anionic species to the soil column.

The occurrence of organic compounds within trench sediments was also assessed as part of this study. The presence of organic compounds in sediments/soils is important because they can form complexes with radionuclides, thus enhancing their mobility. Hydrophillic organic constituent concentrations are presented in Table 3-24. Identification of specific hydrophobic organic compounds was very difficult, with alkenes, alkanes, alkynes, elemental sulfur, and three cyclic sulfur species among those compounds found (Robertson et al. 1984).

Vadose zone contamination at the 116-N-1 and 116-N-3 cribs and trenches is scheduled for investigation in calendar year 1995 as described in the DOW (DOE-RL 1994h) in order to comply with requirements established in Tri-Party Agreement Change Number M-15-94-04 (Ecology et al. 1994c). Vadose zone contamination at the selected high-priority sites was investigated in the 100-NR-1 LFI (DOE-RL 1994c) and the results are summarized in the work plan sections as noted below at the following areas:

High-Priority Site	Work Plan Section
1322-N/NA	3.1.1.4.2
116-N-2	3.1.1.5.1
120-N-1 Percolation Pond	3.1.1.20.1
South Settling Pond	3.1.1.20.2
120-N-2 Surface Impoundment	3.1.1.20.3
119-N	3.1.1.2.1
166-N Tank Farm (UN-100-N-17)	3.1.1.3.2

3.1.2.4 Inferred Soil Contamination. Most of the unplanned release locations throughout the 100 N Area have not been sampled to determine extent of contamination. Although screening sampling or radiation surveys were usually performed, and exposed surface contamination was excavated, quantitative radionuclide- and chemical-specific analyses were not performed. Based on the areas of known releases (i.e., 116-N-3 crib and trench) and areas of inferred releases discussed in previous sections of this report, inferred areas of soil contamination have been identified. These areas are shown in Figure 3-32. Soil contamination was confirmed at many of the high-priority sites investigated during the 100-NR-1 LFI (DOE-RL 1994c). Results of the investigation are summarized in prior sections of this work plan as noted above.

Although estimates of total activity released or remaining in soil were usually included in unplanned release or "occurrence" reports, the bases for these estimates were uncertain. However, the general extent of contamination at these locations can be inferred from the studies discussed in previous sections.

Where a release of a few hundred to a few thousand L of radionuclide-contaminated wastewater occurred, it is reasonable to expect that the unsaturated soil column directly below the release location is still holding most of the long-lived radionuclides. These locations include the 119-N building and 1322-N/NA sampling buildings, among several others described in Section 3.1.1.

At locations where more than a few thousand L of radionuclide-contaminated water were released (particularly with high concentrations), the long-lived radionuclides are expected to be present in the saturated soils and (to an unknown extent) in the groundwater directly below and downgradient from the release location. These locations include the 116-N-2 radioactive chemical waste treatment and storage tank, the 118-N-1 spacer storage silos, the 1304-N EDT, and the 1314-N LWLS.

3.1.3 Groundwater

The known nature and extent of groundwater contamination in the 100 N Area is discussed in the 100-NR-2 work plan (DOE-RL 1994a).

3.1.4 Surface Water and River Sediments

The known nature and extent of contamination in the Columbia River water and sediment in the 100 N Area are discussed in the 100-NR-2 work plan (DOE-RL 1994a).

3.1.5 Air

Atmospheric releases of radioactive and nonradioactive materials from the 100 N Area represent a possible direct pathway to human exposure. Past releases may have included gaseous-phase radionuclides and radioactive or nonradioactive particulates.

Air monitoring data is available for onsite and off-site monitoring locations. This section presents release data specific to the 100 N Area.

There are six units located at the 100 N Area which are known to have emitted gases and particulates to the atmosphere. These are:

- 184-N power house (boilers)
- 116-N stack
- 109-N roof vent
- 109-N cell no. 6 roof vent (A.K.A. cell no. 6 exhaust)

- 105-N ventilation stack
- burning pit.

No data specific to the HGP were available in the information reviewed. Therefore, air releases from the HGP cannot be characterized at this time.

Nonradioactive emissions from sources at 100 N are presented in Table 3-25. The data presented in this table was collected from the 1971 through 1987 environmental release reports, or effluent release reports. The monitoring equipment or methods used to calculate the emissions were not evaluated for preparation of this plan.

The environmental release and effluent release reports also present information on the annual amount of radionuclides released to the atmosphere. This information is tabulated in Tables 3-26 and 3-27.

The data reported were not consistent from year to year. Sources were dropped or added to the listings, as were specific radionuclides. Table 3-26 presents the results from air monitoring from 1971 through 1974. No information on the type of monitoring equipment used to determine the amount of radionuclides released was noted in the reports. A review of this table indicates that large releases of gaseous argon-41 occurred in 1973 and 1974. Such releases may have occurred in previous years, but such data are not currently available.

In 1975, the monitoring of radionuclides increased to include particulate releases as well as gaseous releases. The list of radionuclides monitored also expanded over time. A review of the data indicates that only trace amounts of radionuclides were emitted each year.

The Hanford Site environmental surveillance program, which was begun in 1980, included air sampling at the 100 N Area. There are no data for 1980, as the air monitoring stations were not fully operational (Greager 1980).

From 1981 through 1988, four continuous air sampling stations were used. The locations of the sampling stations are shown in Figure 3-33. These stations were labeled: A1, located at the west side of the 116-N-1 crib and trench; A2, located at the 151-N sample shed; A3 located near the 1900-N water supply tanks; and, A4 located at 120-N-1 percolation pond. The sampling train consisted of an air mover and an air filter system. The collection device used was a standard cartridge sampler (UNC Print H-1-39022). The cartridge contained an engineered flow-limiting 0.03 m^3/min (1 ft^3/min) orifice, particulate filtration, and a charcoal absorber for halogens. A continuous duty low volume vacuum air pump was installed, along with the cartridge in a weather proof enclosure. Samples were collected monthly and analyzed for gamma emitters. The particulate filters were also analyzed for gross alpha and beta (Greager 1981). A filter air monitoring station was installed near 116-N-3 in 1989. Table 3-27 presents the average data per sampling location for the years 1981-1988.

3.1.6 Biota

Impacts of 100 N Area activities on plants and animals outside of its boundaries are difficult to distinguish from the effects of other activities within the Hanford Site. This section therefore contains information specific only to the 100 N Area. Several documents may be consulted for information regarding offsite studies (Eberhardt et al. 1989), and Appendix D-2 of the 100-NR-2 work plan contains a description of the 100 Area aggregate ecological investigations (DOE-RL 1994a).

3.1.6.1 Flora. Collection and analysis of vegetation for radionuclides has occurred annually in the 100 N Area at three locations: along the Columbia River at the N Springs, near the 116-N-1 crib and

trench, and in the southeast section of the 100 N Area. The average concentration of selected radionuclides for the years 1980 through 1988 are presented in Tables 3-28, 3-29, and 3-30.

Vegetation analysis has not utilized the same number of samples each year. No sampling of vegetation was conducted at the N Springs in 1984, and only three samples were taken in 1985, 1986, and 1987. A maximum number of eight samples were taken near N Springs during 1981 and 1988. The usual number of samples collected from the 116-N-1 area was five, but in 1987 only four were collected. The minimum number of samples collected in the southeast section of the 100 N Area was three during 1981, 1982, and 1983, and the maximum number was seven during 1984, 1985, 1986, and 1988.

In 1990, the Columbia River shoreline within the Hanford Site was surveyed for potential edible natural vegetation, and samples collected for radiological analysis. Table 3-31 shows results for samples of mulberry leaves and berries, and one sample of curly dock collected from the N Springs area. The DOE initiated removal of all contaminated vegetation from the N Springs area in September 1990. Mulberry trees and other plants were removed and disposed of in the 200 Area burial grounds.

3.1.6.2 Fauna. The effects of the 100 N Area on animals living near or at the 100 N Area have been investigated since 1979. The predominant area of investigation has been the 116-N-1 crib and trench. Rabbits were trapped and collected around the 116-N-1 in 1981. In 1982 and 1985, deer mice were trapped and collected in the 116-N-1 vicinity. In 1983, deer mice at the N Springs were trapped and collected.

3.1.6.2.1 Use of Mud for Nests. The first study conducted was an investigation of barn swallow nests and barn swallow excrement. Samples were collected in the vicinity of the 1304-N EDB. One of the sources of mud used to build the nests was the 116-N-1 Trench. The nests and excrement were sampled to determine the amount of radionuclides in the nests. Two rounds of sampling were performed. The second round of sampling results, including soil sampling results for the same time period are presented in Table 3-32. Nests, excrement, and shell/embryo samples of barn swallows were collected in 1985 near the 1304-N EDB. The results are also presented in Table 3-33. The lowering of radionuclide concentrations may be the result of the installation of a cover over the 116-N-1 trench, which prevents the birds from using mud from the unit for nest building or eating insects which live in the unit (Jacques 1985).

Investigation of other nests at the 100 N Area noted a contaminated bird nest on the side of the J.A. Jones craft building. The nest was tentatively identified as a robin nest which was partly built using mud from the 116-N-1 trench. A Cutie Pie reading of 250 mrad/hr was the highest reading observed for the nest. Subsequent surveys located one contaminated wasp's nest on the J.A. Jones building and about 15 inside the building. The highest reading of the nests was 15,000 counts per minute, however, the meter and frequency of monitoring were not described. A sample of either a wasp's nest or a composite sample of several wasp's nest was collected and analyzed. The following results were reported (in pCi/g) (Greager 1980):

- manganese-54 1.68E+5
- cobalt-60 1.06E+6
- cesium-137 1.55E+5
- cerium/praseodymium-144 5.02E+4

3.1.6.3 Ingestion of Water and Vegetation. Cottontail rabbits (*Sylvilagus nuttallii*) were collected and radioanalyzed in 1981. Five rabbits were collected from inside the 116-N-1 security fence and four rabbits were collected to the northwest of the fenced area. Rabbit feces were also collected around 116-N-1 for analyses. The study found much higher concentrations of radionuclides in rabbits collected within the 116-N-1 fenced area (Table 3-34). Concentration differences were attributed to rabbits inside the security

fence drinking from the 116-N-1 trench, and eating vegetation growing near the trench. The rabbits outside the fenced area were found to have radionuclide concentrations at or near background levels (Greager 1981).

Deer mice (*Peromyscus maniculatus*) were collected near the 116-N-1 trench in 1981 for radioanalysis. A total of 18 mice were collected over a three day period from 30 snap traps set along the first leg of the trench. Results of the sampling are presented in Table 3-35. Fission and activation products were detected in the mice. The cobalt-60 concentrations ranged from 54 to 17,000 pCi/g and cesium-137 concentrations ranged from 25 to 26,000 pCi/g. Concentrations of iodine-131 were also noted, which indicated the mice were using the 116-N-1 trench as a drinking water supply. Ingestion of vegetation in the area also may have increased the concentrations of radionuclides in the mice. Total gamma activity ranged from about 3,200 pCi to nearly 1 μCi in the mice. Four composite samples of the 18 mice were formed based on the concentration of cesium-137 in each mouse. The composite with the highest average cesium-137 (1,800 pCi/g) also had the highest strontium-90 concentration (190 pCi/g). This study was conducted prior to the installation of a concrete cover on the 116-N-1 trench (Greager 1982).

Deer mice were collected at the N Springs for analysis of gamma-emitting radionuclides in 1982. A total of 12 mice were collected over a three day period from 30 snap traps. The results of the analyses, presented in Table 3-36 indicate that the levels were probably due to ingestion of vegetation growing at the springs and drinking N Springs water (Greager 1983).

During 1985, 16 mice were collected from 50 traps. The sampling results from whole body analysis are presented in Table 3-37. Many of the mice sampled contained relatively high concentrations of cobalt-60, iron-59, and manganese-54. Iodine-131 and cesium-137 were also detected. The data suggests that the mice were still obtaining radionuclides directly from the effluent to the 116-N-1 trench (Jacques 1986).

3.1.7 Qualitative Risk Assessments

Qualitative risk assessments were performed for the 100-NR-1 and 100-NR-2 Operable Units (BHI 1994b, BHI 1994c) using historical information and data from the limited field investigations (DOE-RL 1994c, DOE-RL 1994d). The QRAs were conducted following the HSRAM methodology (DOE-RL 1994b) which involves both a human health evaluation and an ecological evaluation. The QRA were conducted to provide sufficient information to help the Tri-Party signatories make defensible decisions regarding IRMs in the two operable units.

The results of the QRA for the 100-NR-1 Operable Unit (BHI 1994b) are summarized in Table 3-38. In general, the risk-driving pathway is external exposure to radionuclides. Specific radionuclides identified as key contributors to the overall risk estimates were potassium-40, cobalt-60, cesium-137, radium-226, thorium-228, and uranium-238. Risk was quantified at the 116-N-1 and 116-N-3 cribs and trenches, at the 116-N-2 treatment and storage facility, and at the 1322-N and 1322-NA sample buildings. Except for the 1322-N and 1322-NA sample buildings site, at which the risk was rated medium, the risk at these sites was rated high under the frequent-use scenario. Under the occasional-use scenario, risk was rated high at the 116-N-1 and 116-N-3, medium at the 116-N-2, and low at the 1322-N and 1322-NA.

The ecological evaluation estimated the likelihood of an adverse effect occurring to wildlife. The risk assessment assumed a key receptor organism, the Great Basin pocket mouse, was a frequent site user and was exposed to the maximum level of soil contamination at an individual waste site. Organism dose that exceeded the total internal dose rate of 1 rad/day was classified as a high risk. For radiological constituents, strontium-90 being the primary contributor, the 116-N-1 and 116-N-3 surface soils inside the crib and trench exceed the 1 rad/day benchmark dose rate.

For non-radiological constituents the 120-N-1/120-N-2 Ponds, the 1322-N and 1322-NA sites, and the 116-N-1 trench exceeded the environmental hazard quotient (EHQ) of >1 and no observable effect level (NOEL) vales for wildlife. The primary nonradiological constituents of concern for wildlife toxicity included cadmium, lead and zinc.

The 100-NR-2 QRA (BHI 1994c) estimated incremental cancer risk (ICR) for humans potentially exposed in the frequent-use scenario is "medium" and "low" for the occasional-use scenario (BHI 1994c). The results of the human health QRA indicate total hypothetical ICR of 2×10^{-3} and 3×10^{-5} for exposures under the frequent and occasional groundwater use scenarios, respectively. Hypothetical hazard indices of 20 and 0.4 were estimated for the frequent- and occasional-use scenarios, respectively.

If an ICR is "medium" or "high" under the occasional-use scenario, then there is a need to continue along the IRM path.

Groundwater ingestion was determined to be the major pathway contributing to human ICR in both the frequent- and occasional-use scenarios for the following reasons (BHI 1994c):

- Two radionuclides (strontium-90 and tritium) and one inorganic contaminant (arsenic) were determined to be the major contributors to the ICR in both groundwater use scenarios (Table 3-39). A 38% reduction in ICR through 2018, resulting from radioactive decay of tritium and strontium-90.

- Six systemic toxicants (arsenic, cadmium, chromium, fluoride, manganese, and nitrate) were determined to have hazard quotients above the adverse human health effects threshold in the frequent-use scenario (Table 3-40). Systemic toxicants did not present a human health hazard in the occasional-use scenario (Table 3-40).

In the ecological risk assessment:

- The dose rate from radionuclides in groundwater from near-river wells was estimated to exceed the 1 rad/day benchmark to plant-eating ducks established by DOE Order 5400.5.

- Six constituents (chromium, iron, zinc, 2,4-dichlorophenol, 2,4-dimethylphenol, 4-chloro-3-methylphenol) were measured in the near-river well water at concentrations exceeding the lowest observable effect level standard applicable to aquatic organisms.

3.2 POTENTIAL CORRECTIVE ACTION REQUIREMENTS

Corrective action at the 100-NR-1 Operable Unit is generally required to comply with federal and state environmental laws and promulgated standards, requirements, criteria, and limitations that are legally applicable or relevant and appropriate under the circumstances presented by the release or threatened release of hazardous substances, pollutants, or contaminants. As stated in Chapter 1.0, cleanup of the 100-NR-1 Operable Unit will be addressed under RCRA corrective action authority. Cleanup requirements for RCRA corrective actions (40 CFR 264.100) are not as fully documented as are those for remedial actions under CERCLA. The EPA has, however, identified groundwater protection standards for RCRA corrective actions, and has stated that other "relevant and applicable standards for the protection of human health and the environment" are to be identified in the RFI/CMS process.

For the purpose of this section, which is to identify potential corrective action standards for protection of human health and the environment, both EPA's RCRA regulation (40 CFR 264.100) and CERCLA

guidance (EPA 1988a) pertaining to ARARs are used as the basis for the identification of potential RCRA CARs. In this work plan, CARs are intended to indicate RCRA CARs that are analogous to CERCLA ARARs.

Three categories of potential CARs will be evaluated: contaminant-specific CARs, location-specific CARs, and action-specific CARs. When requirements in each of these categories are identified, a determination must be made as to whether those requirements are applicable or relevant and appropriate. A requirement is applicable if the specific terms (or jurisdictional prerequisites) of the law or regulations directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirements.

To-be-considered (TBC) information includes non-promulgated advisories or guidance issued by federal or state governments that are not legally binding and do not have the status of potential CARs; however, in some circumstances, TBCs will be considered along with CARs in determining the corrective action necessary for protection of human health and the environment. The TBCs complement CARs in determining what is protective at a site or how certain actions should be implemented. As an example, drinking water maximum contaminant levels (MCLs) do not exist for all contaminants, and TBCs may be helpful in defining appropriate corrective action goals.

The EPA has developed the two-volume guidance document *CERCLA Compliance with Other Laws Manual, Interim Final* (EPA 1988c, EPA 1989c) for use in preparing ARARs. This guidance document defines the three categories of ARARs as follows.

- Ambient or contaminant-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a contaminant that may be found in, or discharged to, the ambient environment.

- Performance, design, or other action-specific requirements are usually technology- or activity-based requirements or limitations on remedial actions.

- Location-specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special geographic areas.

Potential contaminant- and location-specific CARs are preliminarily identified in this section, and potential action-specific CARs are briefly discussed. A detailed compilation of preliminary ARARs for the 100 Area is currently being performed.

3.2.1 Contaminant-Specific Requirements

A contaminant-specific requirement sets concentration limits in various environmental media for specific hazardous substances, pollutants, or contaminants. Based on existing data, some of the currently known or suspected contaminants that may be present in the 100 Area include: cadmium, chromium, lead, mercury, nitrite, chloroform, tetrachloroethylene, 1,1,1-trichloroethane, tritium, carbon-14, cobalt-60, nickel-63, strontium-90, iodine-129, cesium-137, europium-152, europium-154, uranium-235, uranium-238, plutonium-239/240, and americium-241.

Contaminant exposure pathways include: ingestion of soils, water, and biota; inhalation of particulates; dermal contact with soils, water, and building rubble; and exposure to radiation. The currently identified potential federal and state CARs are summarized in the following sections.

3.2.1.1 Federal Requirements. Federal contaminant-specific requirements come from seven main citations in the CFR.

Nuclear Regulatory Commission Standards for Protection Against Radiation (10 CFR 20). These regulations apply to activities licensed by the Nuclear Regulatory Commission and specify radiation dose standards for individuals in restricted and unrestricted areas. The standard for emissions to air in unrestricted areas are potential CARs both for ambient conditions and during any corrective action that could affect the air pathway. These standards are listed in Table II of Appendix B of 10 CFR 20 for various isotopes. For example, the standards for concentrations in air above background (soluble values) range from $2x10^{-7}$µCi/ml for tritium to $7x10^{-8}$ µCi/ml for technetium-99 to $3x10^{-12}$ µCi/ml for uranium-238.

National Emission Standards for Hazardous Air Pollutants (40 CFR 61). Subpart H—National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities (40 CFR 61.90-61.97), and Subpart M—National Emission Standard for Asbestos (40 CFR 61.140-61.156), are included in 40 CFR 61.

National Emission Standards for Emissions of Radionuclides other than Radon from Department of Energy Facilities apply to facilities owned or operated by the DOE, except for any facilities regulated under 40 CFR 190, 191, and 192. These standards could be either contaminant-specific or action-specific (such as a removal action) CARs for the air pathway. The standards mandate that emissions of radionuclides to air from DOE facilities shall not exceed those amounts that cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr. Doses from radon-220, radon-222, and their respective decay products are excluded from these limits.

National Emission Standards for Asbestos provide standards for demolition and disposal of asbestos. These standards could be either contaminant-specific or action-specific CARs for the air pathway.

Resource Conservation and Recovery Act, Subtitle C Requirements (40 CFR 260-271). These regulations are the governing requirements for owners and operators of hazardous waste TSD facilities, and for generators and transporters of hazardous wastes.

Environmental Protection Agency Rules for Controlling Polychlorinated Biphenyls under the Toxic Substances Control Act (40 CFR 761). These regulations control the manufacture, processing, storage, disposal and cleanup of PCBs. Spills that occurred after May 4, 1987, must be cleaned up in accordance with the spill policy in 40 CFR 761.120. These regulations set forth requirements based on specific circumstances.

Safe Drinking Water Act [42 U.S.C. 300(f)]. The Safe Drinking Water Act establishes MCLs for constituents in drinking water.

Clean Water Act (33 U.S.C. 1251). The Clean Water Act establishes water quality standards for surface waters and pretreatment standards for waste waters released to publicly-owned treatment works (POTWs).

Clean Air Act (42 U.S.C. 7401). The Clean Air Act establishes National Primary and Secondary Ambient Air Quality Standards (40 CFR 50), National Emission Standards for Hazardous Air Pollutants (40 CFR 61), and New Source Performance Standards (40 CFR 60).

3.2.1.2 State of Washington Requirements. State of Washington contaminant-specific requirements are listed in the following regulations.

Model Toxics Control Act (WAC 173-340). The Model Toxics Control Act establishes standards for clean-up levels in environmental media, including groundwater, surface water, and soil. Additionally, this regulation contains standards for air emissions. It also provides a methodology for determining clean-up alternatives.

Washington Radiation Protection Standards (WAC 246-221). These regulations specify dose standards for permissible levels of radiation in unrestricted areas. Table II of Appendix A of WAC 246-221 itemizes the allowable concentrations in air above natural background. The values in Table II are the same as Table II, Appendix B, of 10 CFR 20.

Washington Ambient Air Quality Standards and Emission Limits for Radionuclides (WAC 173-480). The Washington Department of Ecology ambient air quality standards and radionuclide emission limits mandate that radionuclides in the air must not cause a maximum accumulated dose equivalent of more than 25 mrem/yr to the whole body or 75 mrem/yr to a critical organ of any member of the public (excluding doses from radon and radon decay products).

Washington Radiation Protection--Air Emissions (WAC 246-247). The Washington Department of Social and Health Services Air Quality and Emission Standards for Radionuclides adopt the Ecology standards in WAC 173-480 by reference.

Dangerous Waste Regulations (WAC 173-303). The Washington Department of Ecology procedures for characterizing hazardous waste as Dangerous Waste (DW) or Extremely Hazardous Waste (EHW). Additional distinction is based on persistence, carcinogenicity, mutagenicity, tetratogencity, concentration of certain compounds, and toxicity as defined by WAC 173-303-070 to 110. Wastes excavated on sites which upon testing designates as DW or EHW must be handled under this regulation. Other sections not identified here should be considered relevant and appropriate.

General Regulations for Air Pollution Sources (WAC 173-400). Establishes standards that are technically feasible and reasonably attainable for air pollution sources.

Ambient Air Quality Standards for Sulfur Oxides (WAC 173-474). Establishes maximum acceptable levels for sulfur dioxide. May be applicable for remedial processes that release oxides of sulfur to the atmosphere.

Ambient Air Quality Standards for Carbon Monoxide, Ozone, and Nitrogen Dioxide (WAC 173-475). Establishes state wide air quality standards for carbon monoxide, ozone, and nitrogen dioxide. May be applicable for remedial processes that release Carbon Monoxide, Ozone, or Nitrogen dioxide to the atmosphere.

Emission Standards and Controls for Sources Emitting Volatile Organic Compounds (173-490). Establishes technically feasible and reasonably attainable standards for sources emitting VOCs.

Water Quality Standards for Ground Waters of the State of Washington (WAC 173-200). Establishes groundwater quality standards for cleanup actions exclusive of those actions approved under the Model Toxics Control Act (WAC 173-340).

Public Water Supplies, Part 3. Water Quality (WAC 246-290-300 through 246-290-330). Establishes MCLs for drinking water.

3.2.2 Action-Specific Requirements

Action-specific CARs are requirements that are triggered by specific corrective actions at the site. These corrective actions are not fully defined until the CMS phase; however, the universe of action-specific CARs defined by a preliminary screening of potential corrective action alternatives will help focus the CMS alternatives. Potential action-specific CARs are identified in the following subsections.

3.2.2.1 Federal Requirements. Federal action-specific CARs include the following:

40 CFR 50, National Ambient Air Quality Standards

40 CFR 52, Prevention of Significant Deterioration

40 CFR 60, New Source Performance Standards

40 CFR 61.90, National Emissions Standards for Radionuclide Emissions from DOE facilities

40 CFR 191, Radiation Protection Standards for Managing and Disposing of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes

40 CFR 260 through 280, RCRA Hazardous Waste Regulations

49 CFR 171-172, Hazardous Materials Regulations.

3.2.2.2 State Requirements. State action-specific CARs include the following:

Regulatory Code of Washington (RCW) 70.95, Washington Solid Waste Management Recovery and Recycling Act

RCW 90.03, Washington Water Code

WAC 173-160, Washington Minimum Standards for Construction and Maintenance of Water Wells

WAC 173-216, Washington Waste Discharge Program

WAC 173-303, Washington State Dangerous Waste Regulations

WAC 173-304, Washington Minimum Functional Solid Waste Handling Standards

WAC 173-400, Washington Air Pollution Control Regulations

Washington Department of Environmental Quality Air Toxics Policies

RCW 90.48, Water Pollution Control

WAC 173-218, Underground Injection Control Program

RCW 70.94 Washington Clean Air Act

RCW 90.52, Pollution Disclosure Act

RCW 90.54, Water Resources Act

RCW 70.95, Solid Waste Management Act

RCW 70.98, Nuclear Energy and Radiation

WAC 173-162, Rules and Regulations Governing the Licensing of Well Contractors and Operators

RCW 70.105 Hazardous Waste Management

WAC 173-303-670 Incinerators - May be relevant and appropriate for remedial processes that require the use of incinerators.

WAC 173-403 Implementation of Regulations for Air Contaminant Sources

WAC 173-470 Ambient Air Quality Standards for Particulate Matter

WAC 296-62 Washington Industrial Safety and Health Act, Occupational Health Standards and Safety Standards for Carcinogens

RCW 18.104, Water Well Construction

RCW 90.44, Regulation of Public Ground Water.

3.2.3 Location-Specific Requirements

Location-specific CARs identify requirements for site activities that are triggered by site location. These can include sensitive habitats, floodplains, fault locations, historical and prehistorical resources, and wetlands.

3.2.3.1 Federal Requirements. Federal location-specific CARs are as follows:

40 CFR 264.18(a); Prohibits the establishment of a new TSD facility within 200 ft of a fault displaced in Holocene time.

40 CFR 264.18(b); Requires that a TSD located within the 100 year flood plain must be designed, constructed, operated, and maintained to avoid washout.

40 CFR 6, App. A; Fish and Wildlife Coordination Act (16 USC 661 *et seq.*); 40 CFR 6.302(b); 40 CFR 6 subpart A sets EPA policy for carrying out E.O. 11988 and 11990 which are binding on the level of government for which they are issued. 10 CFR 1022 is DOE's policy. Requires action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values.

National Historical Preservation Act (16 USC 469); 36 CFR 65; 25 CFR 261; 43 CFR 3; 43 CFR 7; Requires action to recover and preserve artifacts, within area where action may cause irreparable harm, loss, or destruction of significant artifacts.

National Historic Preservation Act, Section 106 (16 USC 470 *et seq.*); 36 CFR 800; Requires action to preserve historic properties; and planning of action to minimize harm to National Historic Landmarks.

Endangered Species Act of 1973 (16 USC 1531 *et seq.*); 50 CFR 402; 50 CFR 10 *et seq.*; Fish and Wildlife Coordination Act (16 USC 661 *et seq.*); 33 CFR 320.3; Requires action to conserve endangered species or threatened species, including consultation with the U.S. Fish and Wildlife Service.

Clean Water Act Section 404; 40 CFR 230, 33 CFR 320-330; Prohibits the discharge of dredged or fill material to wetlands; wetlands as defined by U.S. Army Corps of Engineers.

40 CFR 6, Appendix A; Executive Order 11990, Protection of Wetlands; 10 CFR; 1022 (DOE policy); Requires action to avoid adverse effects, minimize potential harm, and preserve and enhance wetlands, to the extent possible.

Fish and Wildlife Coordination Act (16 USC 661 *et seq.*); 40 CFR 6.302(g); Requires action to protect fish and wildlife habitat during the diversion, channeling or other activity that modifies a stream or river.

Wild and Scenic Rivers Act (167 USC 1271); Requires action to protect the free-flowing characteristics or scenic, recreational, or fish and wildlife values of a Wild and Scenic River or Study River.

Historic Sites, Buildings and Antiquities Act (16 USC 461); Requires action to undertake the recovery, protection and preservation of data.

Fish and Wildlife Improvement Act (16 USC 742); Requires mitigation of actions that will have an adverse effect on fish and wildlife or their habitat.

Fish and Wildlife Conservation Act (16 USC 2901); Requires action to conserve and promote conservation of nongame fish and wildlife and their habitat.

3.2.3.2 State Requirements. State location-specific CARs are as follows:

RCW 27.53; Within an area where action may impact archeological sites and resources, requires action to recover and preserve artifacts.

Shoreline Management Act (RCW 90.58); Requires actions to restrict activities or limit the concentration of contaminants to assure no adverse environmental or health effect.

Bald Eagle Protection Rules (WAC 232-12); Requires action to protect bald eagle habitat, such as nesting or roost sites, through the development of a site management plan.

Endangered, Threatened or Sensitive Wildlife Species Classification (WAC 232-12-297); Requires action to protect wildlife classified as endangered, threatened or sensitive, through development of a site management plan.

Minimum Functional Standards for Solid Waste Handling (WAC 173-304); Provisions for facility design, maintenance and closure of landfills (solid waste handling facilities).

Transport of Hazardous Materials (WAC 446-50); Regulates the off-site transportation of hazardous materials.

Water Quality Standards for the State of Washington (WAC 173-201); Surface water classifications according to water quality and use. The surface waters of the Columbia River are classified as Class A.

Certification of Operators of Solid Waste Incinerator and Landfill Facilities (WAC 173-300); Defines when certification of operators of the referenced facilities is required.

Solid Waste Incinerator Facilities (WAC 173-434); Defines emission standards, design and operation requirements for solid waste incinerator facilities.

Washington State Water Code and Water Rights (RCW 90.03 and 90.14); Specify conditions for extracting surface or ground water for non-domestic uses. The laws provide that water extraction must be consistent with beneficial uses of the resource and must not be wasteful.

Protection of Upper Aquifer Zones (WAC 173-154); Provides for the protection of the upper aquifers and upper aquifer zones to avoid depletions, excessive water level declines, or reductions in water quality.

National Pollutant Discharge Elimination System Permit Program (WAC 173-220); Establishes a state permit program, applicable to the discharge of pollutants and other wastes and materials to surface waters of the state.

Submission of Plans and Reports for Construction of Waste Water Facilities (WAC 173-240); These regulations require that the Washington Department of Ecology review and approve plans for waste water treatment facilities that discharge to ground water.

3.2.4 Other Criteria and Guidance

In addition to the listed CARs, there are other federal and state criteria, advisories, and guidance that can be considered in determining the appropriate degree of corrective action for the 100-NR-1 Operable Unit. These additional items are summarized in the following paragraphs.

3.2.4.1 Health Effects Assessment. Several contaminants detected at the site do not have standards for soils. For individual carcinogens that do not have federal or state standards, but have a carcinogenic potency factor, soil concentrations can be calculated that would result in a 10^{-4} to 10^{-6} excess lifetime cancer risk by inhalation or ingestion. The National Oil and Hazardous Substance Contingency Plan (NCP) states that for known or suspected carcinogens, acceptable exposure levels are generally concentration levels that represent an excess upperbound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6}. For noncarcinogenic compounds, reference doses or acceptable chronic daily intakes can be used to estimate concentrations that would result in no observable adverse health effects by ingestion or inhalation.

3.2.4.2 International Commission on Radiological Protection and the National Council on Radiation Protection Guidance. The International Commission on Radiological Protection (ICRP 1991) and the National Council on Radiation Protection (NCRP 1987) recommend an effective dose limit of 100 mrem/yr to individual members of the general public.

3.2.5 Proposed Regulations

The EPA has issued an Advance Notice of Proposed Rulemaking for radiation regulations in 40 CFR 193 and 40 CFR 194. These potential regulations are for low-level radioactive waste and residual radioactivity from demolition and decommissioning activities, respectively. At this time, EPA has not issued any proposed regulations. The EPA has also issued Proposed Rules for Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities in 40 CFR Parts 264, 265, 270, and 271 (55 FR 30798). These rules would create a new Subpart S in the RCRA Part 264 regulations to define

requirements for conducting remedial investigations, evaluating potential remedies, and selecting and implementing remedies at RCRA facilities.

3.3 POTENTIAL IMPACTS TO PUBLIC HEALTH AND THE ENVIRONMENT

This section presents a conceptual model of exposure pathways. Information on waste sources, pathways, and receptors is used to develop a conceptual understanding of exposure pathways for evaluation of potential risks to human health and the environment. The conceptual model of exposure pathways presented in Draft A of this work plan was used by the three parties during work plan rescoping as a basis for evaluating the need for ERAs, and for identifying potential locations for IRMs and, hence, areas where the LFI investigation would focus. The conceptual model has remained essentially unchanged since Draft A, and hence does not alter the decision of the three parties regarding ERAs. The conceptual model is developed in Section 3.3.1, and the assessment of the need for ERAs is reviewed in Section 3.2.2. The conclusions in this section are tentative, and will be subject to refinement as data is gathered throughout the RFI/CMS process.

3.3.1 Conceptual Exposure Pathway Model

This section presents a conceptual model of potentially significant contaminant exposure pathways for the 100-NR-1 Operable Unit. The conceptual model is based upon information presented in Chapter 2 and Section 3.1, and is therefore intended to be preliminary. The exposure pathways in the conceptual model include soil, air, groundwater and surface water and sediments, as shown in Figure 3-34. Exposure pathways resulting from contamination of media below the 100-NR-1 Operable Unit are specifically discussed in the groundwater operable unit work plan (DOE-RL 1994a).

3.3.1.1 Sources. Primary contaminant sources in the 100-NR-1 Operable Unit include process effluent transfer, treatment, and disposal units; sanitary sewage transfer, treatment, and disposal units and the N Reactor exhaust stack. The significant sources, as indicated in Figures 3-1 and 3-2, appear to be those within the process and decontamination effluent and reactor and fuel rod cooling water categories.

Once a release to the environment occurs, contaminants can be bound in soils and river sediments before being slowly re-released. These media thus serve as potentially significant secondary contaminant sources.

Detailed information on each of the operable unit waste facilities and their associated contaminants is presented in Sections 2.1.4 and 3.1.1, respectively. A summary of the known extent of soil contamination at the 100-NR-1 Operable Unit is contained within Section 3.1.2. There are currently no data available on river sediment quality in the vicinity of the 100-NR-1 Operable Unit.

3.3.1.2 Release Mechanisms. Release mechanisms can be divided into primary and secondary categories. A primary release is from a primary contaminant source and a secondary release is from a secondary contaminant source.

Process effluents at the 100-NR-1 Operable Unit are known to have infiltrated, intentionally and unintentionally, into the soils surrounding the various process effluent transfer, treatment, and disposal facilities. Contaminated groundwater enters the Columbia River through both exposed and submerged springs. Riprap has been placed over exposed springs to reduce potential for exposure.

Wastes from ion exchange column regeneration, petroleum spills, and sewage also have infiltrated into underlying and adjacent soils. Reactor exhaust stack emissions were discharged directly into the atmosphere.

As indicated in Figure 3-34, the most significant of these primary release mechanisms at the 100-NR-1 Operable Unit is infiltration, and the most substantial contributions are from process effluents. Although the reactor is no longer generating process effluents, past discharge of water contaminated with immobile substances could be a significant source of present contamination of river sediments.

The most significant release mechanism from the secondary soil sources is desorption of the immobile contaminants from the aquifer matrix, and infiltration to groundwater. Other potential secondary release mechanisms include volatilization of organic compounds, air transport of fugitive dust from contaminated soils, and movement of contaminated soils through overland flow during precipitation events.

3.3.1.3 Environmental Transport Media. Contamination introduced to the soil can eventually reach the groundwater, which may transport the material to the Columbia River. This is currently considered to be the predominant mode of contaminant transport at the 100-NR-1 Operable Unit. The Columbia River also serves as a transport medium for these contaminants, as well as those which were introduced directly into the river. Air currents may serve to transport contaminated dust and/or volatile compounds from the site. Other potential secondary release mechanisms include volatilization of organic compounds, air transport of fugitive dust from contaminated soils, and movement of contaminated soils through overland flow during precipitation events.

3.3.1.4 Exposure Routes. Receptors can be exposed to contaminants through the following routes:

- inhalation of contaminants in the ambient atmosphere
- absorption of soil contaminants (for plants) or ingestion of contaminated materials and biota (for animals and humans)
- direct contact with contaminated media, including external exposure to radionuclides.

3.3.1.5 Receptors. Receptors are organisms that have the potential for exposure to the released contaminants. Figure 3-34 divides this component of the pathway into biota and humans.

A likely point of exposure for terrestrial biota is in the plant root zone, where flora could absorb buried contaminants. Terrestrial animals (especially burrowing animals) may be exposed by direct contact, inhalation, and ingestion of contaminated soil, water, plants, and animals. The likely exposure points in the aquatic environment are covered in Section 3.3.1 of the 100-NR-2 Operable Unit work plan (DOE-RL 1994a).

Because of the absence of nearby residences, the most likely potential for current human exposure to the 100-NR-1 Operable Unit contaminants is to onsite workers. Most, if not essentially all, of the contamination is now buried beneath the ground surface; therefore the workers with the greatest potential for exposure are those who will be involved in collecting environmental samples and conducting remedial activities for this project.

This preliminary assessment is based on current land and water use in the 100-NR-1 Operable Unit and the Columbia River. This is appropriate since DOE is currently maintaining active institutional controls of the Hanford Site. However, the possibility and consequences of future residential, agricultural, commercial/industrial, or recreational land uses will need to be considered for determining potential risk to receptors under these scenarios. The methodology for conducting both a qualitative and baseline risk assessment for future potential land use scenarios is currently under development. Therefore, the conclusions of this section are tentative, and will be subject to refinement based on the development of the risk assessment methodology and on the results of the RFI.

3.3.1.6 Summary. Preliminary evaluation suggests that the most probable primary sources of contaminant releases to the 100-NR-1 Operable Unit environment are the process effluent disposal facilities. In the past, contaminated groundwater has resurfaced causing surface contamination before flowing into the Columbia River. The current mechanism of contaminant release is through infiltration from contaminated soils near the facilities into the underlying groundwater. This groundwater eventually discharges into the Columbia River where it can contaminate the sediments and has the potential to impose adverse impacts upon local biota. Of particular concern are impacts to sensitive and economically important hyporheic fauna (e.g., salmonid eggs and fry). Skyshine from insufficiently shielded gamma emitters may raise the external radiation exposure rate to levels significantly higher than background. The conceptual exposure pathway model will be tested and refined during the RFI as additional data provide a better understanding of the operable unit.

3.3.2 Assessment of Need for ERAs

Expedited Response Actions are either removal actions under the DOE authority of the Atomic Energy Act, removal actions under CERCLA 40 CFR 300.415, or interim measures under RCRA proposed 40 CFR 264.540. In deciding whether an ERA is appropriate, both technical engineering judgement, and an evaluation of potential threat to human health and the environment are considered. The decision to conduct an ERA is based on the immediacy and magnitude of the potential threat to human health and the environment, the nature of appropriate corrective action, and the implications of deferring the corrective action. Basically, ERAs are conducted when an unacceptable health or environmental risk and a short-time frame available to mitigate the problem exist.

During work plan rescoping the three parties determined that ERAs are not currently warranted in the 100-NR-1 Operable Unit. This determination was based in part on the conceptual exposure pathway model presented in Draft A of this work plan. This conceptual model has remained essentially unchanged since Draft A, and hence does not alter the decision of the three parties regarding the need for ERAs. The discussion in this section briefly reviews the assessment of the need for ERAs, which was based on the current understanding of site conditions. The conclusions in this section are tentative, and will be subject to refinement as data is collected throughout the RFI process.

Although the three parties determined that ERA are not warranted for the 100-NR-1 Operable Unit, an ERA in process for the 100-NR-2 Operable Unit to address the discharge of strontium-90 contaminated groundwater to the Columbia River at the N Springs. Furthermore, the three parties have agreed to utilize the N Area as a pilot project with the objective of ensuring coordinated efforts in facility deactivation, decontamination, decommissioning, and closure. Part of this pilot project involves the abatement of skyshine from 116-N-1 and 116-N-3, and a limited field investigation of 116-N-1 and 116-N-3 as documented in Change Number M-15-94-04 to the Tri-Party Agreement of January 25, 1994 (Ecology et al. 1994c).

3.3.2.1 Human Health. Based on the existing environmental data discussed in Section 3.1, and the exposure pathways discussed in Section 3.3.1, the 100-NR-1 Operable Unit does not appear at this time to pose an immediate danger to human health. Although several dangerous wastes have been disposed of and detected in the 100-NR-1 Operable Unit, the conceptual exposure pathway model indicates that on site workers are currently the most significant potential human receptor population. Essentially all of the contamination is below the ground surface, and on site controls are sufficient to prevent contact with contaminants. Although no ERAs are planned at this time, as data is collected and evaluated during the RFI process, the need for ERAs will be reassessed.

3.3.2.2 The Environment. Based on the existing environmental data discussed in Section 3.1, and the exposure pathways discussed in Section 3.3.1, the 100-NR-1 Operable Unit does not appear at this time to

pose an immediate danger to the environment. Essentially all of the contamination is below the ground surface, and as such is inaccessible to most animals. Although no ERAs are planned at this time, as data is collected and evaluated during the RFI process, the need for ERAs will be reassessed.

3.3.3 Summary

Preliminary evaluation suggests that the primary sources of contaminant releases to the 100-NR-1 Operable Unit are the process effluent disposal facilities. The current mechanism of contaminant release is infiltration into the underlying groundwater from contaminated soils in and near the facilities. This groundwater eventually discharges into the river, where it can contaminate the sediments and has the potential to cause adverse impacts on local biota, with possible food-chain effects on humans off site. An ERA is in process for the 100-NR-2 Operable Unit to address the discharge of strontium-90 contaminated groundwater to the Columbia River at the N Springs. Skyshine from insufficiently shielded gamma emitters may raise the external radiation exposure rate to levels significantly higher than background. Abatement of skyshine is one part of the N Area pilot project. The 100-NR-1 Operable Unit does not currently pose an immediate danger to human health or the environment. The conclusions of this section will be subject to refinement based on the information collected during the RFI process. In addition, a baseline risk assessment conducted as part of the final RFI will provide a quantitative analysis of the topics presented in this section.

3.4 PRELIMINARY CORRECTIVE ACTION OBJECTIVES AND CORRECTIVE ACTION ALTERNATIVES

This section develops both interim and final preliminary corrective action objectives, general response actions, remedial technologies and process options, and a range of preliminary corrective action alternatives for each group of prioritized facilities within the 100-NR-1 Operable Unit. This evaluation is based on available site data, use of the qualitative risk assessment and the conceptual exposure pathway model that were presented earlier in this work plan, for the 100-NR-1 Operable Unit. General response actions are identified and represent broad classes of corrective actions that may be appropriate to achieve the corrective action objectives. Corrective action objectives may change or be refined as additional site data are gathered and evaluated during the LFI and implementation of the IRMs. Recommendations are made as to the range of preliminary corrective action alternatives that will be considered and more fully developed in the feasibility study, outlined in Section 5.2 of this work plan. In addition, the observational approach is described and incorporated throughout this section with a bias towards action through implementation of IRMs. This approach and the *Hanford Past-Practice Strategy* (DOE-RL 1991a) are used to limit the range of remedial action alternatives which will be evaluated in the focused feasibility study, if necessary.

Overall, the Hanford past-practice RI/FS process is defined as the combination of IRMs (including concurrent characterization), LFIs for final remedy selection where interim actions are not clearly justified, and feasibility/treatability studies for further evaluation of treatment alternatives. After completion of an IRM, data will be evaluated including concurrent characterization and monitoring data, to determine if a final remedy can be selected for the operable unit.

Interim corrective measures may be implemented before the land use issues are resolved. The corrective action alternatives will not be limited during evaluation and implementation of IRMs because of land use. If land use is later determined to require more stringent cleanup standards than required during implementation of the IRMs, a final corrective action alternative based on land use will be selected.

Interim actions to be completed under the N Area pilot project as documented by Change Number M-15-94-04 to the Tri-Party Agreement of January 1994 include the abatement of skyshine from 116-N-1 and 116-N-3 and closure of the N Springs source terms, i.e., 116-N-1 and 116-N-3 (Ecology et al. 1994b).

Figure 3-35 identifies the interim corrective action objectives, the general interim response actions, the interim corrective technologies, and the process options, which are discussed in the following sections. It also presents the potential conflict with CARs or future land/water use associated with each of the process options. The criteria used to determine whether conflict exists includes the extent of site contamination, type of contaminants, land use options, governing regulatory authority (state or federal), and the implications of each process option. Ecology reserves the right to final decision as to the waiving of CARs on Ecology lead sites.

3.4.1 Preliminary Corrective Action Objectives

The fundamental objective of the RFI/CMS at the 100-NR-1 Operable Unit is to protect environmental resources and/or human receptors from the threats that may exist resulting from the known or suspected contamination. Specific corrective action objectives will depend, in part, on current and potential future land use for the 100 Area and the Columbia River.

Specific interim and final corrective action objectives must consider both current land and water uses, and reasonable potential future land and water use in the 100 Area and the Columbia River. Potential future land and water use will affect the risk-based cleanup objectives, potential CARs and point of compliance. The corrective action objectives for protecting human health for residential or agricultural land use would be based on risk assessment exposure scenarios requiring cleanup to lower levels than for recreational or industrial land use. It is important that potential future land use and the corrective action objectives be clearly defined and agreed upon by the three parties, prior to further and more detailed evaluation of corrective actions. Data collection requirements and corrective actions required to meet the objectives based on a specific land use may not be consistent with objectives for other land uses.

To focus the RFI/CMS with a bias for action through implementing IRMs, the following preliminary corrective action objectives are identified for the 100-NR-1 Operable Unit. These objectives are identified for both current and reasonable potential future land uses.

- Reduce the risk of harmful effects to the environment and human recreational users of the area by reducing the toxicity, mobility, or volume of contaminants from the source areas to meet CARs or risk-based levels that will allow the use of the area for wildlife habitat and/or recreational use (this is a potential final corrective action objective, and is also an interim corrective action objective based on current wildlife and recreational use of the Columbia River).

- Reduce the risk of harmful effects to human receptors by reducing the toxicity, mobility, or volume of contaminants from the source areas to meet CARs or risk-based levels that will allow residential use of the 100 Area (this is a potential final corrective action objective, but interim actions could be implemented consistent with this objective).

- Reduce the risk of harmful effects to livestock, food chain crops and human receptors by reducing the toxicity, mobility, or volume of contaminants from the source areas to meet CARs or risk-based levels that will allow agricultural use of the 100 Area (this is a potential final corrective action objective, but interim actions could be implemented consistent with this objective).

- Reduce the risk of harmful effect to onsite workers by reducing the toxicity, mobility, or volume of contaminants from the source areas to meet CARs or risk-based levels that allow industrial use of

the 100 Area (this is a potential final corrective action objective and an interim corrective action objective based on current land use).

3.4.2 Preliminary General Response Actions

General response actions represent broad classes of corrective actions that may be appropriate to achieve both interim and final corrective action objectives at the 100-NR-1 Operable Unit are presented in Figure 3-35 The following are the general response actions, followed by a brief description for the 100-NR-1 Operable Unit:

- no action (applicable to specific facilities)
- institutional controls
- waste removal and treatment or disposal
- waste containment
- waste treatment
- combinations of the above actions.

No action is included for evaluation as required by the NCP (40 CFR 300.68 (f)(1)(v)). No action also provides a baseline for comparison with other response actions. Finally, no action may be appropriate for some facilities and sources of contamination if the risk assessment determines that unacceptable natural resource or human health risks are not presented by those sources or facilities and that contaminant-specific CARs are not exceeded.

Institutional controls involve the use of physical barriers or access restrictions to reduce or eliminate public exposure to contamination. Considering the nature of the 100-NR-1 Operable Unit and the Hanford Site as a whole, institutional controls will likely be an integral component of all interim corrective action alternatives. Many access and land use restrictions are currently in place at the site and will remain in place during implementation of IRMs. Institutional controls may also be important for final corrective alternatives. The decisions regarding future land use at the 100 Area will be important in determining whether institutional controls will be a part of the corrective alternative, and the type of controls required.

Waste removal and treatment or disposal involves excavation of contamination sources for eventual treatment and/or disposal either on a small- or large-scale basis. One approach being considered for large-scale waste removal is based on high-volume excavation using conventional surface mining technologies. Waste removal on a large scale would be used over areas such as groups of waste sites, operable units, or operational areas. Waste removal on a small scale would be conducted for individual waste units on a selective basis. Waste removal could be conducted as either an interim or final corrective action.

Waste containment includes the use of capping technologies (i.e., capping and grouting) to minimize the driving force for downward or lateral migration of contaminants. Capping also provides a radiation exposure barrier and a barrier to direct exposure. In addition, these barriers provide long-term stability with relatively low maintenance requirements. Containment actions may be appropriate for either interim or final corrective actions.

Waste treatment involves the use of biological, thermal, physical, or chemical technologies. Typical treatment options include biological landfarming, thermal processing, soils washing/dechlorination, and stabilization/fixation. Some treatment technologies may be pilot tested at the highest priority facilities. Waste treatment could be conducted either as an interim or final action and may be appropriate in meeting corrective action objectives for all potential future land uses.

Combinations of the above actions may be used in several different alternatives. For example, containment actions could be used in combination with removal actions for highly contaminated areas, and institutional controls (i.e., fences and deed restrictions) to prevent disruption of the containment system.

Implementation of the general response actions will be accomplished using an observational approach. Such an approach is iterative, where each iteration results in a more refined conceptual model. Data needs are determined by the model, and data collected as a result of an action to fulfill these needs are used as additional input to the model. Use of the observational approach while conducting response actions in the 100 Area will result in the opportunity for integrating these actions with longer range objectives of final site remediation including other analogue areas. Site characterization and remediation data will be collected concurrently with the use of LFIs, IRMs, and pilot-scale remediation testing to apply knowledge gained to similar areas. The overall goal of this approach is convergence on a response action as early as possible while continuing to obtain valuable characterization information during remediation phases.

3.4.3 Preliminary Corrective Action Technologies and Process Options

The preliminary contaminant-specific CARs listed in Section 3.2, the QRA discussed in Sections 3.1.7 and 3.3, and the current and potential future land and water use of the 100 Area will serve as the basis for establishing target cleanup levels for remediation of each operable unit facility area. Preliminary corrective action technologies and process options associated with each general response action and corrective action objective are identified and compared with potential CARs and future land and water use in Figure 3-35. These technologies and process options may be applicable to the 100-NR-1 Operable Unit based on currently available data, present knowledge of the site and individual facility units, and their associated primary contaminants of concern. Available treatment technologies are limited for radiological and hazardous waste contaminated sites. The technologies are described below and will be developed and evaluated in detail as part of the focused feasibility study, if necessary.

Minimal corrective actions, taken to reduce the potential of exposure, such as site access and use restrictions are identified as institutional control interim response actions. Options included for such interim response action are continued security patrols and site fencing. Deed restrictions and special permitting would be possible institutional controls for final remedy.

The waste removal and treatment or disposal interim response action includes both large-scale remediation technologies in addition to onsite soil washing and other waste reduction technologies. Large-scale remediation involves the large-scale movement of contaminated materials using continuous mining equipment and the use of a low technology treatment (i.e., soil washing) or separation techniques (i.e. intensive dry screening) for waste reduction. Small-scale removal would be the use of conventional excavation equipment and treatment technologies or disposal methods for individual waste sites.

The waste containment interim response action includes technologies such as the following: capping with a suitable cover material (i.e., clay or soil, asphalt, concrete, or a multimedia cap), horizontal grout barriers pressure injected into closely spaced drilled holes, and vertical grout barriers pressure injected in a regular pattern of drilled holes.

The waste treatment interim response action includes both physical and chemical remedial technologies. Physical process options include in situ vitrification and preliminary chemical options could consist of stabilization/solidification. In situ vitrification involves the placement of electrodes in the soil. A soil/graphite mix is used to conduct electricity producing resistive heating. High temperatures destroy all organics and molten soil cools to completely immobilize heavy metals and radionuclides. Stabilization/ solidification utilizes a variety of pozzolonics and polymer materials to mix with soil and chemically react with or encapsulate the heavy metals.

3.4.4 Preliminary Corrective Action Alternatives

A range of preliminary interim and final corrective action alternatives will be evaluated for implementation at the 100-NR-1 Operable Unit. In evaluating alternatives, emphasis will be placed on selecting alternatives that will achieve final remediation. Section 5.2 (Feasibility Study) describes how these alternatives will be assembled and evaluated. During the work plan rescoping efforts, the three parties have established priority waste sites where it is anticipated that an IRM will be implemented. These high priority waste sites are identified in Section 4.2. Final selection of sites for interim action will be based on the results of LFIs and the conceptual exposure pathway model and qualitative risk assessments. Corrective action alternatives for lower priority sites will be evaluated as part of the final remedy selection process for the operable unit ROD.

Interim and final corrective action alternatives for waste sources in the 100-NR-1 Operable Unit would be similar for some alternatives. However, the corrective action alternatives must meet corrective action objectives based on future land uses in the 100 Area to select a final remedy. Some interim and final corrective action alternatives may only meet specific objectives for certain land uses and may be inconsistent with other land uses. A range of alternatives will be developed for evaluation in the focused feasibility study, and will likely include:

- Alternatives emphasizing containment - Several alternatives emphasizing containment may be appropriate for interim or final actions. These alternatives may include various combinations of capping, removal, or treatment of highly contaminated areas, institutional controls, and long-term monitoring. These alternatives would likely be most effective for meeting corrective action objectives based on the protection of wildlife and recreational use of the area and may also be appropriate for industrial use of the area. They may be less effective at meeting corrective action objectives based on the protection of human health for residential or agricultural land uses.

- Alternatives emphasizing removal - Alternatives emphasizing removal could be developed for both interim and final corrective actions. This alternative could include a combination of the removal of a majority of the contamination at individual waste sites, with some in-situ treatment or containment actions, and institutional controls. Removal alternatives could include excavation on a selective scale or large scale remediation which is characterized by the removal of contamination from groups of waste disposal facilities or the entire operable unit. The design of the removal alternatives would be very dependent on the corrective action objective. Limited removal actions for both interim and final corrective actions may be effective in meeting corrective action objectives based on industrial, wildlife, and recreational land uses. Limited removal actions may be less effective in meeting corrective action objectives for residential or agricultural land use. Large scale remediation alternatives may be effective in meeting remedial action objectives for residential or agricultural land uses, but may be inconsistent with wildlife and recreational land uses. Large scale remediation will require large amounts of excavation which may affect the overall environmental protection objectives for wildlife and recreational uses of the area.

- Alternatives emphasizing treatment - Alternatives emphasizing treatment may be appropriate for both interim and final corrective actions. Treatment alternatives would probably focus on physical and chemical stabilization or solidification as many of the hazards posed by waste sources in the 100-NR-1 Operable Unit are associated with radioactive contaminants. Treatment to be conducted on individual waste sites could be combined with containment, institutional controls, and long-term monitoring. Alternatives emphasizing treatment actions would probably be most effective for meeting corrective action objectives that do not include residential or agricultural land use.

- Alternatives emphasizing institutional controls - Alternatives emphasizing institutional controls may be appropriate for final remedy of the operable unit. These alternatives would place restrictions on access and land use for either the entire area, or specific areas of potential exposure. Containment and removal actions may be included with this alternative; however the emphasis would be on limiting these actions as much as possible, and relying on the institutional controls to prevent exposure. Long-term monitoring would also be required. This alternative would likely preclude residential or agricultural use of portions of the 100 Area, including the 100-NR-1 Operable Unit. However, alternatives emphasizing institutional controls may be effective at meeting corrective action objectives for industrial, wildlife, and recreational use.

- Alternative of no-action - An interim or final no-action alternative may be appropriate for specific waste sites if no risk is found to be present. For interim actions the no-action alternative will be based on the qualitative risk and compliance with CARs. For final actions, the no-action alternative will be based on the cumulative quantitative risk assessment and compliance with CARs.

The corrective action alternatives will be addressed and evaluated in the 100 Area Feasibility Study, the Focused Feasibility Study, and the Final Focused Feasibility Study, discussed in Section 5.2 of this work plan. These studies may address additional alternatives or eliminate certain alternatives described above.

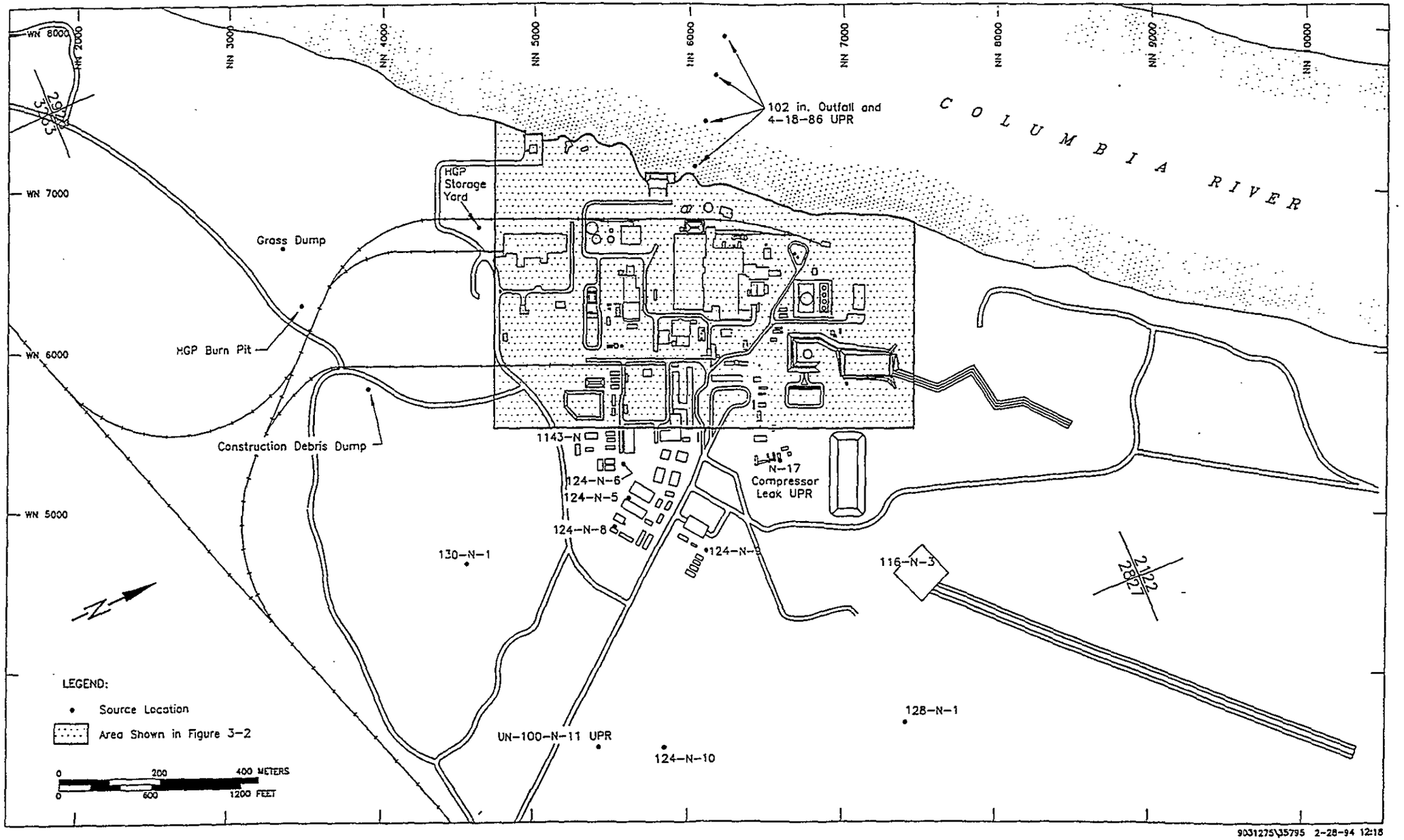

Figure 3-1. Sources in the Peripheral 100 N Area.

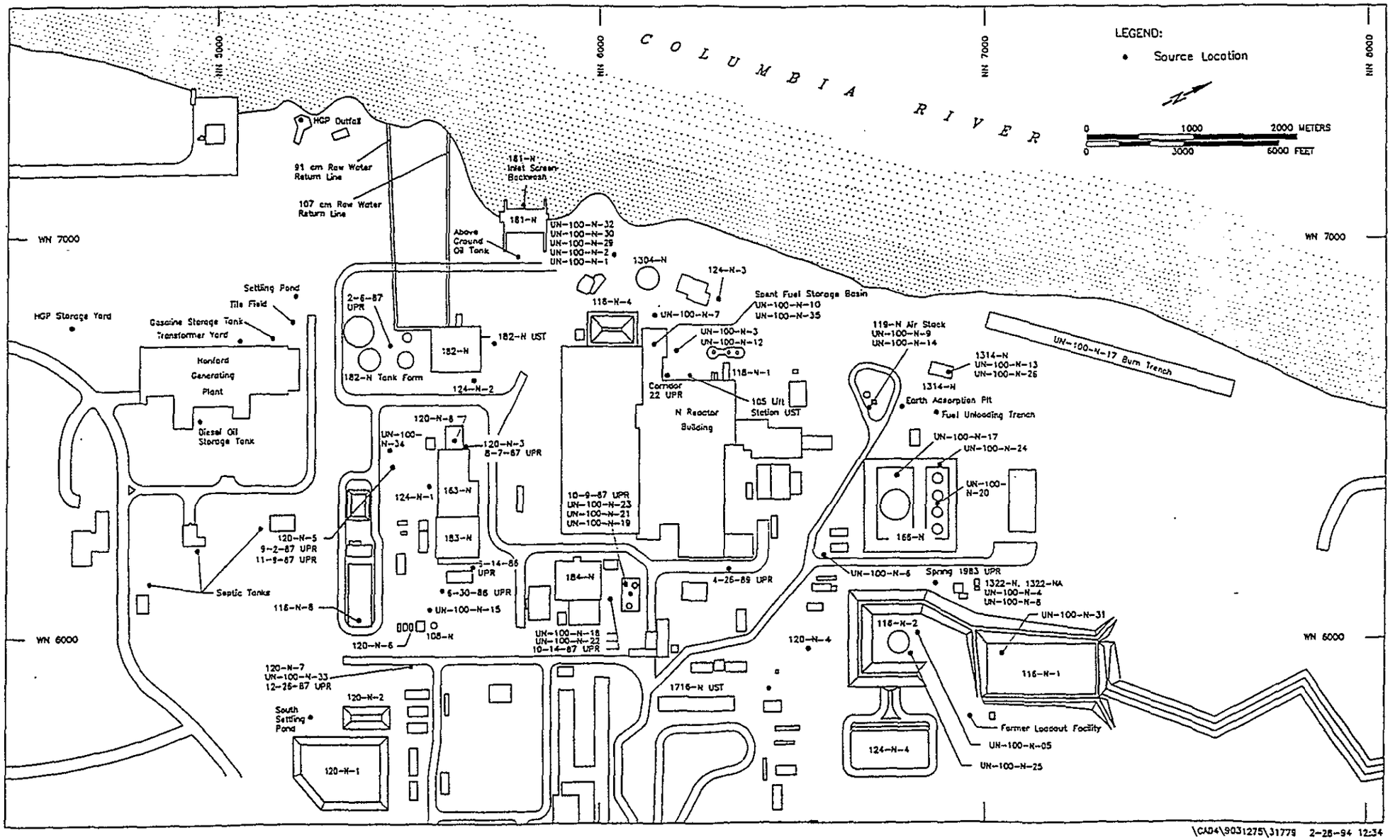

Figure 3-2. Sources in the Central 100 N Area.

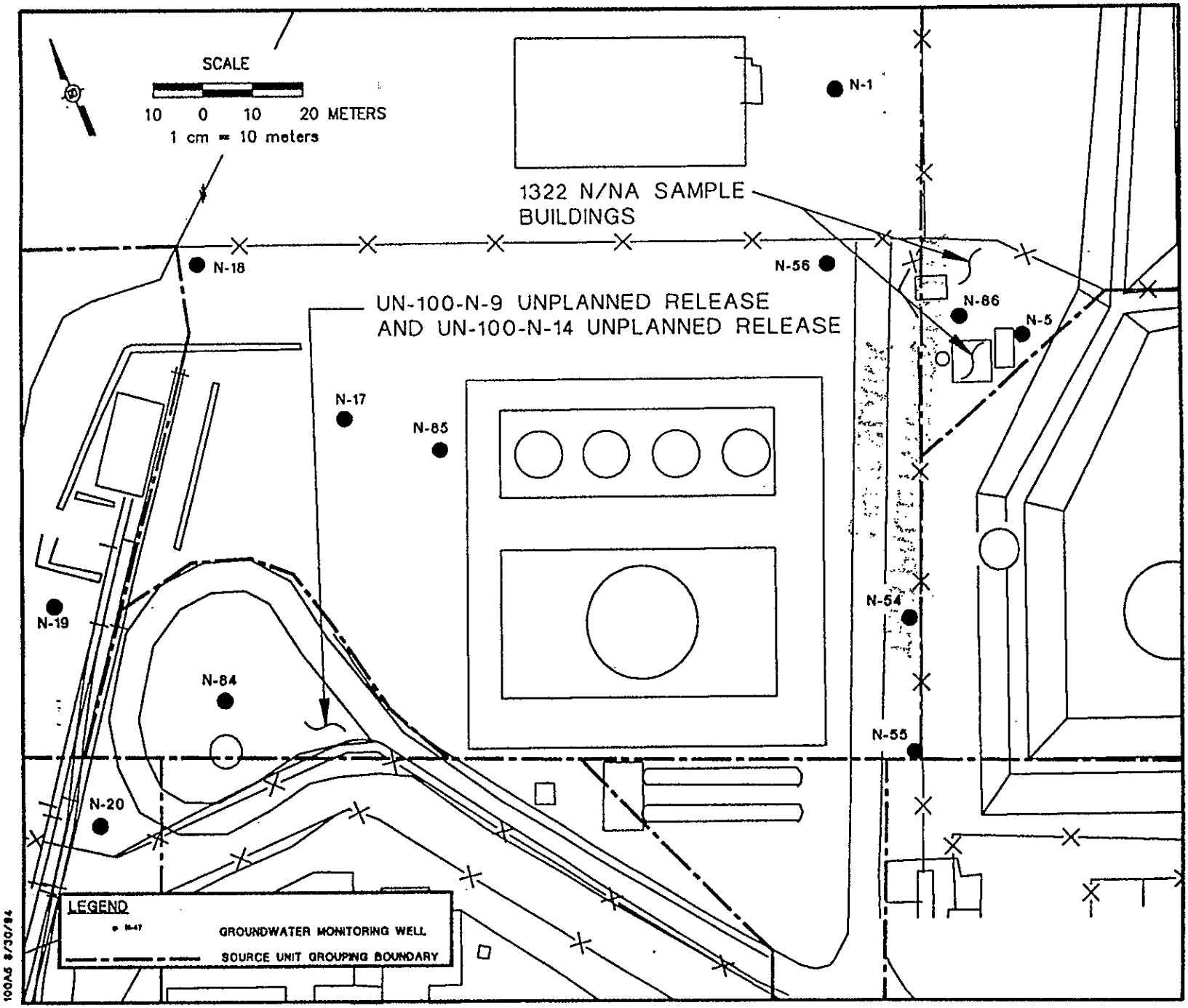

Figure 3-3. Location Map for 1322-N and 1322-NA Sample Buildings.

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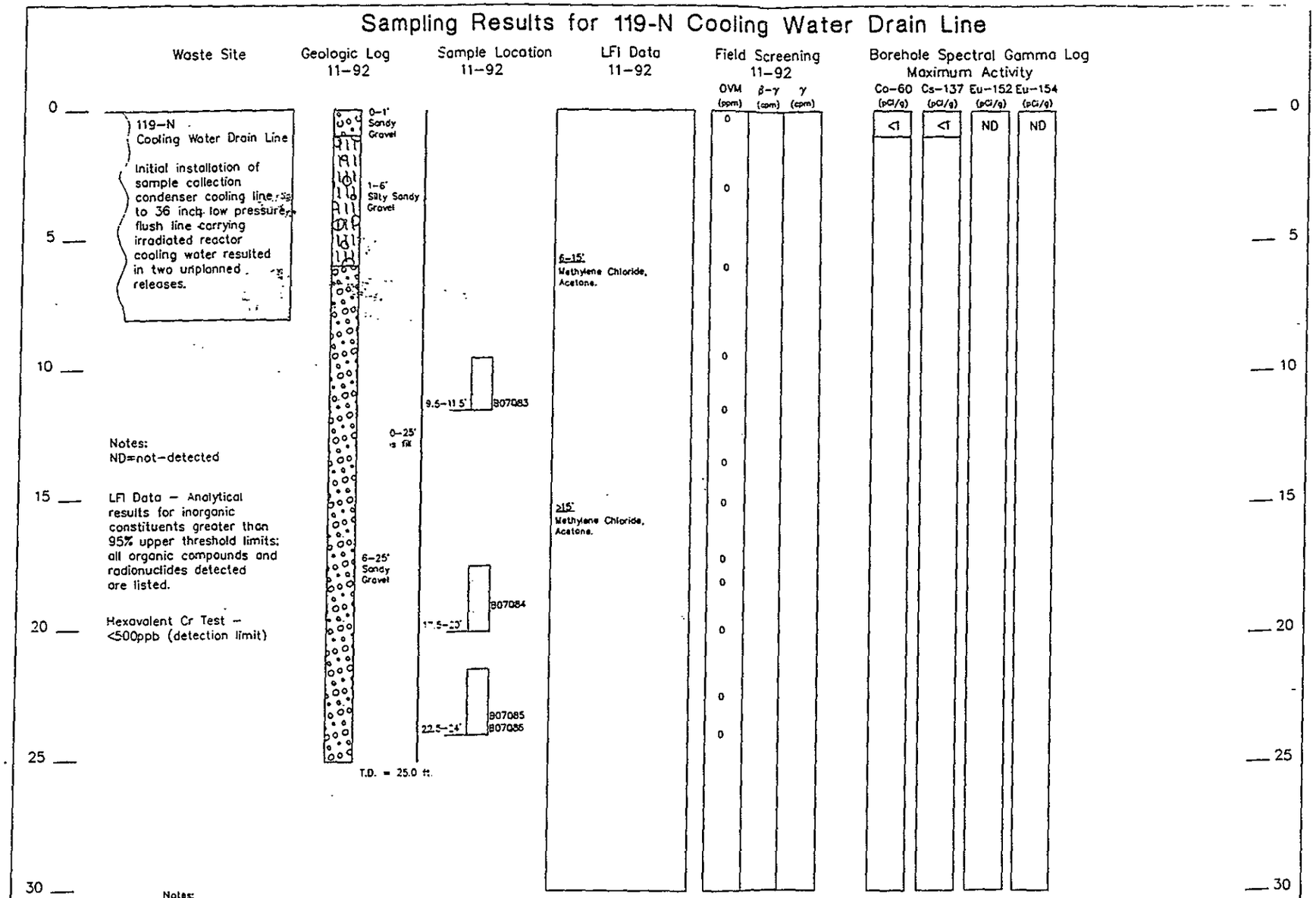
Figure 3-4. Sampling Result for 119-N Cooling Water Drain Line



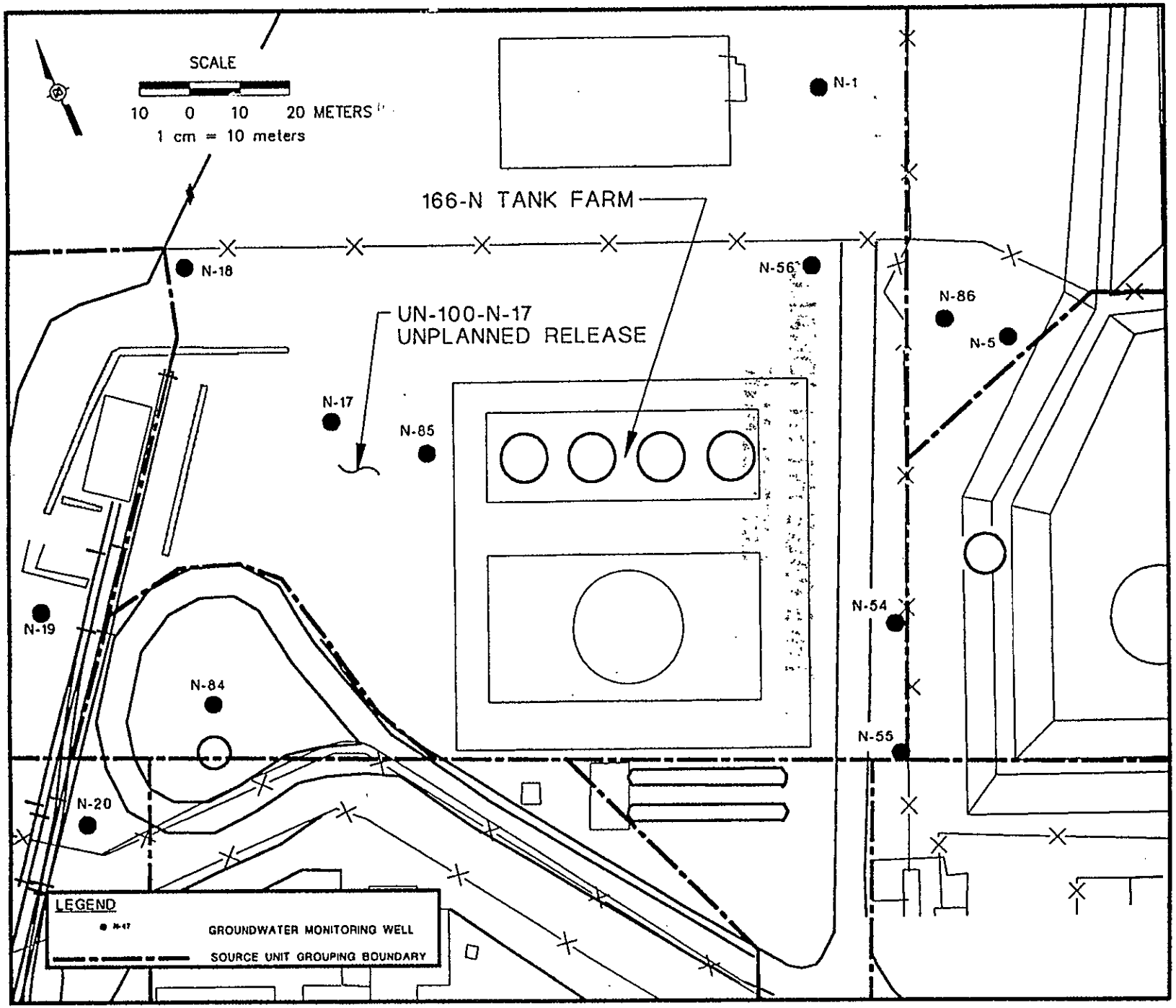


Figure 3-5. 166-N Fuel Tank Unloading and Storage Area.

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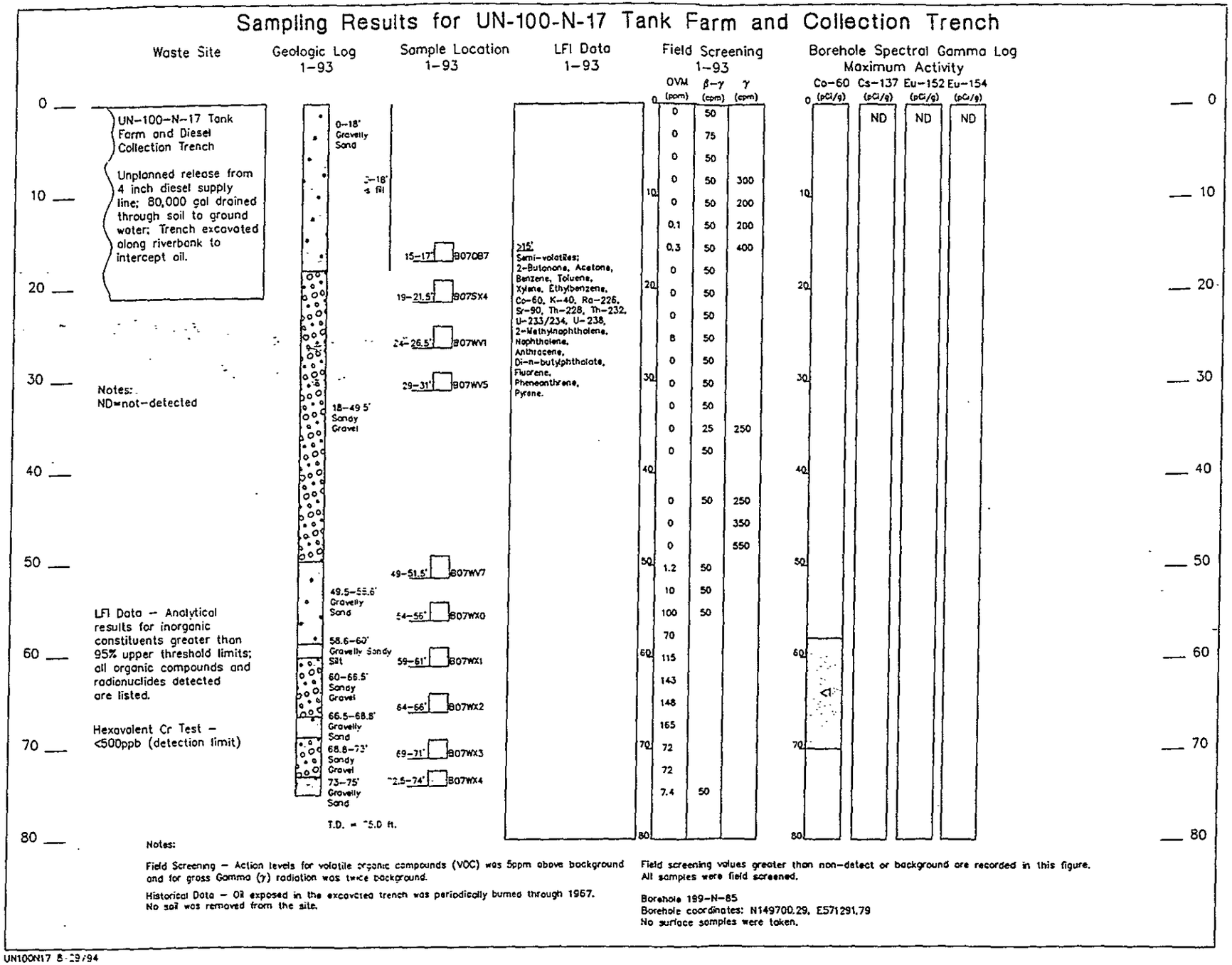
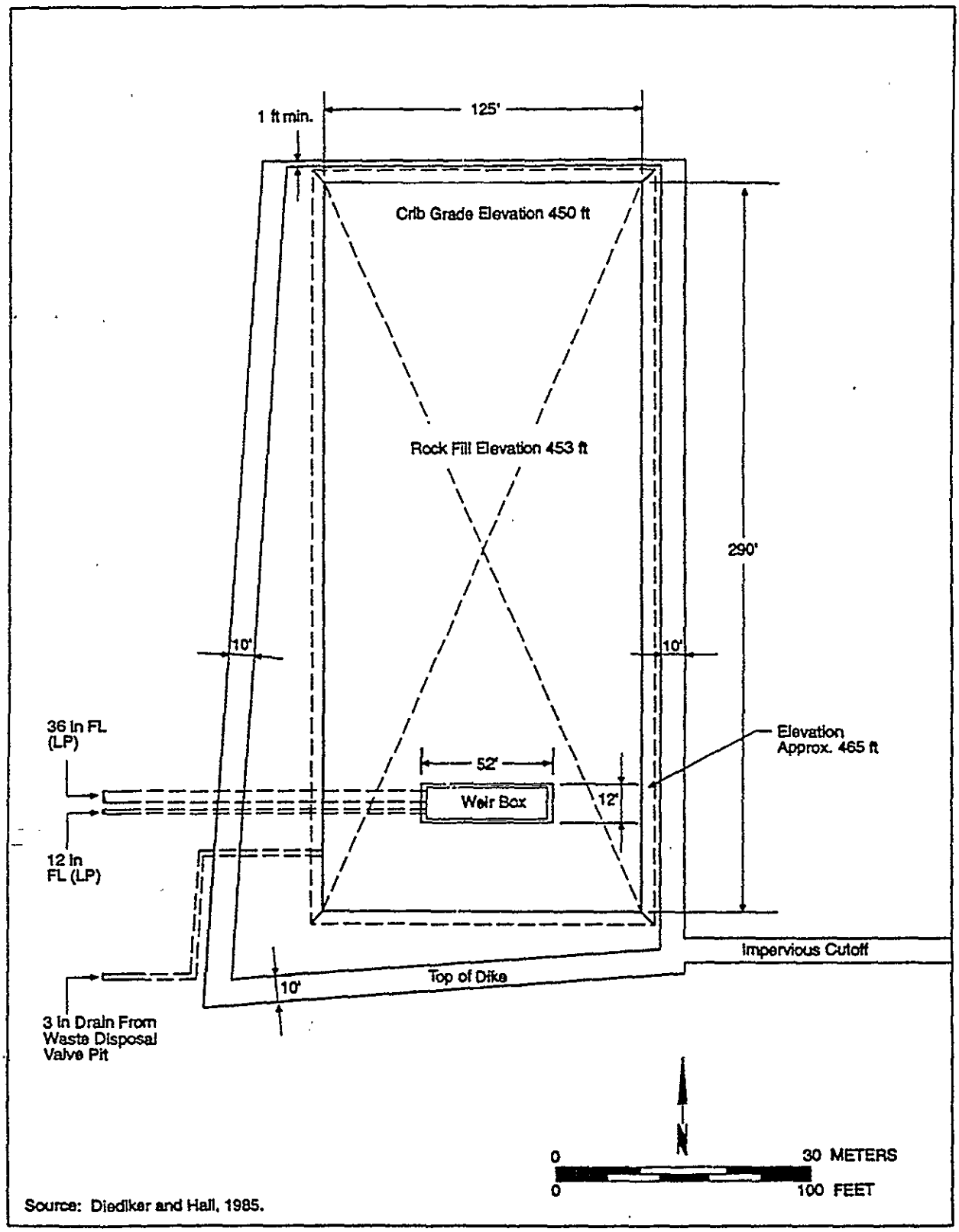


Figure 3-6. Sampling Result for 100-N-17 Tank Farm and Collection Trench

Figure 3-7. Original 116-N-1 Crib Layout.



Source: Diedlker and Hall, 1985.

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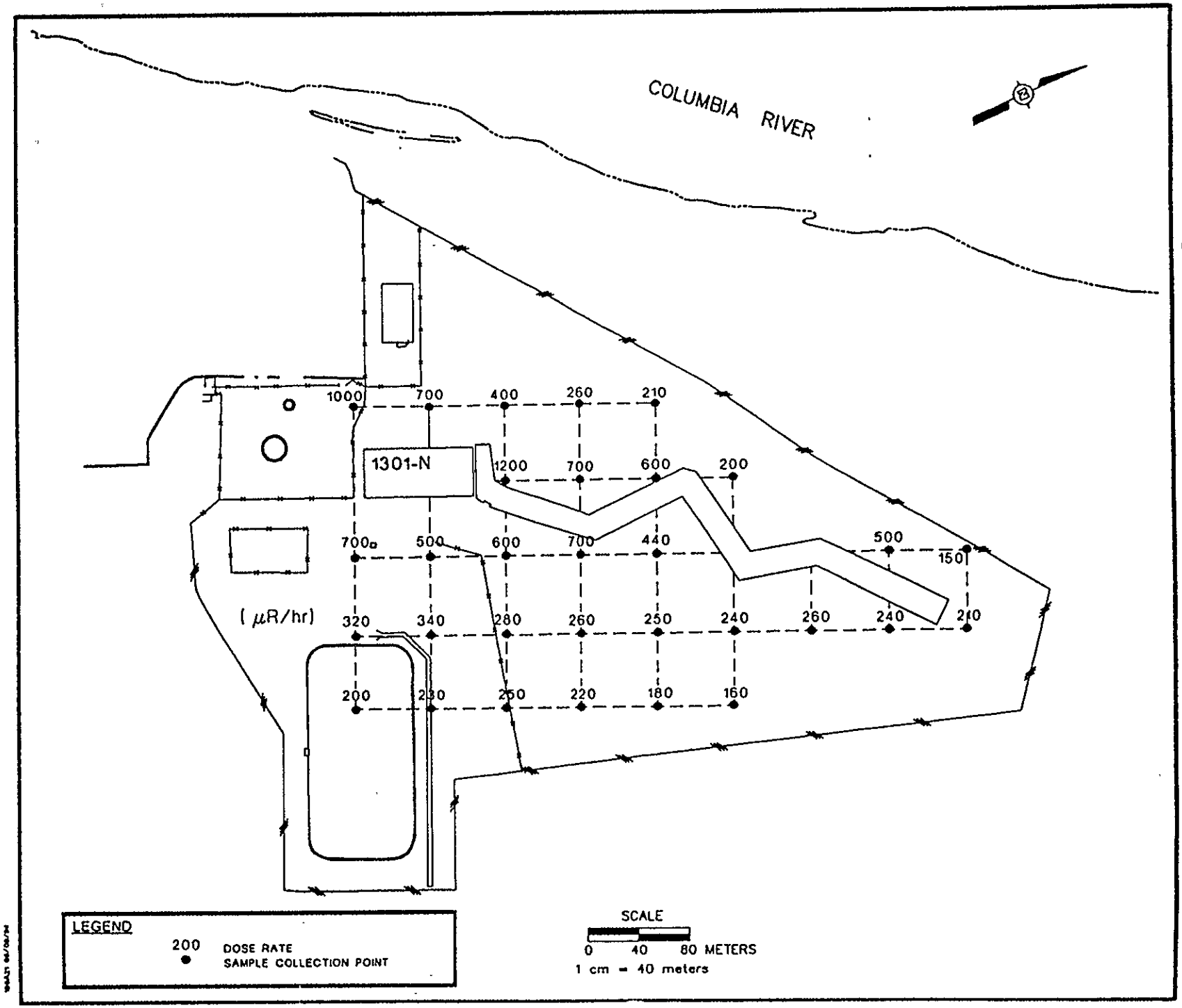

Figure 3-8. Environmental Dose Rates Detected Around 116-N-1.

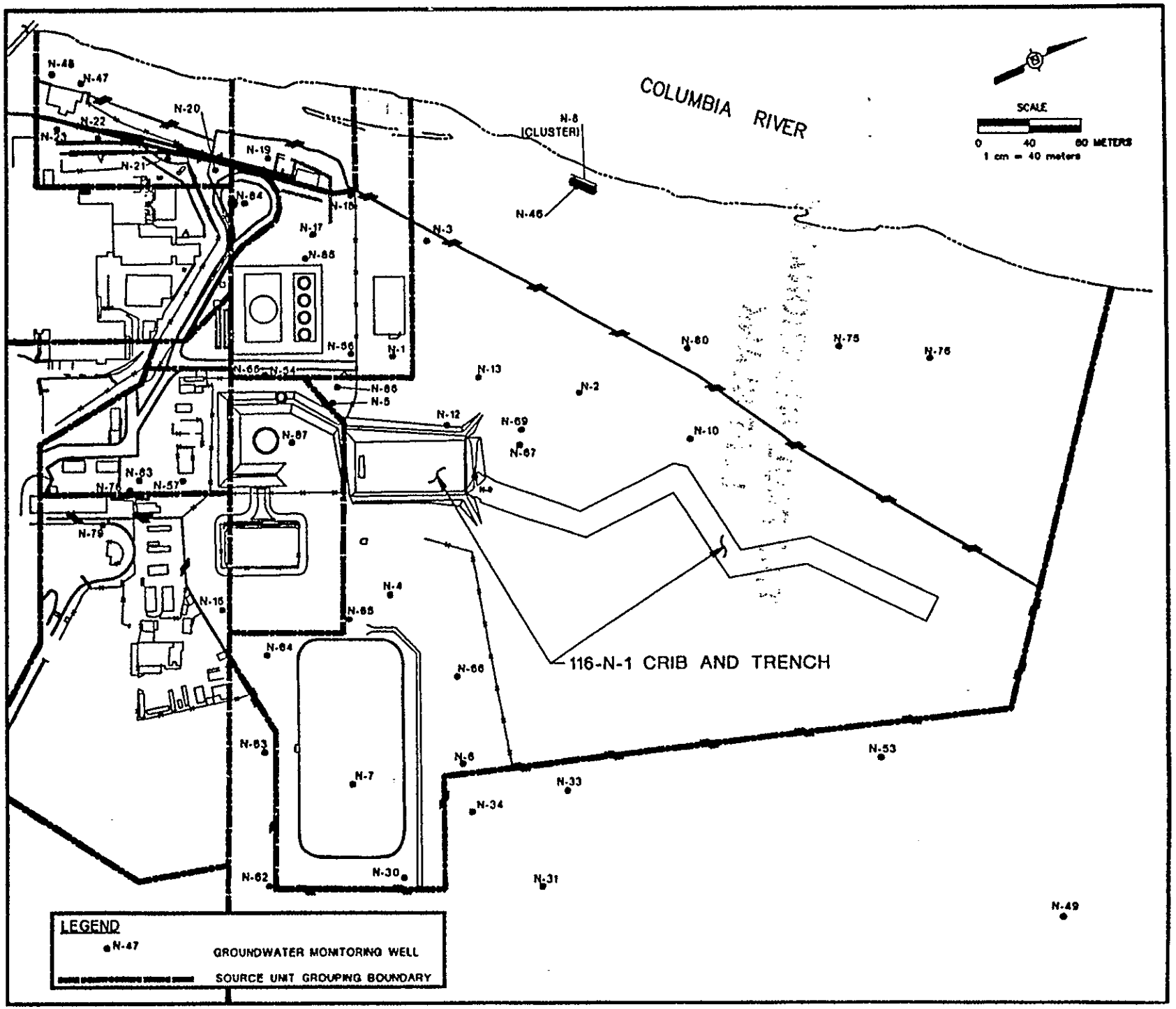

Figure 3-9. 116-N-1 Crib and Trench.

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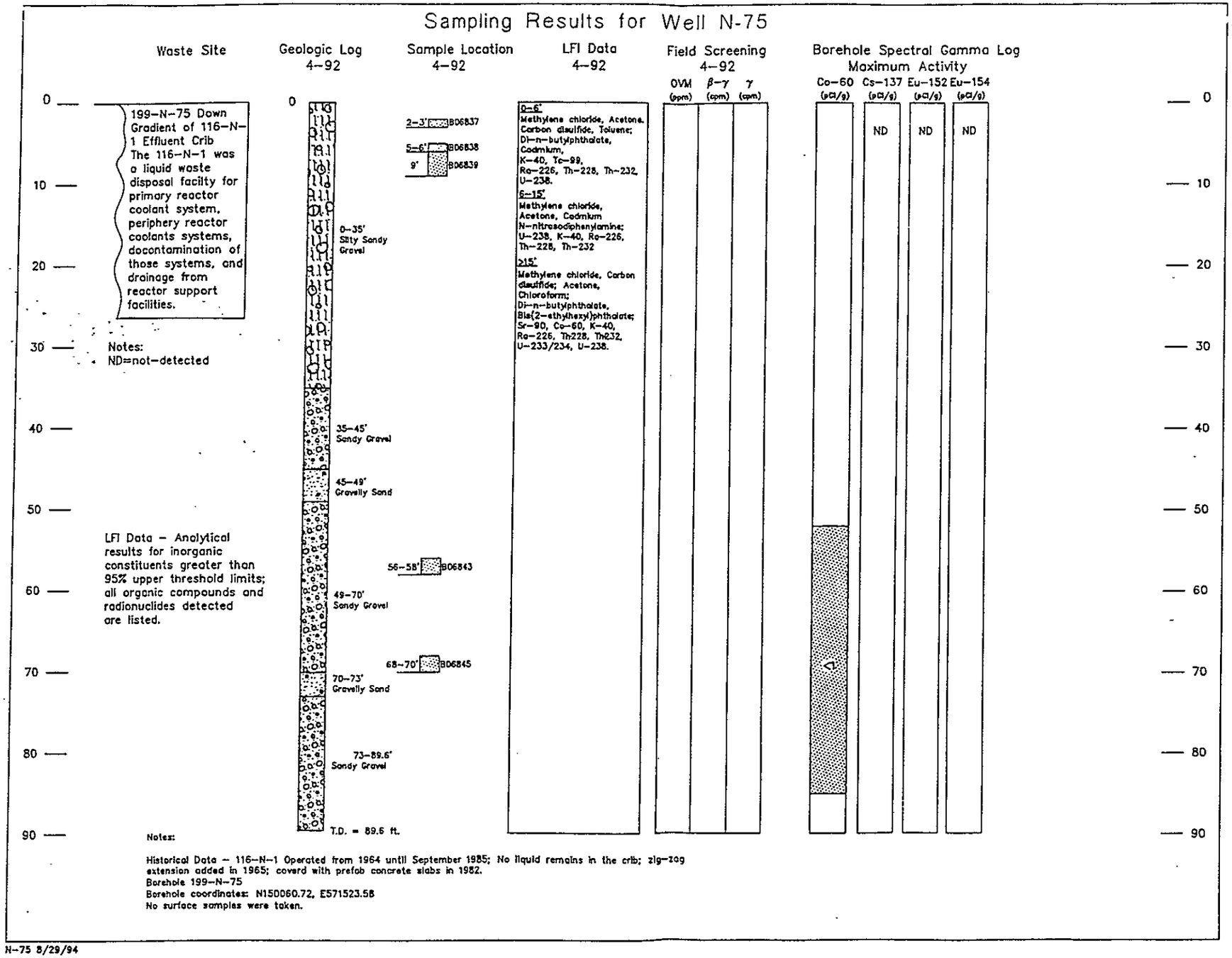


Figure 3-10. Sampling Result for We N-75 Downgradient of 116-N-1

Figure 3-11. Sampling Result for Well N-76 Downgradient of 116-N-1

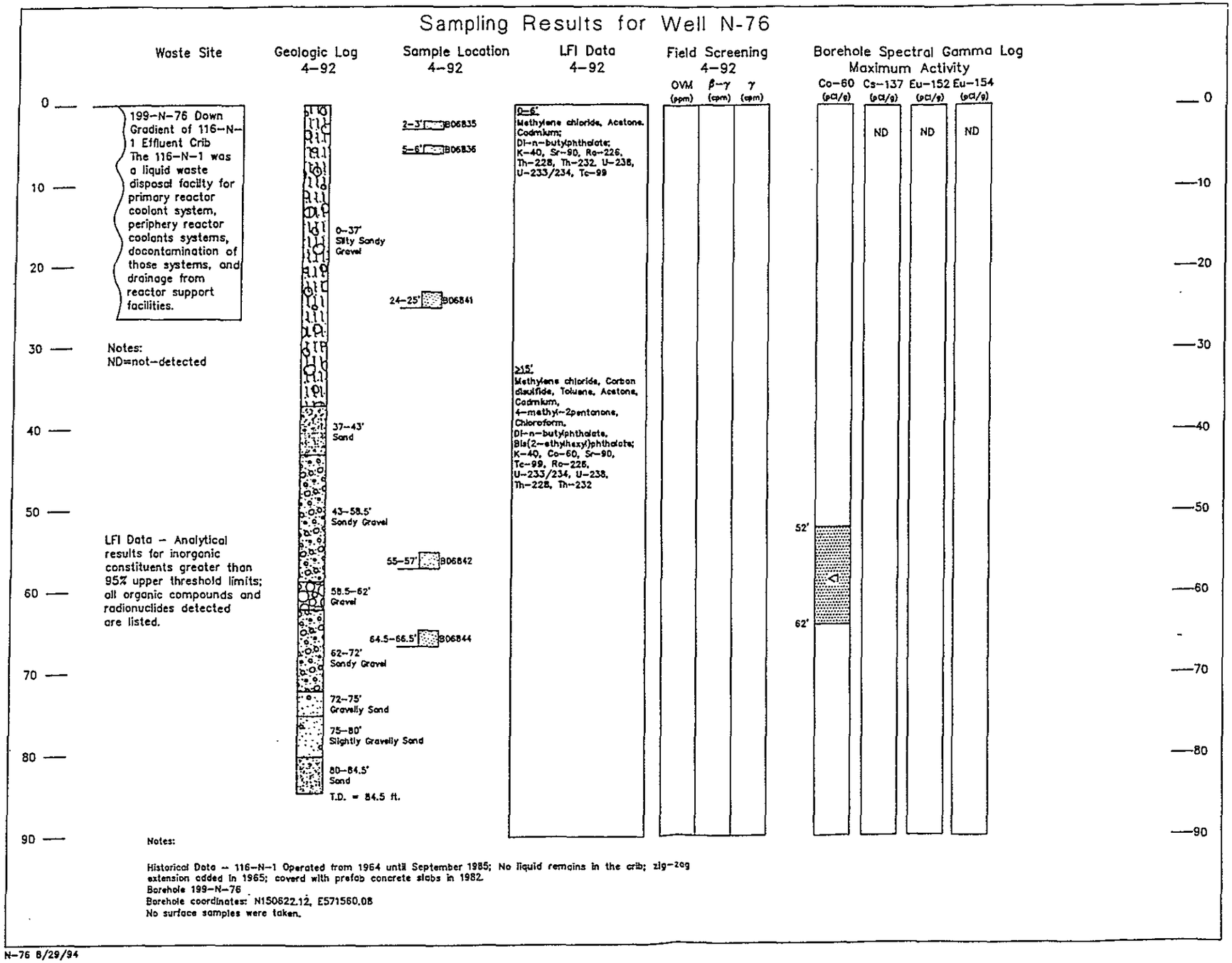
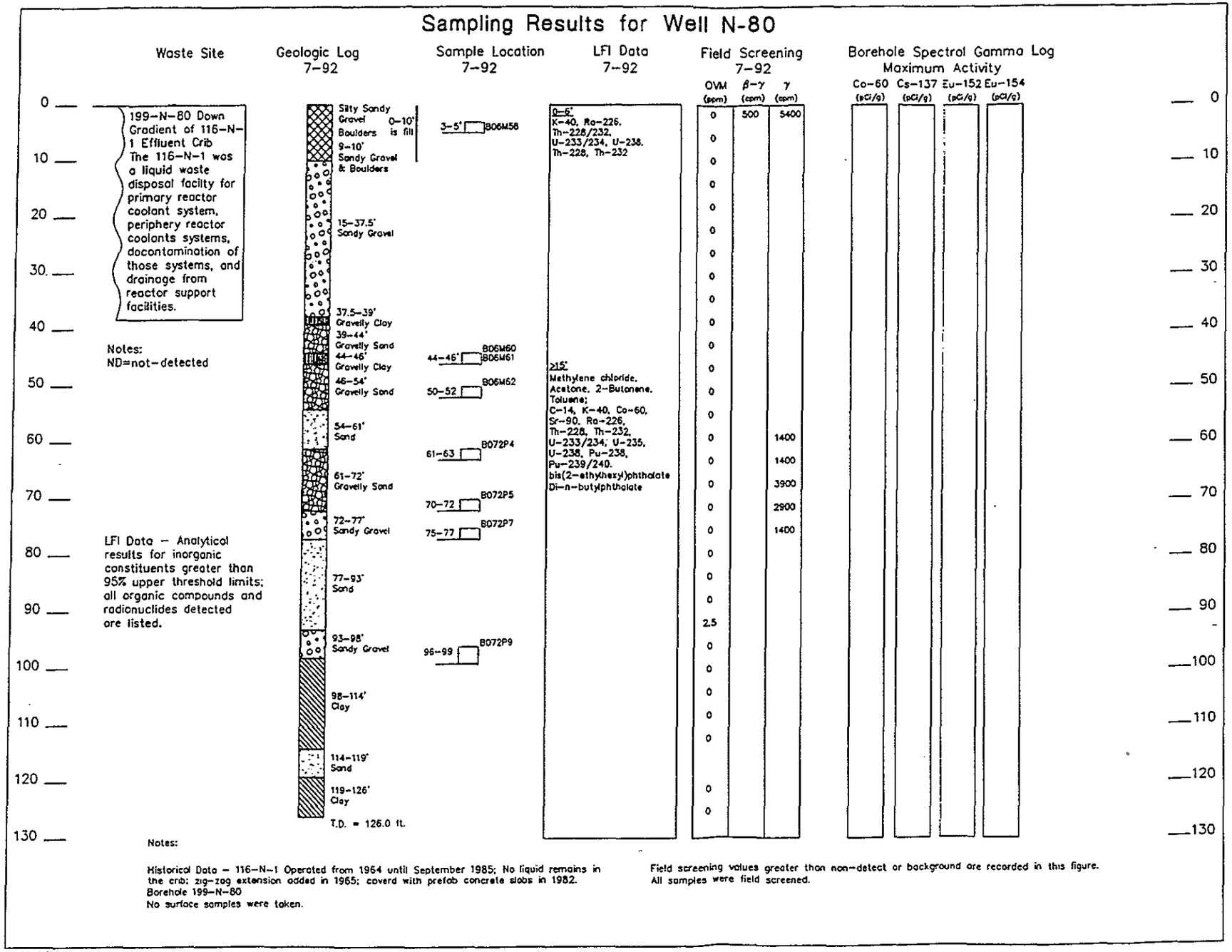


Figure 3-12. Sampling Result for Well N-80 Downgradient of 116-N-1



Notes:

Historical Data - 116-N-1 Operated from 1964 until September 1985; No liquid remains in the crib; zig-zag extension added in 1965; coverd with prefab concrete slabs in 1982.
Borehole 199-N-80
No surface samples were taken.

Field screening values greater than non-detect or background are recorded in this figure.
All samples were field screened.

N-80 8/30/94

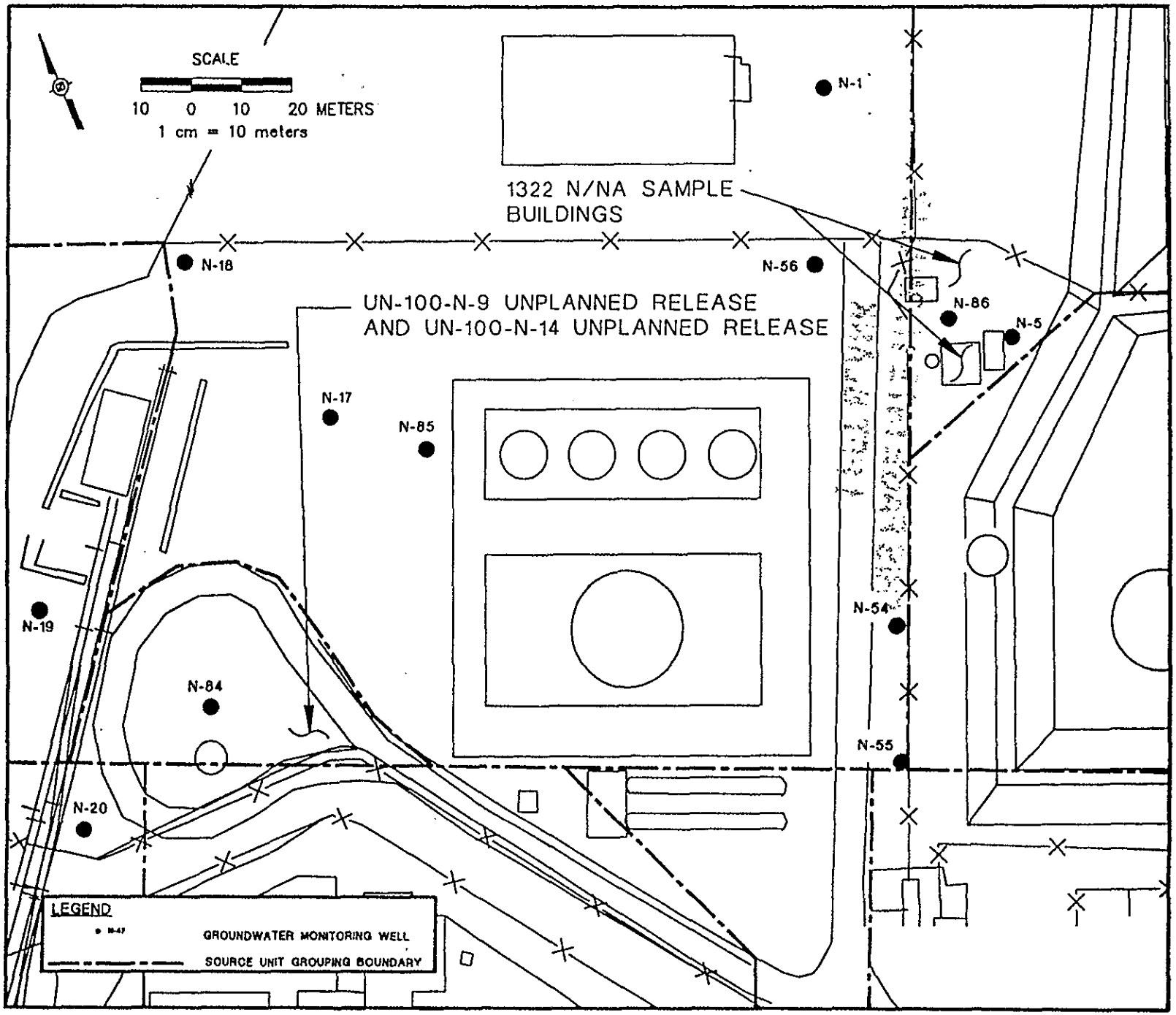


Figure 3-13. 119-N Cooling Water Drain Line and Air Sampling and Monitoring Building.

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Figure 3-14. Sampling Results for 1322-N and 1322-NA Sample Buildings

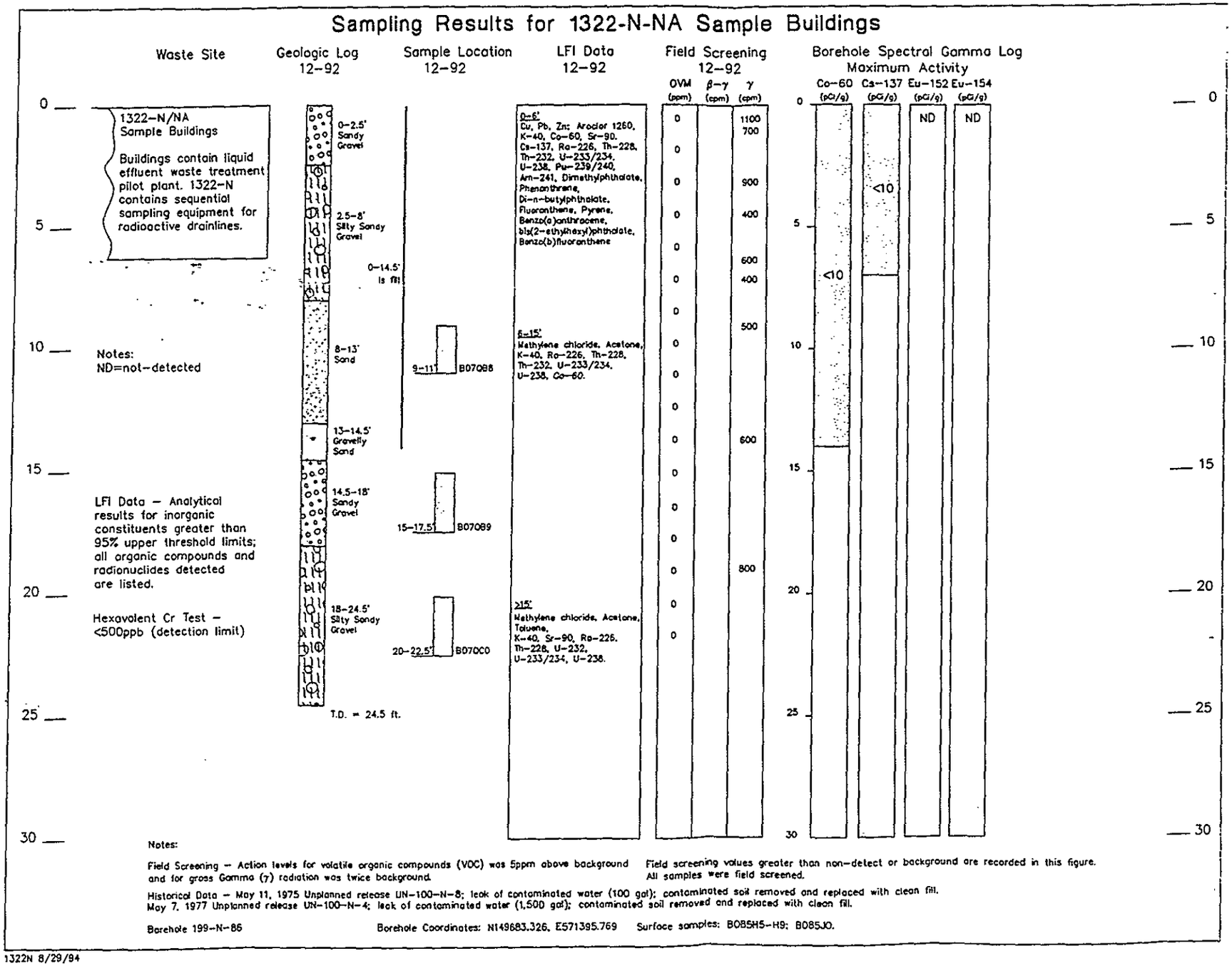

Figure 3-15. 116-N-2 Radioactive Chemical Waste Treatment and Storage Facility.

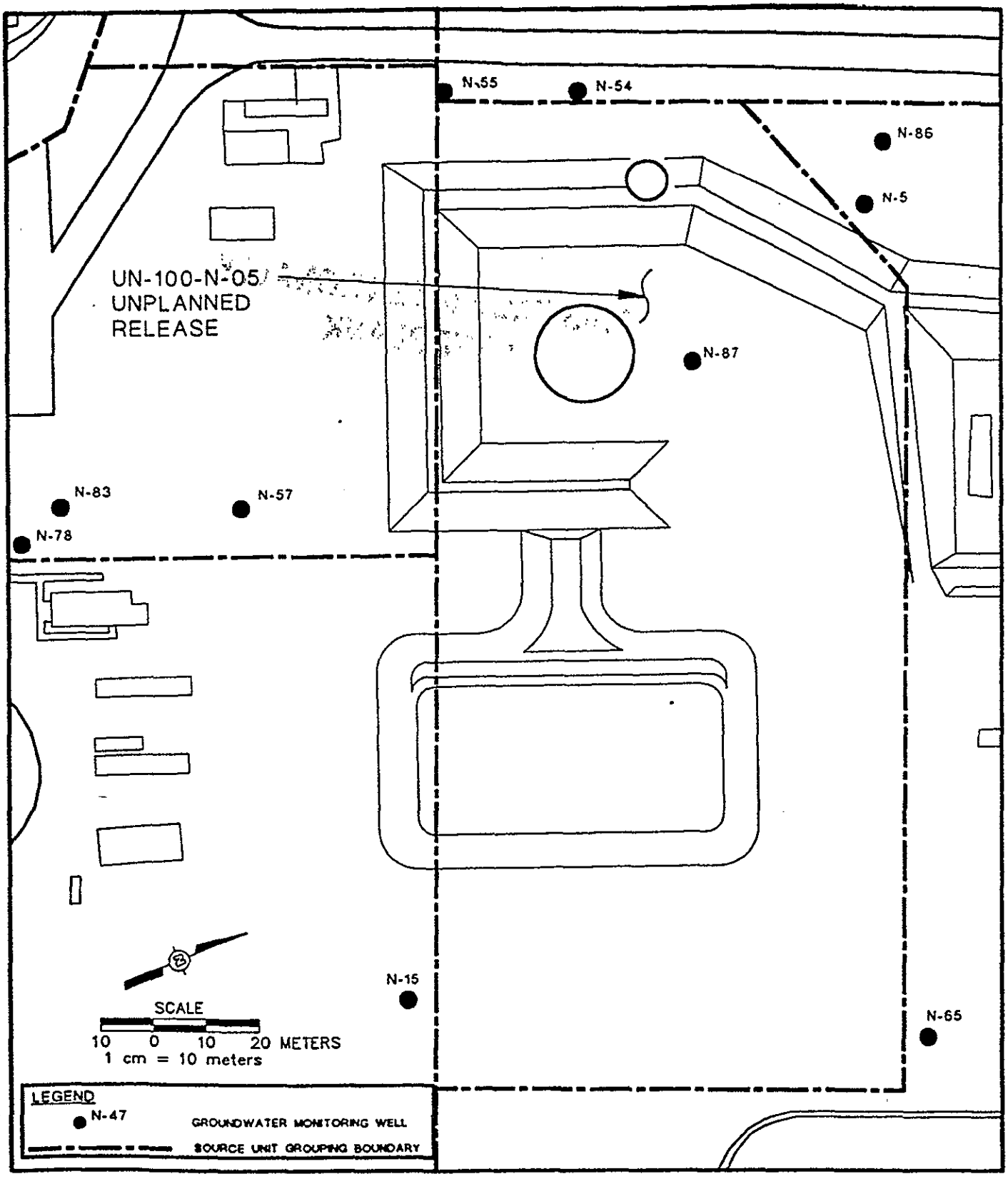

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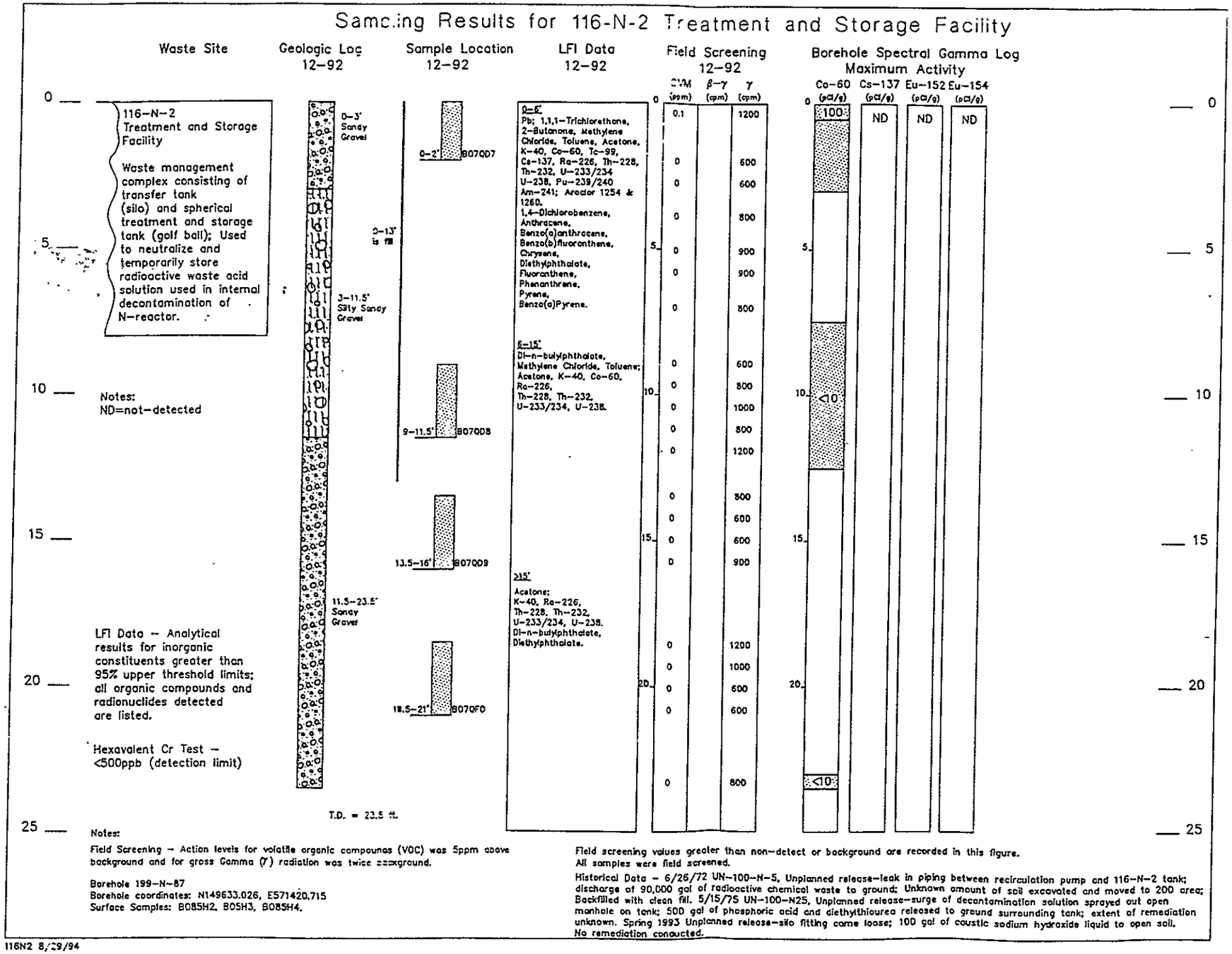
Figure 3-16. Sampling Result for 116-N-2 Treatment and Storage Facility



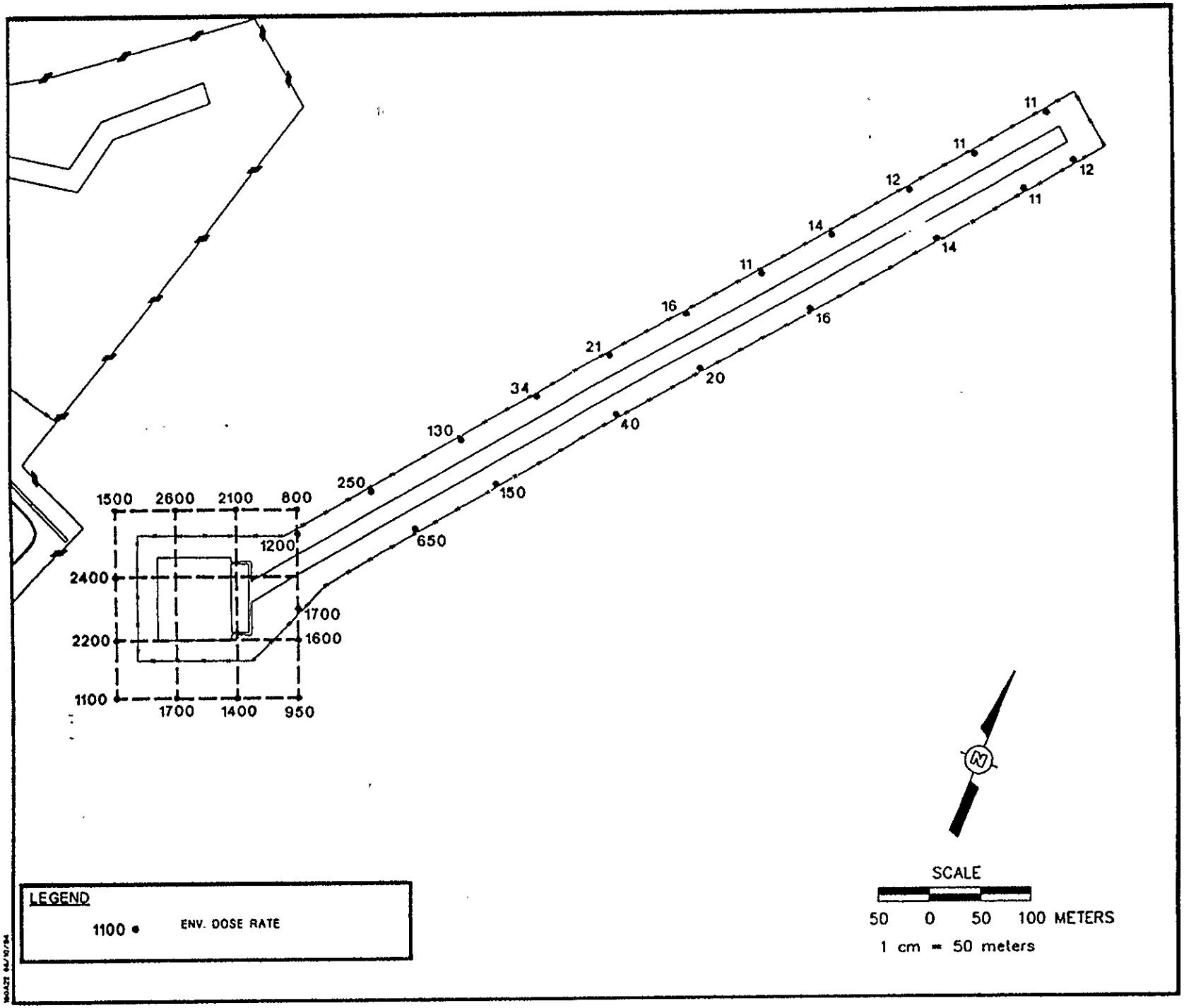


Figure 3-17. Environmental Dose Rates Detected Around the 116-N-3.

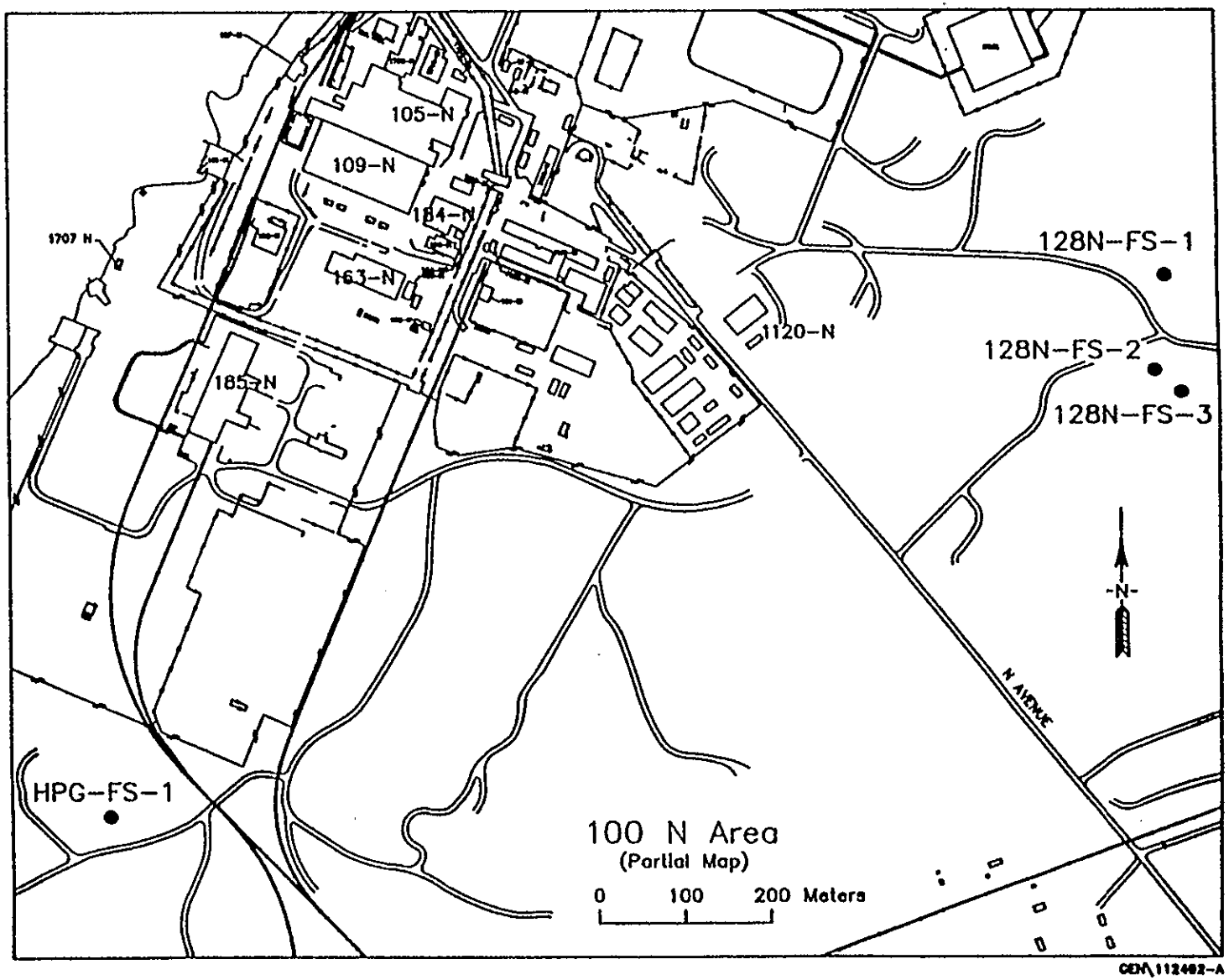


Figure 3-18. Burn Pit Sampling Locations.

Figure 3-19. Regeneration Waste Transport System, 1977-1983.

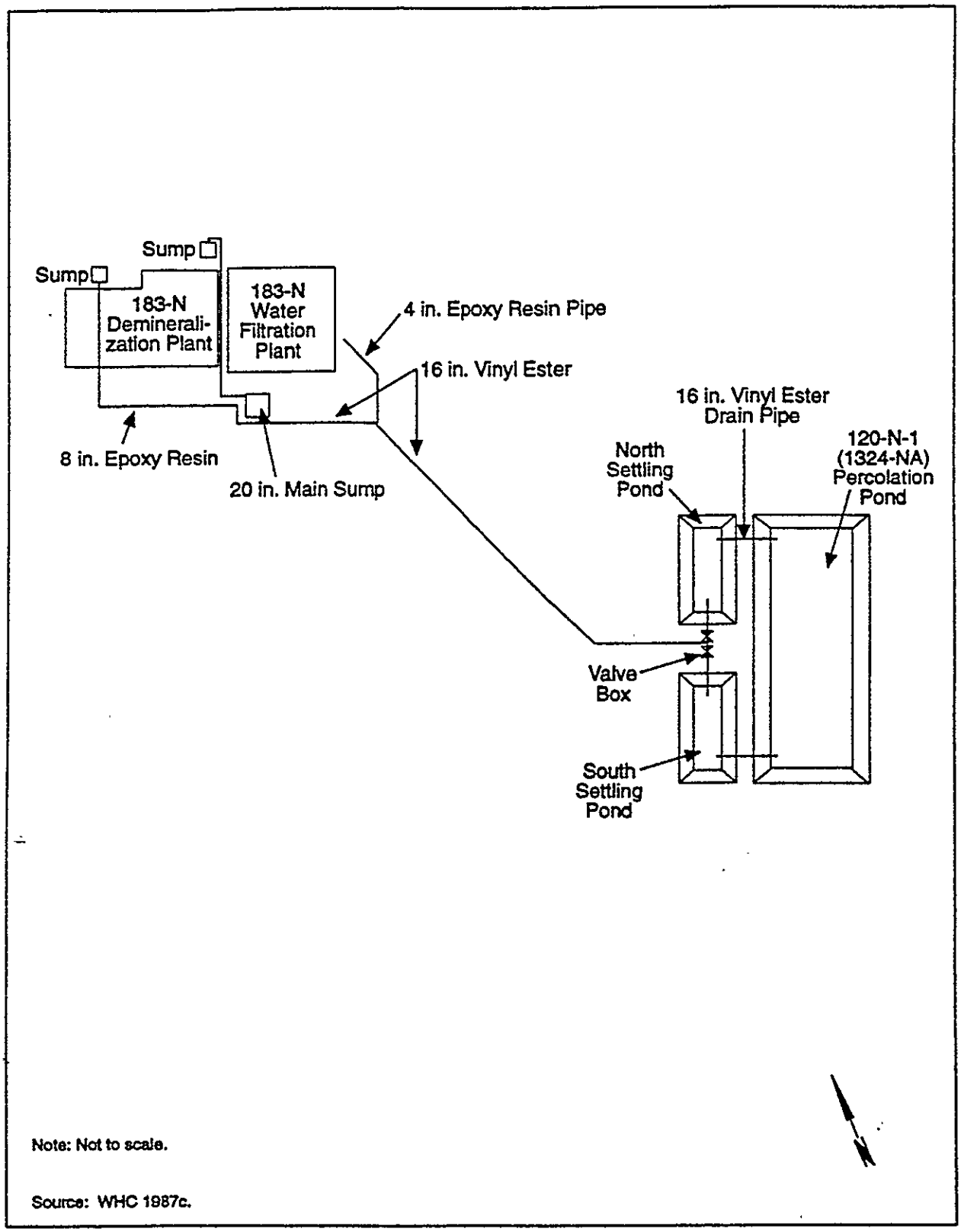


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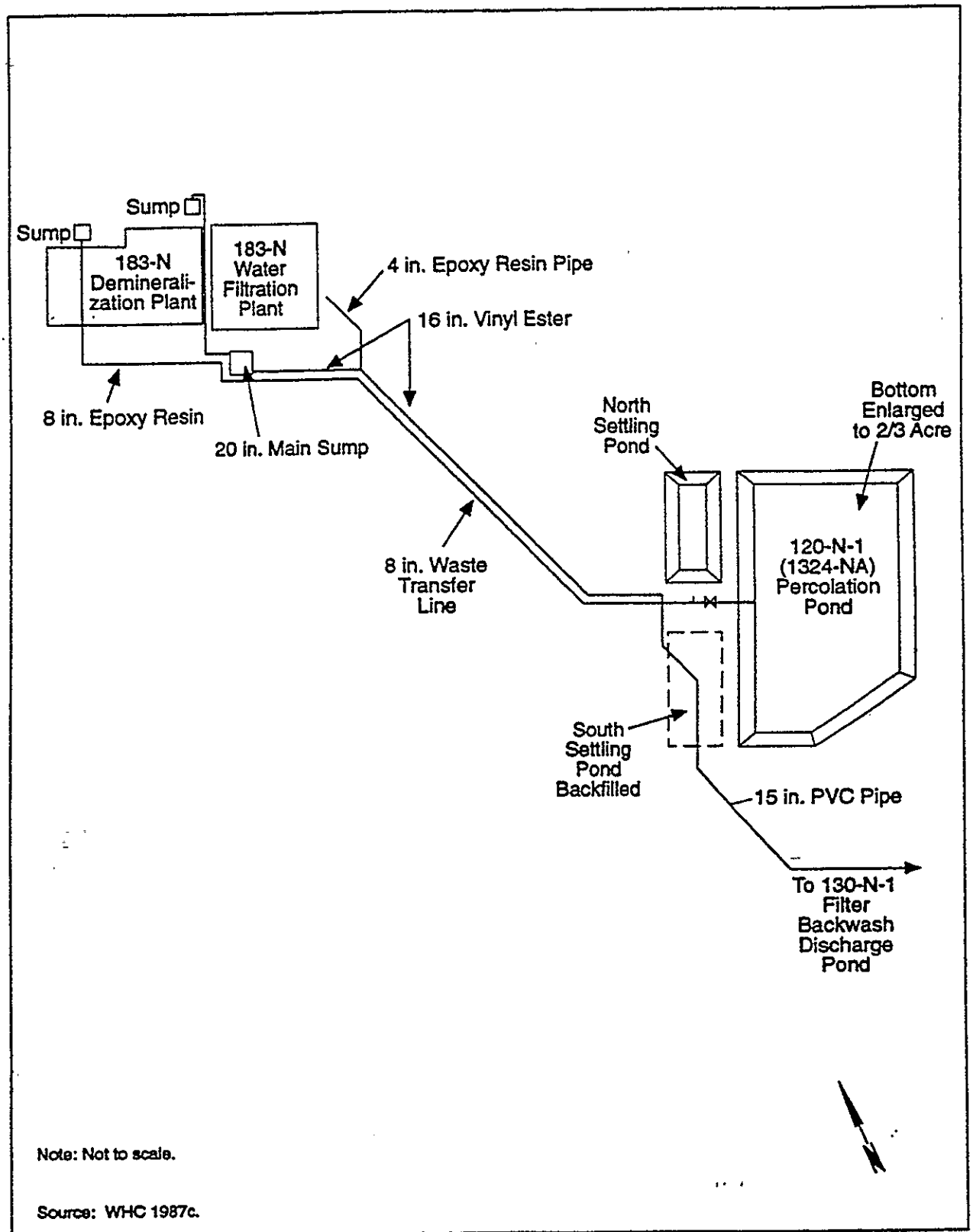
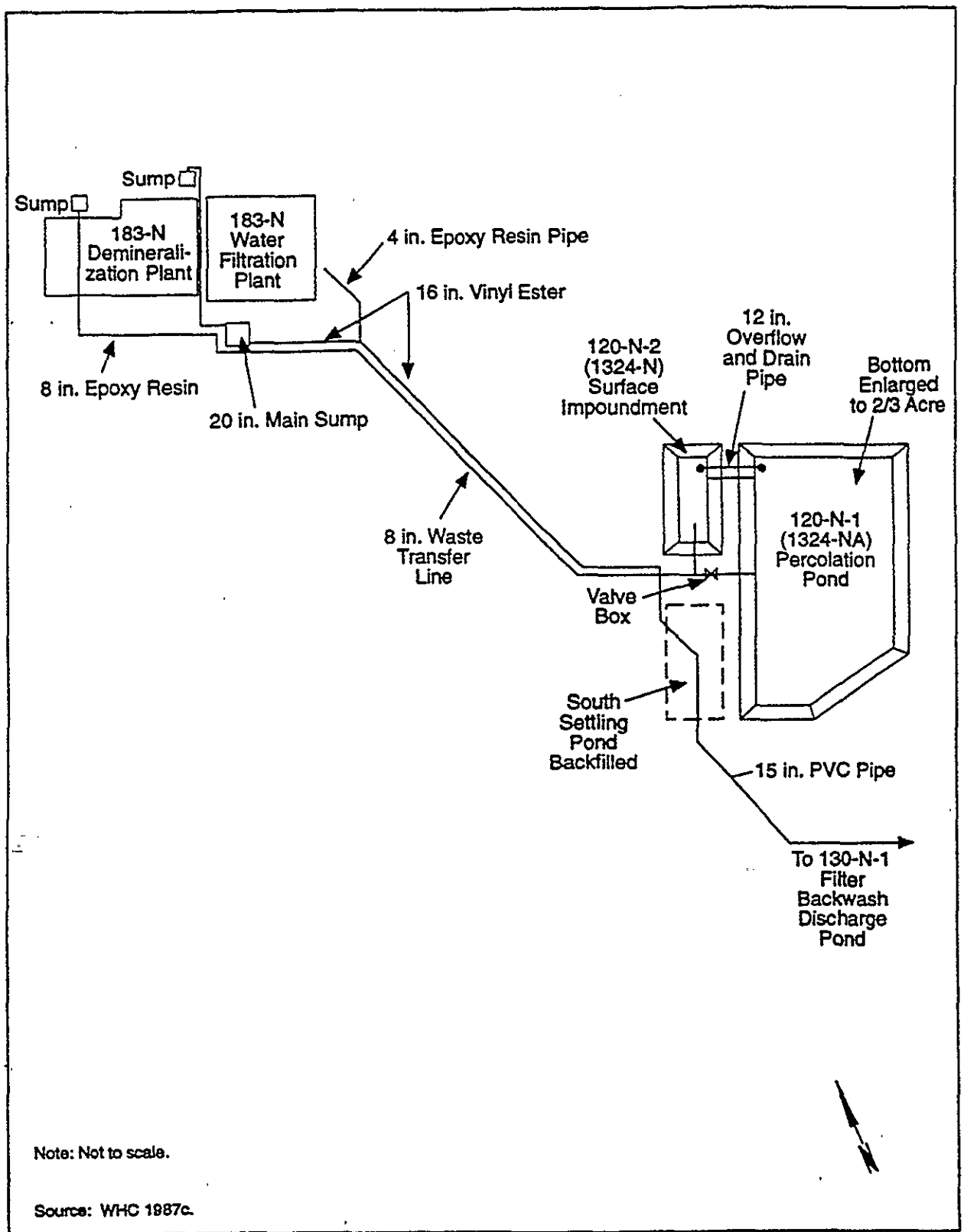
Figure 3-20. Regeneration Waste Transport System, 1983-1986.



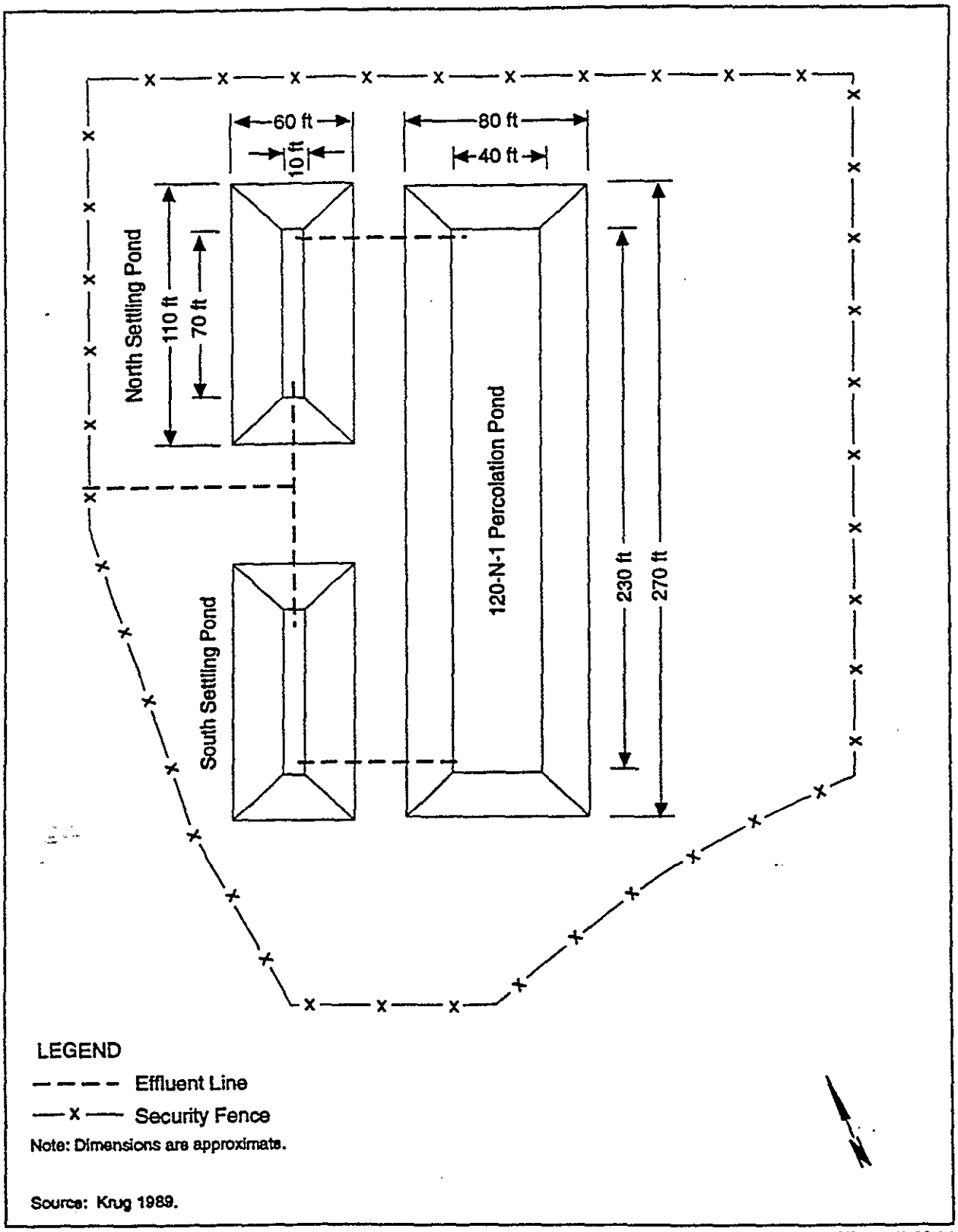
903 1275/26621/2-28-94

Figure 3-21. Regeneration Waste Transport System, 1986-1988.



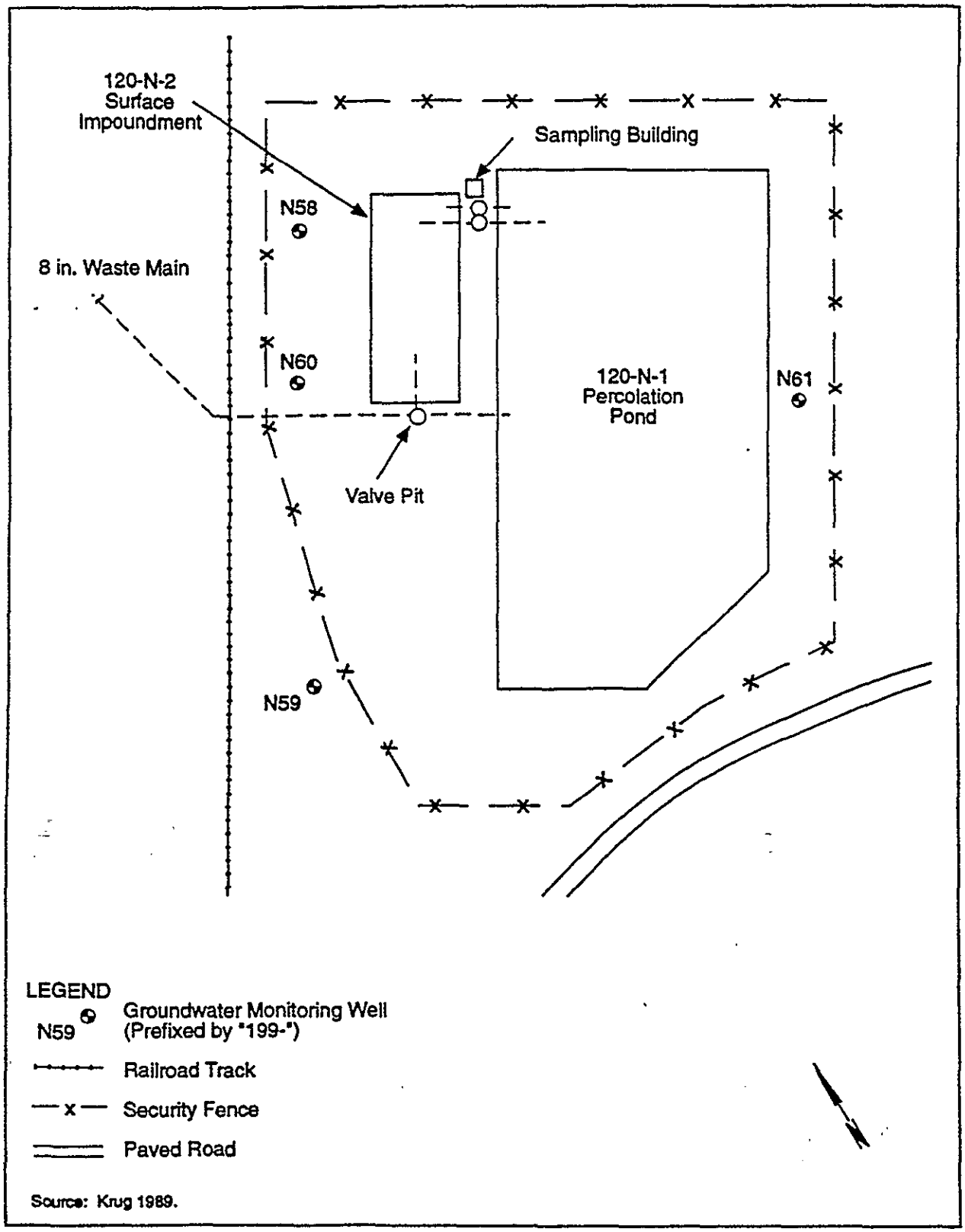
903 1275/26620/2-28-94

Figure 3-22. 120-N-1 Percolation Pond Area as it existed from 1977 to 1983.



903 1275/26623/2-28-94

Figure 3-23. 120-N-1 Percolation Pond/120-N-2 Surface Impoundment Area as they existed from 1986 to 1988.



Source: Krug 1989.

903 1275/26614/2-28-94

Figure 3-24. Regeneration/Filter Backwash Disposal Area.

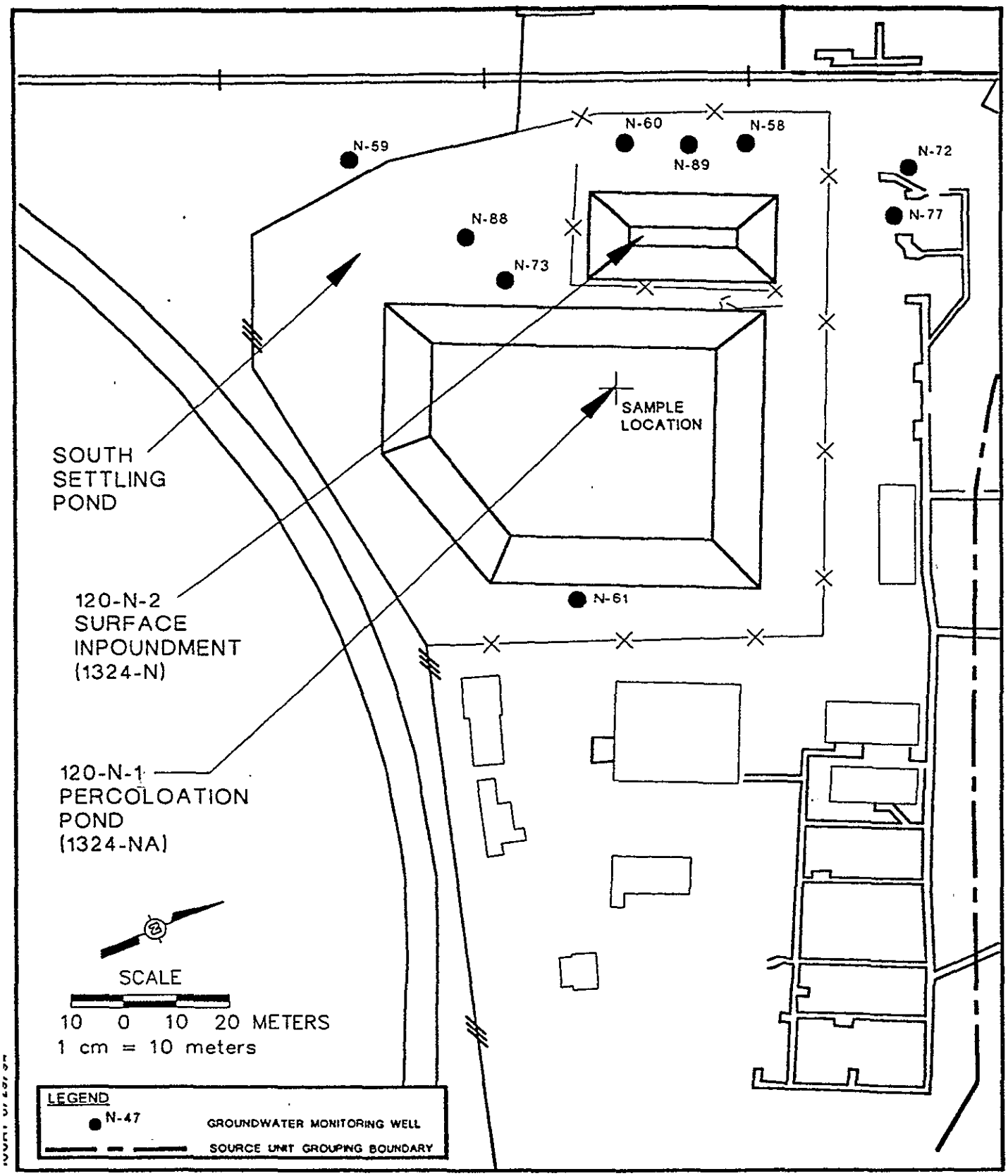


Figure 3-25. Sampling Result for 120-N-1 Percolation Pond

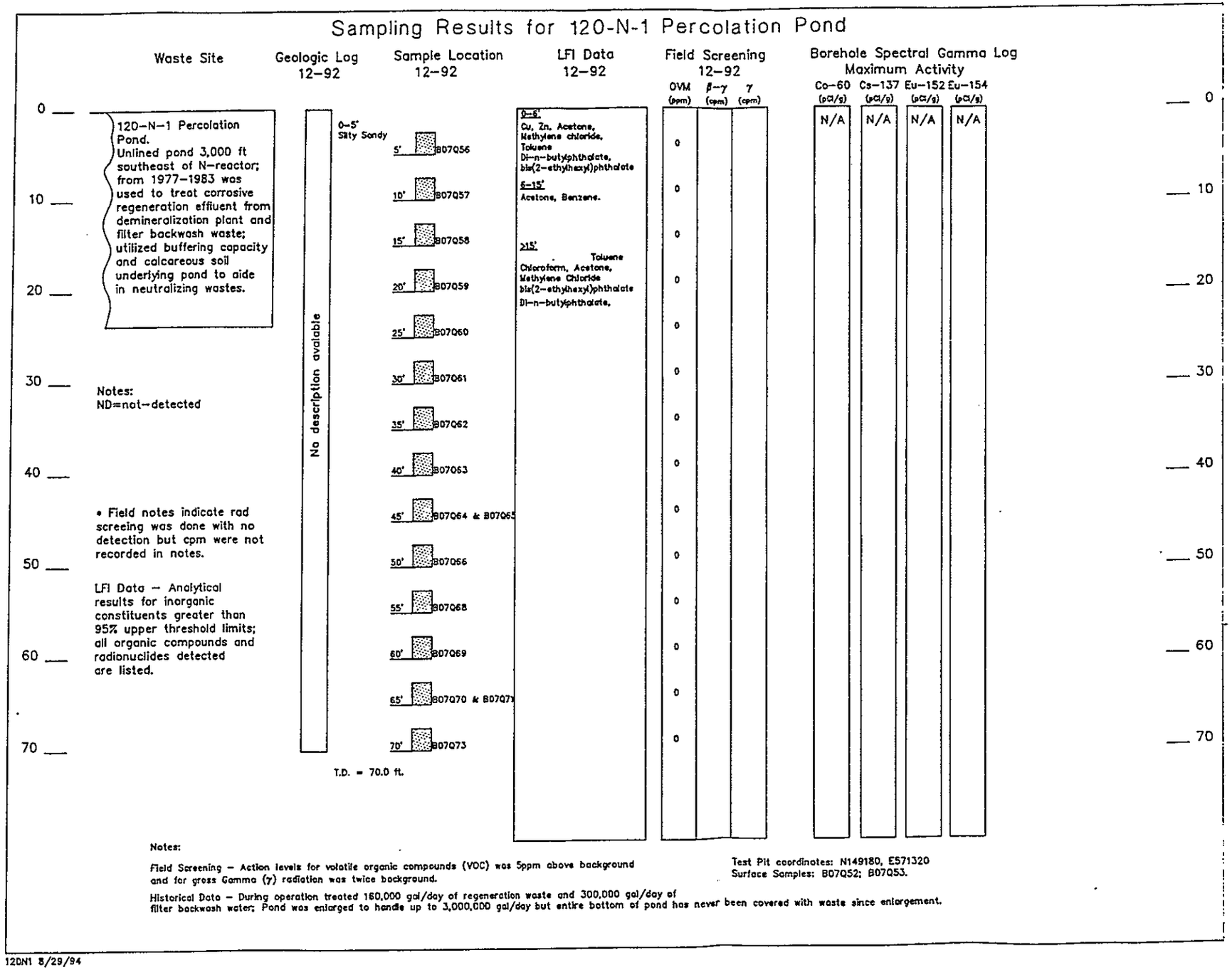


Figure 3-26. Sampling Result for Well N-77 Downgradient of 120-N-1 120 and South Settling Pond

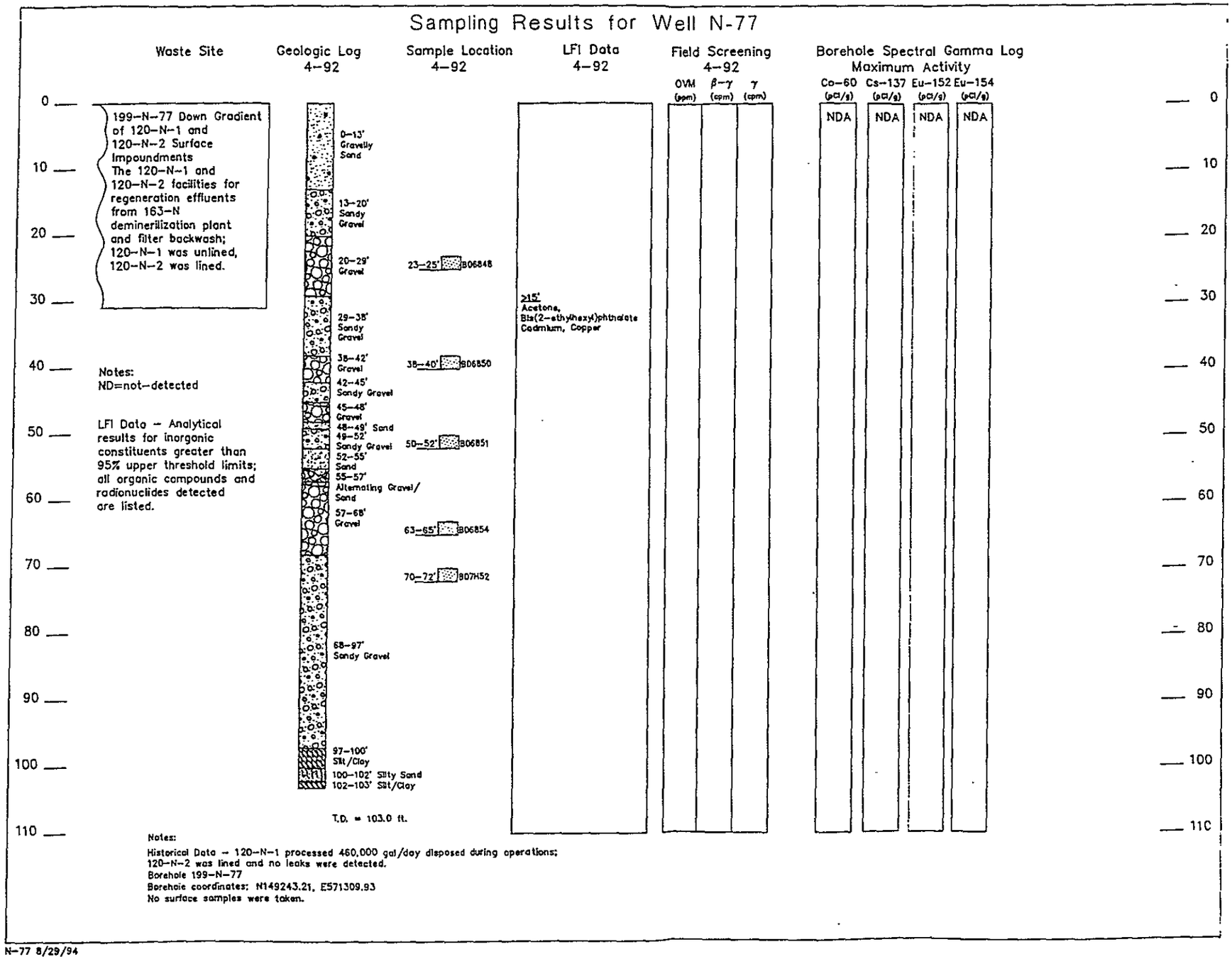
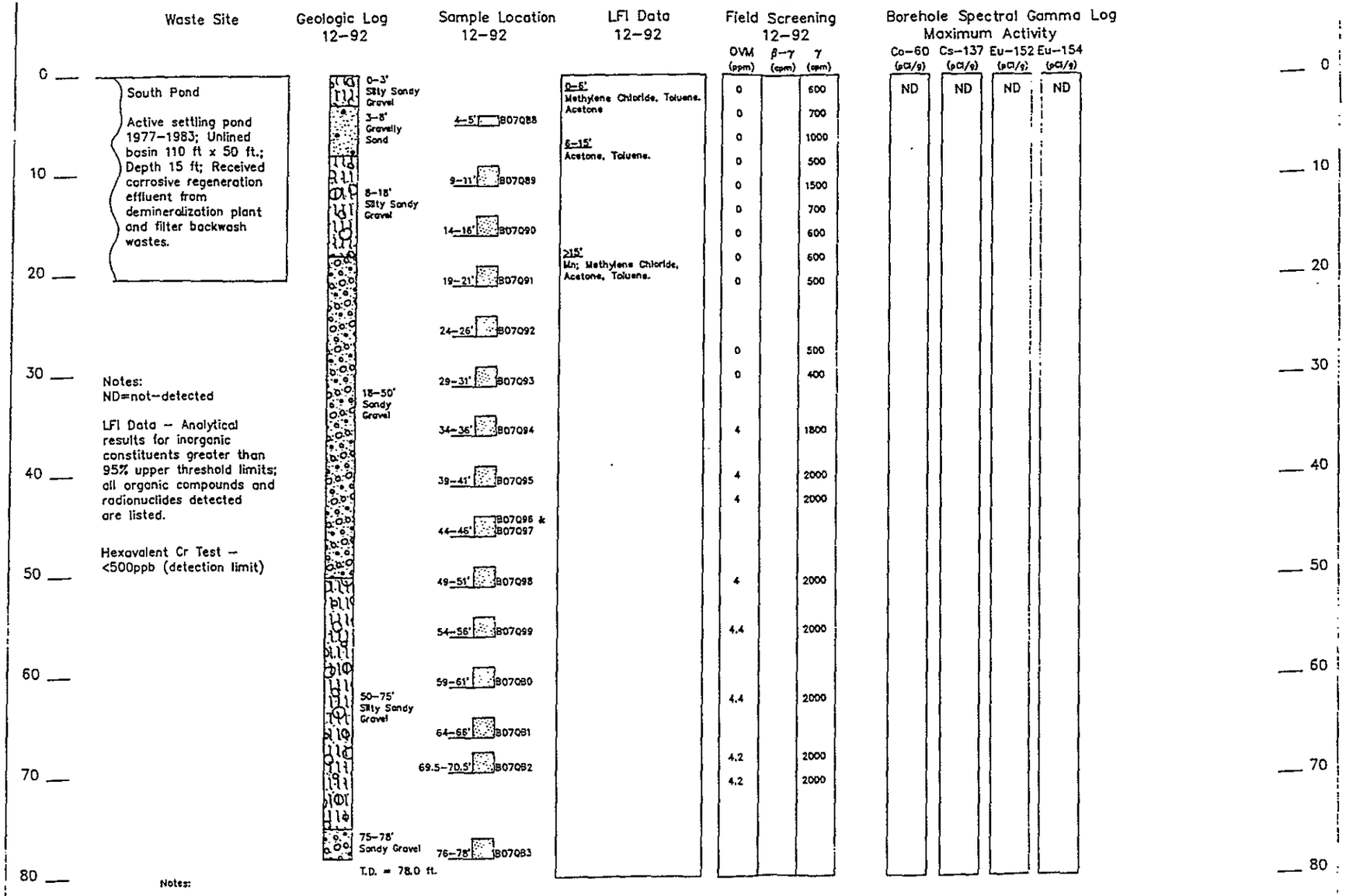


Figure 3-27. Sampling Results for South Settling Pond

Sampling Results for South Settling Pond



Notes:

Field Screening - Action levels for volatile organic compounds (VOC) was 5ppm above background and for gross Gamma (γ) radiation was twice background.

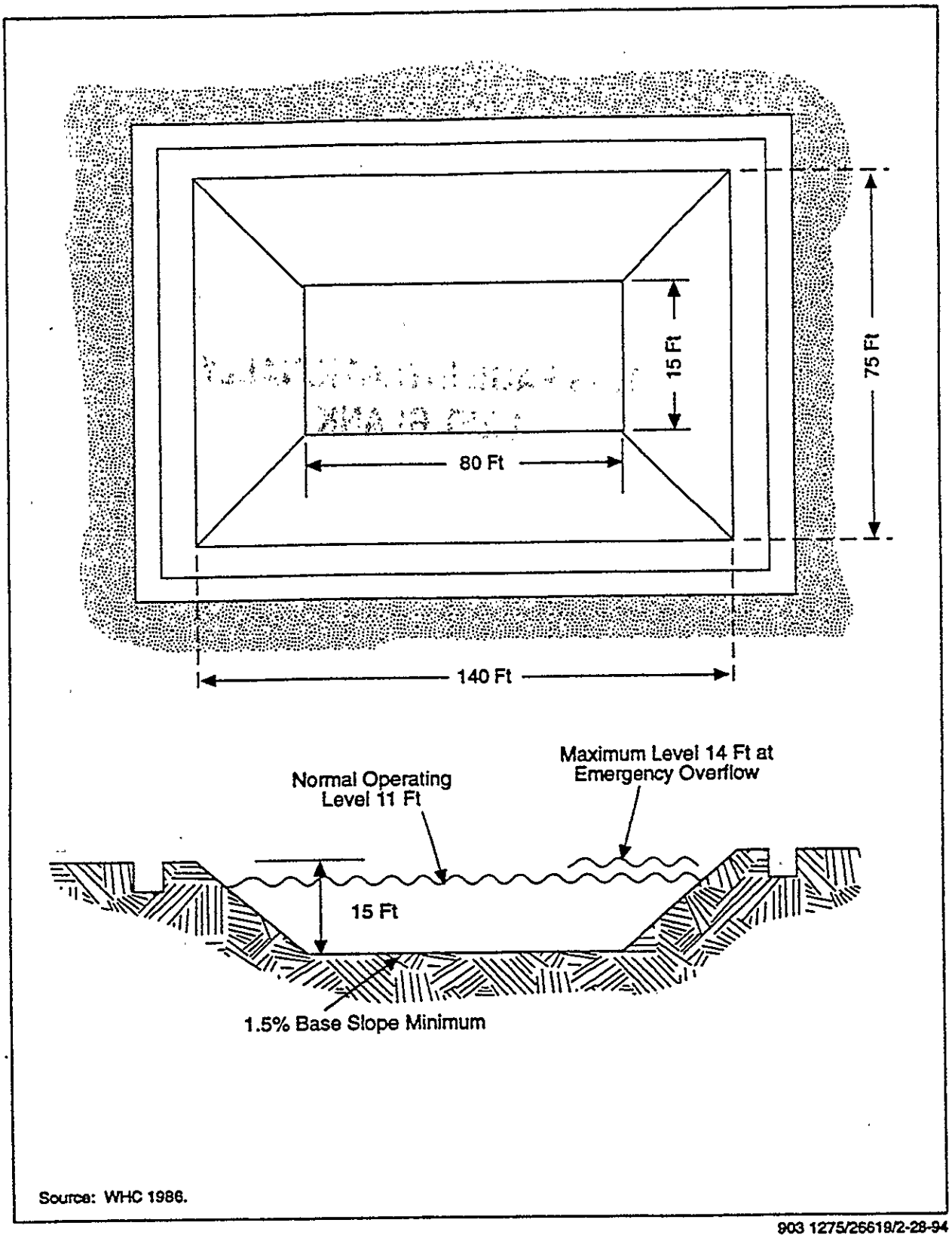
Historical Data - After settling solids from filter backwash, effluent was transferred to 120-N-1 percolation pond; after 1983 pond was backfilled.

Field screening values greater than non-detect or background are recorded in this figure. All samples were field screened.

Borehole 199-N-88
Borehole coordinates: N149165.378, E571281.318
Surface samples B0Q87

SOUTHPND 8/29/94

Figure 3-28. 120-N-2 Surface Impoundment Schematic.



Source: WHC 1986.

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Figure 3-29. Sampling Result for 120-N-2 Surface Impoundment

Sampling Results for 120-N-2 Surface Impoundment

Waste Site

120-N-2 Surface Impoundment
Double-lined surface impoundment with leak detection; 1986-1988; 3000 ft southeast of N-Reactor building; 140 ft. x 75 ft.; design capacity 424,000 gal; Acid and caustic regeneration effluent from 163-N demineralization plant and filter backwash wastes were neutralized in this impoundment; Unit replaced by elementary neutralization unit (ENU).

Notes:
ND=not-detected

LFI Data – Analytical results for inorganic constituents greater than 95% upper threshold limits; all organic compounds and radionuclides detected are listed.

Hexavalent Cr Test – <500ppb (detection limit)

Geologic Log 12-92

0-5' Silty Sandy Gravel
5-8' Silty Gravel
8-34' Gravelly Sand
34-40' Sandy Gravel
40-64' Gravelly Sand
64-66' Gravelly Sandy Silt
66-77' Silty Sandy Gravel
T.D. = 77.0 ft.

Sample Location 12-92

Sample Location	Sample No.
0-2'	807QB5
4-6.5'	807QB6
10-11.5'	807SW7
14-16'	807SW8
19-21'	807SW9
24-26'	807SX0
29-31'	807SX1
34-36'	807SX2
39-41'	807SX3
44-46'	807WV0
51-53'	807WV2
55-57'	807WV3
58-60'	807WV4
64-66'	807WV6
69-71'	807WV8
74-76'	807WV9

LFI Data 12-92

0-6'
Di-n-butylphthalate, bis-(2-ethylhexyl)phthalate; Toluene, Acetone.

6-15'
Cd, Cu; Methylene chloride, Toluene; Di-n-butylphthalate, Bis-(2-ethylhexyl)phthalate

>15'
Di-n-butylphthalate, Diethylphthalate, Chloroform, Acetone, 2-hexanone, Methylene Chloride, 2-Butanone, Toluene, Xylene.

Field Screening 12-92

OVM (ppm)	β-γ (cpm)	γ (cpm)
		2000
0.1	25 to 60	1200
0.1	2000	2800
0	900	2800
0	900	1900
0	5000	1200
0	4000	1400
0	200	900
0	200	1400
0	200	1200
0	200	1000
0	100	1800
0	8000	1600
0	400	1000
0	9000	1900
0	400	1800
0	200	1400
0	400	1400
0	600	1400
0	600	1400
0	900	1400
0	200	1600
5.3	200	1600
1.5	2900	1600
2.7	400	1500
4.5	400	1600
0	50	2100

Borehole Spectral Gamma Log Maximum Activity

Co-60 (pCi/g)	Cs-137 (pCi/g)	Eu-152 (pCi/g)	Eu-154 (pCi/g)
ND	ND	ND	ND

Notes:

Field Screening – Action levels for volatile organic compounds (VOC) was 5ppm above background and for gross Gamma (γ) radiation was twice background.

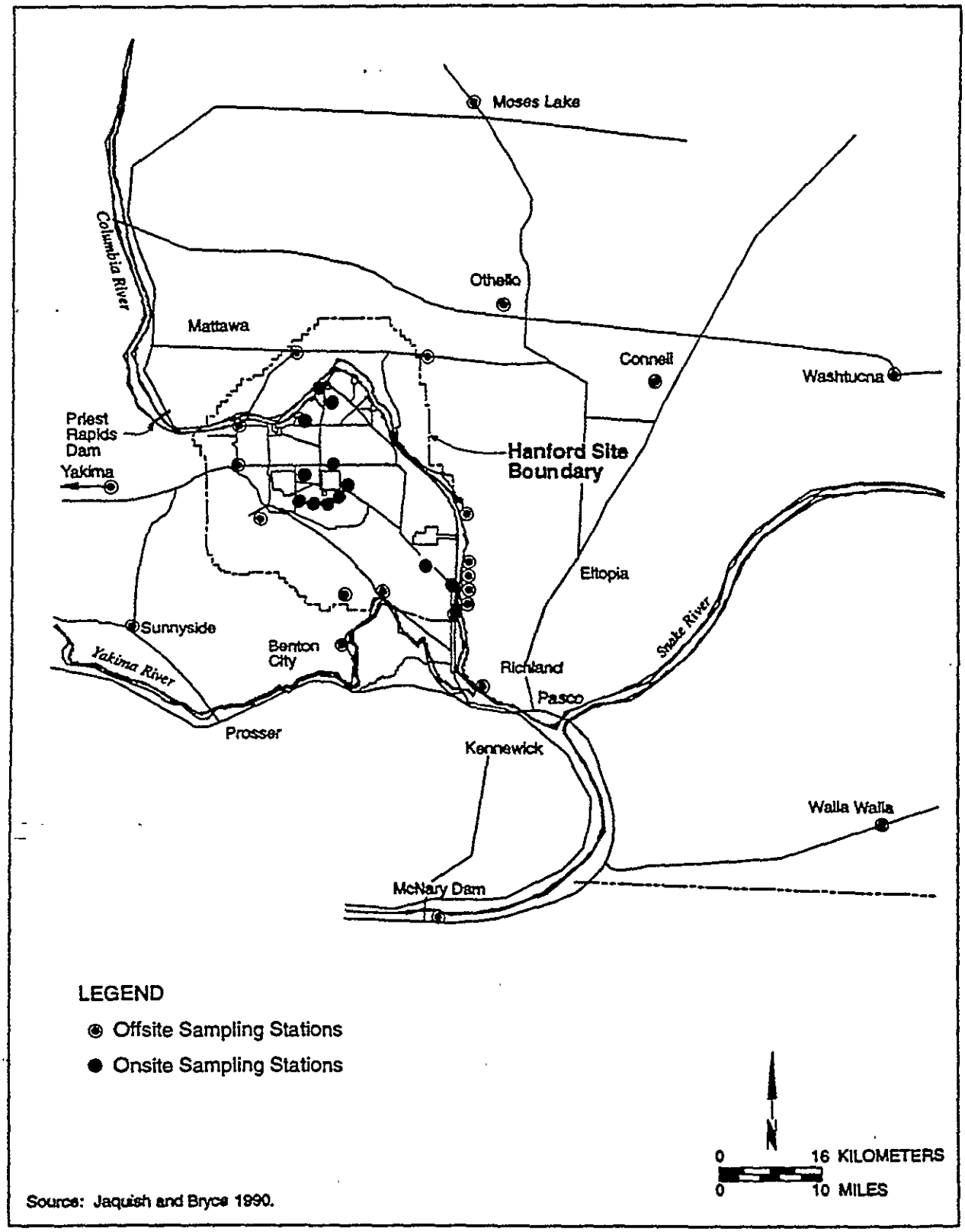
Historical Data – Surface impoundment used to neutralize wastes from demineralization and filter backwash. No leaks detected at this facility.

Field screening values greater than non-detect or background are recorded in this figure. All samples were field screened.

Borehole 199-N-89
Borehole coordinates: N149211.973, E571281.368
No surface samples were taken.

120N2 8/29/94

Figure 3-30. Background Sampling Stations for Soil.



903 1275/27126/2-28-94

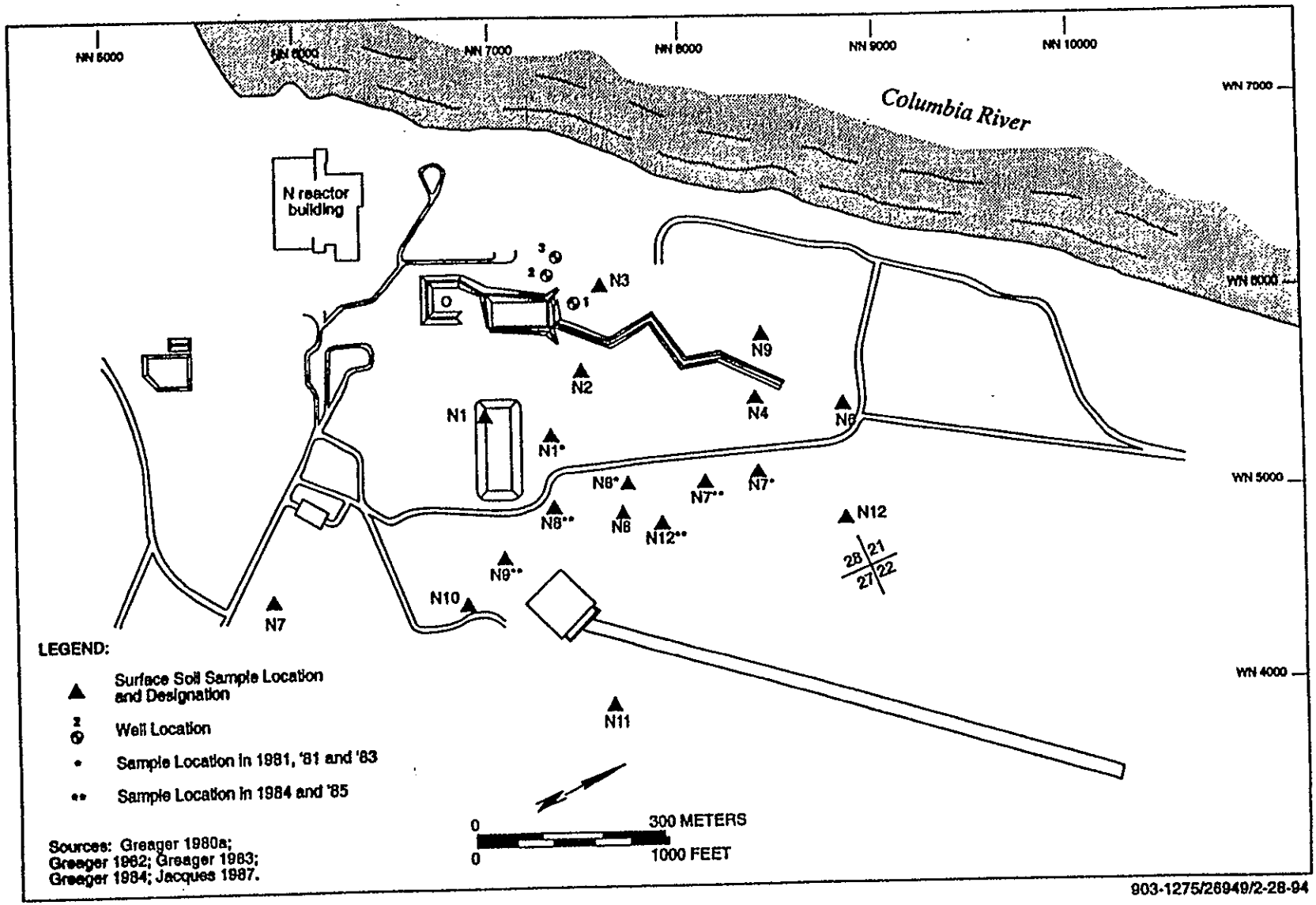


Figure 3-31. Soil Sampling Locations in the 100 N Area.

Figure 3-32. Areas of Inferred Soil Contamination in the 100 N Area.

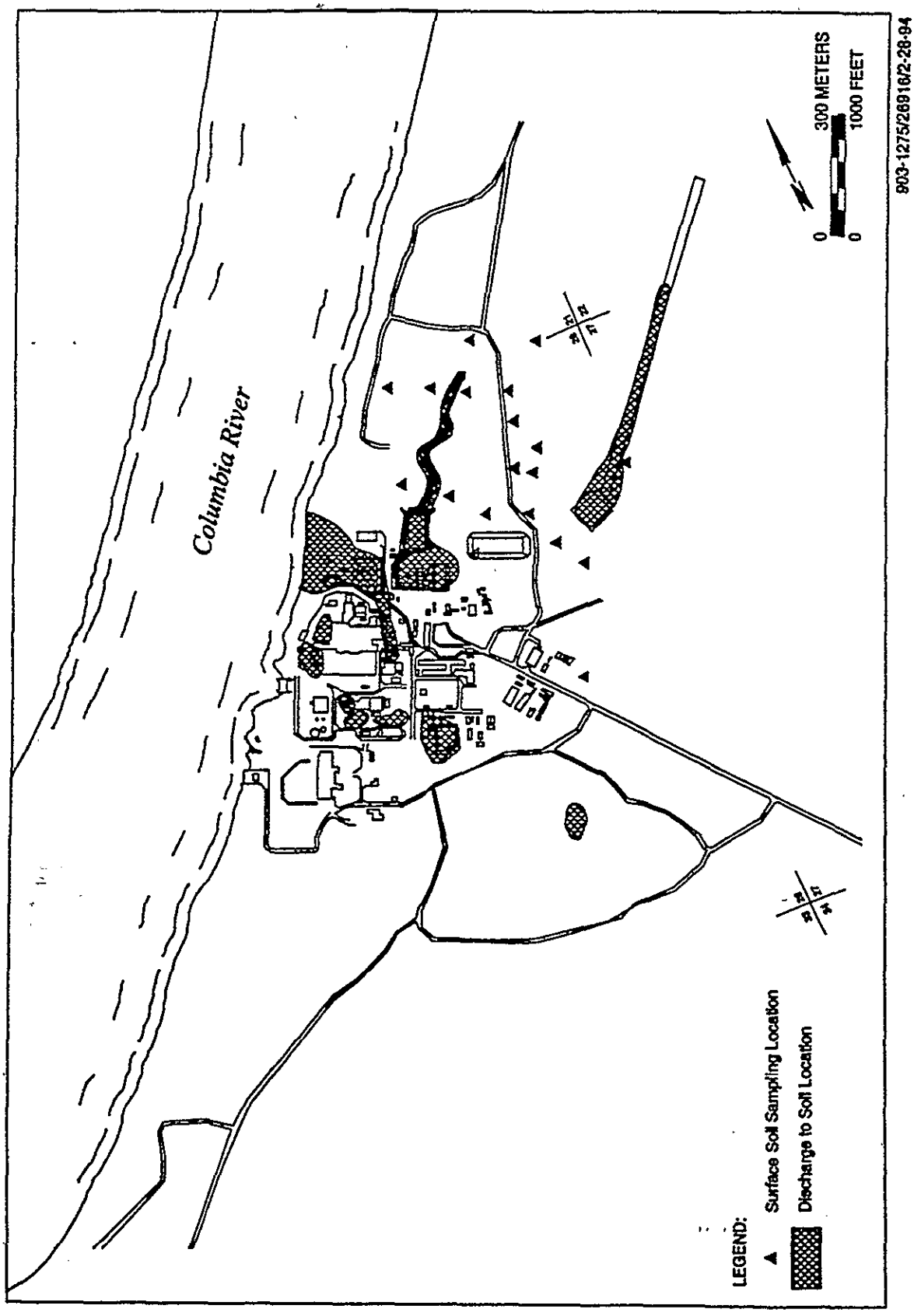
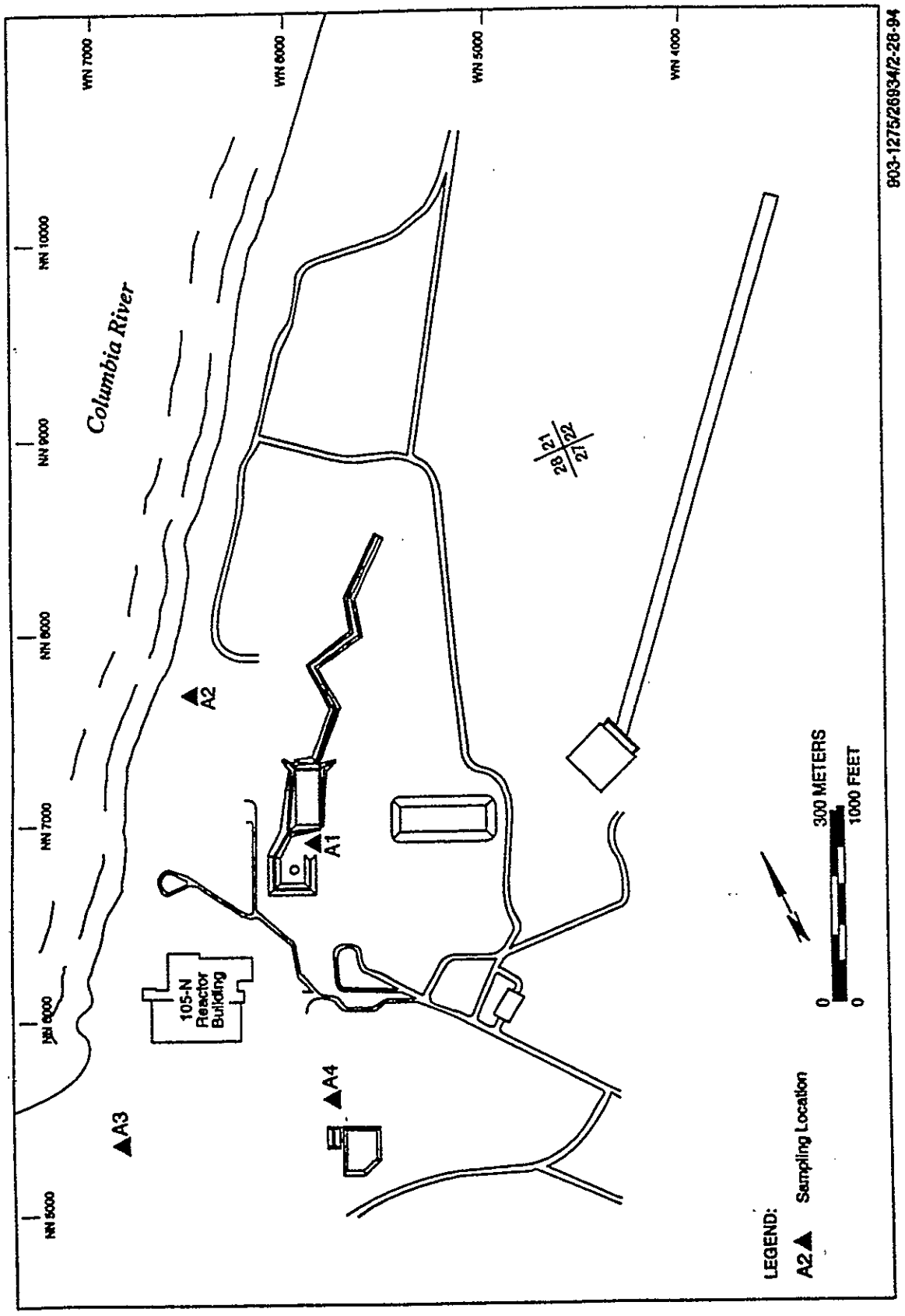
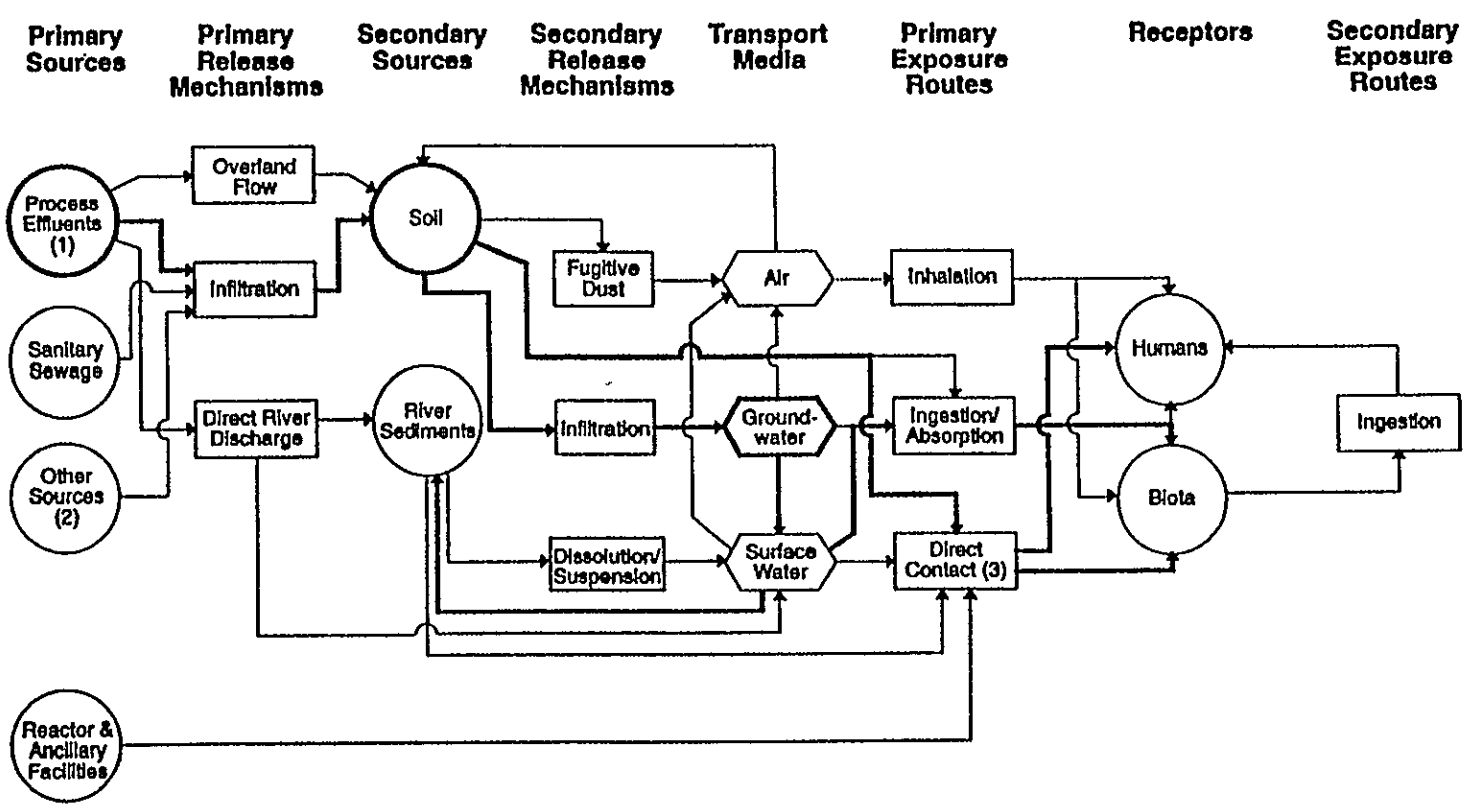


Figure 3-33. Air Sampling Stations for the 100 N Area.





(1) Includes all facilities that received process effluents, including pipelines, basins, cribs, trenches, french drains, and outfall structures.

(2) Includes other sources within limited existing information.

(3) Includes exposure to radiation including exposure from skyshine.

LEGEND:

→ Potential Exposure Pathway

→ Potential Primary Exposure Pathway

○ ⬡ Primary contaminant sources and known contaminated media

903 1275/26595/2-28-94

Figure 3-34. Contaminant Exposure Pathway for the 100-NR-1 Operable Unit.

Figure 3-35. A Matrix of Preliminary Interim Response Actions, Technologies and Process Options Available.

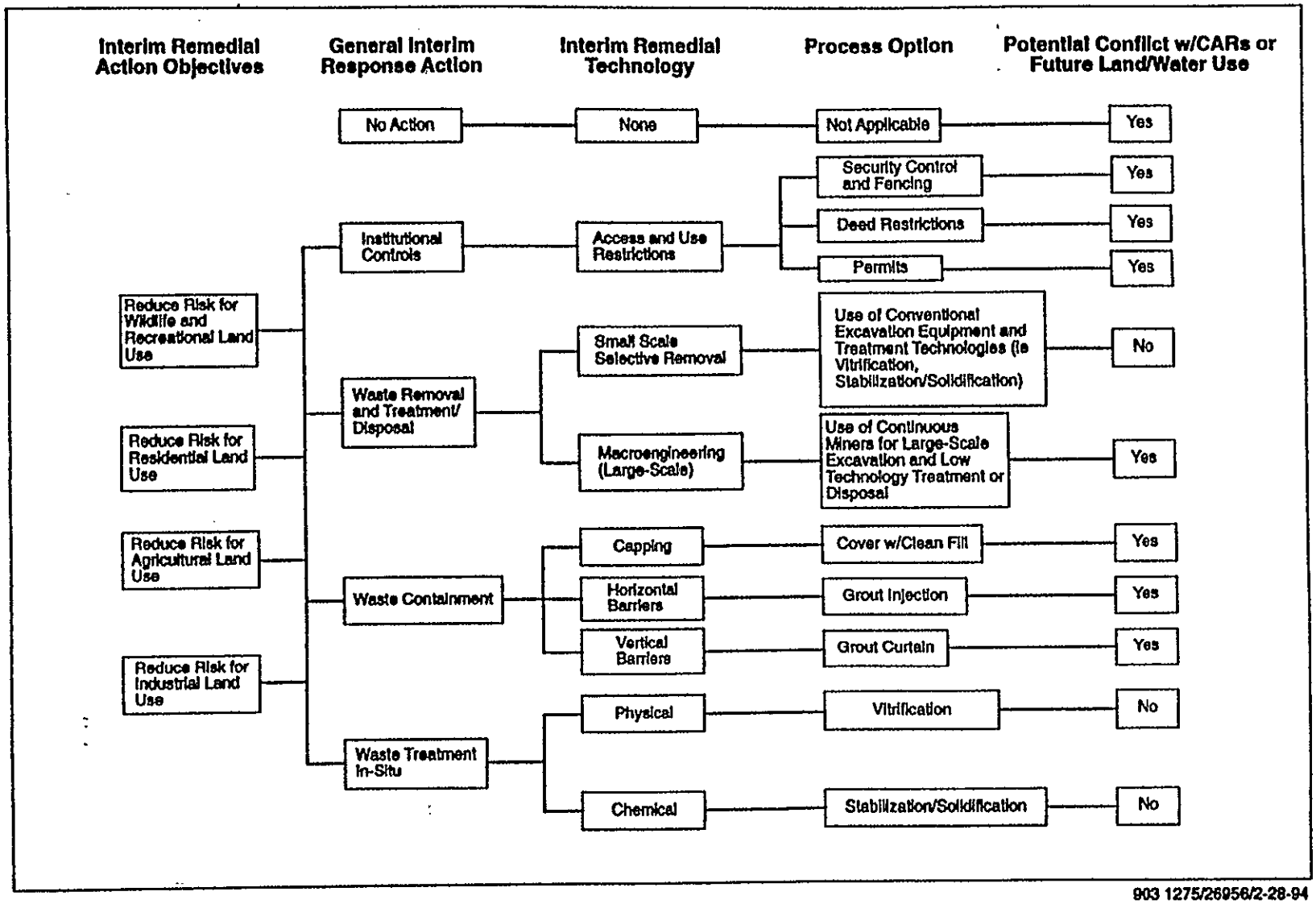


Table 3-1. 100 N Area Sources. (page 1 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
1314-N Liquid Waste Loadout Facility Grouping				
---	1314-N	1972 - present	Receives spent radioactive internal decontamination solution from the 116-N-2 radioactive chemical waste storage facility and the 107-N basin recirculation facility. Effluent transferred by railway tank cars to 200 Area tank farms for processing and disposal.	Liquid waste loadout station.
UN-100-N-13	1314-N Loading Station	9/24/73	100 gal of spent reactor decontamination solution containing 0.011 Ci from 116-N-2 (1310-N) discharged to ground via dry well.	1314-N dry well overflow.
UN-100-N-26	Valve Pit at 1314-N Loading Station	12/7/78	1,000 gal of spent reactor decontamination solution containing phosphoric acid and diethylthiourea backflowed while being pumped into a tank car.	Rail car overflow.
119-N Air Sampling and Monitoring Building Grouping				
UN-100-N-9	119-N Cooling Water Drain Line	10/14/74	2,200 gal of contaminated water with a total activity of 4 mCi released to soil from punctured drain line.	Punctured drain line.
UN-100-N-14	Drain System at 119-N Building	8/5/74	70 gal of effluent water containing 0.8 mCi of beta/gamma activity was released to the ground.	Drain backflow release.
---	116-N Air Stack	1963 - present	Radioactive gases and particulates from reactor operations.	Air stack; primary ventilation outlet for 100 N facility operations.
166-N Fuel Unloading and Storage Area Grouping				
---	Fuel Oil Unloading Station	1963 - 1990	No. 6 fuel oil.	Tank car unloading area and containment trench for piping.
---	166-N Tank Farm	1963 - 1990	No. 6 fuel oil and No. 2 diesel oil.	One aboveground tank for No. 6 fuel oil and four aboveground tanks for No. 2 diesel oil.
UN-100-N-17	166-N Diesel Oil Supply Line	8/66	80,000 gal of diesel oil was released to the ground from the external corrosion of a supply line.	Oil supply line leak. Trench dug along river used to intercept and burn off oil in the groundwater.
UN-100-N-20	2-in Diesel Oil Return Line	6/85	200 gal of diesel oil was released to the ground as a result of a leak in a corroded return line.	Oil line leak in bermed storage tank area.

Table 3-1. 100 N Area Sources. (page 2 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
UN-100-N-24	166-N Oil Supply Line	2/1/87	Unknown amount of No. 6 fuel oil was released to the ground as a result of a leak in a heat transfer line.	Oil line leak in bermed storage tank area.
1301-N Crib and Trench Grouping				
116-N-1	1301-N	1964 - 9/85	Liquid radioactive waste disposal system for N Reactor. Received effluent from reactor coolant system, spent fuel storage basin, periphery coolant systems, various radioactive drain systems in the reactor facility, and various chemicals from laboratory drains. Historical average flow rate of 2,100 gal/min.	Crib and trench.
---	1322-N and 1322-NA Sample Building	1963 - 1991	Irradiated cooling water and water samples from the river bank springs.	Pilot plant treatment facility with sampling points.
UN-100-N-4	1322-N Sump	5/7/77	Approximately 1,500 gal of low-level radioactive wastewater with total activity of 0.5 mCi was released to the ground.	Sump overflow release.
UN-100-N-8	1322-NA Sump	5/11/75	50 to 100 gal of low-level radioactive wastewater with total activity of 0.5 mCi was released to the ground.	Sump overflow release.
UN-100-N-31	1301-N Crib	7/22/74	1,000 gal of radioactive coolant water.	Release through 6-in casing being installed in berm.
1310-N Radioactive Chemical Waste Treatment and Storage Grouping				
116-N-2	1310-N Waste Radioactive Chemical Waste Treatment and Storage Facility	1968 - 1987	Temporary storage of radioactive waste decontamination solution from N Reactor.	Radioactive chemical waste storage facility; waste transferred to 1314-N liquid waste loadout station after cooling and neutralization via piping.
UN-100-N-5	Leak in piping at 1310-N Silo	6/27/72	90,000 gal of low-level radioactive chemical waste from N Reactor decontamination was discharged to the ground.	Underground pipe leak.
UN-100-N-25	1310-N Storage Tank	5/15/75	500 gal of primary loop water and decontamination solution was released to the ground in the radiation zone surrounding the tank.	Vent line discharge on 116-N-2 storage tank.

Table 3-1. 100 N Area Sources. (page 3 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
---	Caustic spill at 1310-N Silo	Spring 1983	Approximately 100 gal of sodium hydroxide.	Spilled during tanker truck unloading to 116-N-2.
124-N-4	Septic tank and drainfield	1963 - 1987	30,000 gal/day of sanitary sewage.	Septic tank and drainfield. Located east of 1310-N storage tank and south of 116-N-1 crib.
1325-N Crib and Trench Grouping				
116-N-3	1325-N	9/85 - 8/93	Liquid radioactive waste disposal system for N Reactor after 116-N-1 ceased operations. Received effluent from reactor coolant system, spent fuel storage basin, periphery coolant systems, various radioactive drain systems in the reactor facility, and various chemicals from laboratory drains. Historical average flow rate of 1,300 gal/min.	Crib and trench.
Burning Pit Grouping				
128-N-1	Burning Pit South of 1325-N Crib	1962 - 1986	Office and lunchroom trash, tumbleweeds were burned using various fuel oils as starters.	Burning pit.
181-N River Pumphouse Grouping				
---	102-in Outfall Line	1963 - present	Secondary cooling water containing a variety of radionuclides.	Discharge pipe extending approximately 400 ft into the Columbia River. NPDES Discharge Point No. 009.
---	102-in Outfall pH Violation	4/18/86	Acidic and caustic regeneration wastewater.	Testing of simultaneous acid and caustic wastewater releases resulted in NPDES pH violations.
---	Aboveground Waste Oil Tank at 181-N	Unknown - circa 1980	Waste oil.	Manages waste oil from pump oil changes.
---	181-N Inlet Screen Backwash Water Outfall	Unknown - present	Backwash water and solids from raw water intake to 100 N. Analyzed for total flow and suspended solids per NPDES permit.	NPDES Discharge Point Number 007.
1304-N Emergency Dump Tank Grouping				
---	1304-N Emergency Dump Tank (EDT)	1973 - 1987	Cooling water containing small amounts of radionuclides.	1.3 Mgal storage tank intended to receive emergency dumpings of thermally hot primary reactor coolant water.

Table 3-1. 100 N Area Sources. (page 4 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
UN-100-N-1	EDT Overflow Line	3/27/74	30,000 gal of cooling water containing 0.2 Ci of radionuclides.	Temporary flow stoppage device malfunctioned during maintenance. Contaminated soil removed.
UN-100-N-29	EDT Bypass Line	4/23/74	100 gal of primary coolant water containing 0.1 Ci of radioactive materials, mostly Mn-56 and Na-24.	Faulty check valve caused the leak. Contaminated soil removed.
UN-100-N-30	EDT Overflow	7/27/74	2,500 gal of irradiated water. Maximum reading of 500 counts per minute.	Overflowed through vacuum breaker vent at top of EDT during filling, stabilized the area. No documented removal.
UN-100-N-32	EDT Bypass Line	9/16/74	500-1,000 gal of primary coolant water. Sample of contaminated soil yielded 20,000 counts per minute.	Faulty check valve (similar to UN-100-N-29). Contaminated soil removed.
UN-100-N-2	FLV-858 valve body relief line	2/19/80	25,000-30,000 gal of radioactively-contaminated water. Less than 1 Ci of radioactivity.	Crack in relief line to 32-in low pressure flash line between EDT and 109-N. Contaminated soil removed.
UN-100-N-7	10-in Drain Line between 105-N and EDT	4/29/85	504,000 gal of irradiated water with unknown levels of radioactivity.	Leak in drain line. Contaminated soil removed.
---	1300-N Emergency Dump Basin	1963 - present	Cooling and blowdown water and sludge containing radionuclides.	One million gal storage basin used for emergency dumping of thermally hot primary reactor coolant water and for blowdown water from 109-N steam generators.
Spacer Storage Silo Grouping				
118-N-1	Spacer Storage Silos	1963 - present	Irradiated fuel spacers.	The silos contained irradiated fuel spacers which came in contact with the reactor fuel rods.
UN-100-N-3	Spacer Transfer Line	3/8/78	360,000 gal of irradiated 105-N fuel storage basin water containing 70 mCi - Co-60, 80 mCi - Sr-90, 250 mCi - Cs-137, 140 mCi - CePr-144, and 0.4 mCi - Pu-239.	Crack in line between 105-N and silos. Contaminated soil removed.
UN-100-N-12	Spacer Transfer Line	2/27/79	250,000 gal of irradiated 105-N fuel storage basin water containing 190 mCi - Co-60, 126 mCi - Sr-90, 396 mCi - Cs-137, 34 mCi - CePr-144, and 0.57 mCi - Pu-239/240.	Similar to UN-100-N-3. Removal of soil undocumented.
124-N-3	107-N Septic System	1982 - present	Sanitary sewage.	Sewage system serving 2-3 employees at 107-N plus construction personnel.

Table 3-1. 100 N Area Sources. (page 5 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
---	Corridor 22 exit	1983 or 1984	Several hundred liters of irradiated filter water.	Discharge to ground. Undocumented.
---	105-N Lift Station Underground Station Tank	1975 - 1990	No. 2 diesel oil.	5,000 gal steel tank which has been removed. No soil contamination found during tank removal.
182-N Underground Storage Tank (UST) Grouping				
182-N-1-DT 182-N-2-DT 182-N-3-DT	182-N Underground Storage Tanks (3)	1970 - 1975, tanks removed December 1990	No. 2 diesel oil.	Three 10,000 to 19,000 gal USTs containing diesel oil for Emergency Diesel pumps, 124-N-3, which have been removed. The sites are scheduled for remediation under UST program.
105-N Spent Fuel Storage Basin Grouping				
---	105-N Spent Fuel Storage Basin	1963 - present	Irradiated cooling water.	Containment basin for storage of spent fuel rods and spacers.
UN-100-N-10	Zone I Gravity Drain Line	5/13/75	Approximately 100 gal of irradiated water containing 1 mCi of radionuclides.	Leaking temporary pump fitting spilled to the ground. Contaminated soil was removed.
UN-100-N-35	Leak in overflow weir drain line	Confirmed on 12/5/86	Unknown amounts of contaminated water from the 105-N fuel storage basin.	Leaking clean out valve from overflow weir. Contamination found in groundwater monitoring wells by the fuel basin.
---	Hanford Generating Plant (HGP) Burn Pit	Unknown - 6/11/89	Paper, wood, and probably trash.	Pit used for burning.
---	Grass Dump	Unknown	Grass; unknown if other wastes were disposed.	Pit for disposal of grass clippings.
---	Construction Debris Dump	Unknown	Construction debris.	Used by J.A. Jones Construction Co. for disposal of construction rubble (e.g., dirt, cement, asphalt, metal, and wood)
182-N High Lift Pumphouse Grouping				
124-N-2	182-N Septic Tank	1963 - present	Sanitary sewage.	Serves personnel from 182-N building.
---	182-N Tank Farm Overflow	1964 - 1990	Overflow water analyzed for temperature, pH, total suspended solids, oil and grease, and chlorine per NPDES permit.	NPDES Discharge Point Number 005 via a 36-in raw water return line.

Table 3-1. 100 N Area Sources. (page 6 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
---	182-N Drain System	1964[1] - 1990	Primarily water analyzed for temperature, pH, total suspended solids, oil and grease per NPDES permit.	NPDES Discharge Point Number 006 via a 42-in raw water return line. Periodic release of low-level radionuclides from emergency core cooling system pumps.
---	Lube Oil Line Leak	2/6/87	5 gal of turbine oil.	Pinhole leak in lube oil line allowed oil to enter secondary steam system. Discharged to river with steam condensate.
Acid/Caustic Storage and Transport System Grouping				
---	108-N Chemical Unloading Facility	1963 - 1990	93% sulfuric acid and 50% sodium hydroxide.	Unloading area for trucks or railcars. Has three above ground sulfuric acid tanks and one aboveground sodium hydroxide tank.
120-N-7	Unloading Station French Drain	1963 - 3/87	93% sulfuric acid and 50% sodium hydroxide.	French drain for receiving incidental spills during railcar or tank truck unloading.
120-N-6	Sulfuric Acid Tank French Drains (5)	1963 - 3/87	93% sulfuric acid.	French drains surrounding acid tanks for containment of incidental spills.
---	108-N Neutralization Pit	1983 - 1990	Waste sulfuric acid.	The unit was used to neutralize waste sulfuric from 108-N floor drains and acid transfer tank drainage.
UN-100-N-15	108-N Unloading Facility	3/20/81	Unknown amount of sulfuric acid and rinsewater.	Transfer line leak during pumping of liquid from 108-N to french drain.
UN-100-N-33	108-N Unloading Facility	11/9/81	Approximately 1,000 gal of sulfuric acid.	Spilled to ground during transfer from railcar to storage tank.
---	108-N Unloading Facility Spill	12/26/87	Approximately 10 gal of sodium hydroxide.	Spilled during transfer from railcar to storage tank.
120-N-5	Acid/Caustic Transfer Trench and Neutralization Unit	1963 - 1990	Sulfuric acid and sodium hydroxide.	Piping trench between 108-N and 163-N and containment vaults.
UN-100-N-34	Acid/Caustic Transfer Trench and Neutralization Unit	5/12/80	Approximately 3,400 gal of sulfuric acid.	Pipeline rupture filled containment vaults and spilled to ground. Acid was neutralized.

Table 3-1. 100 N Area Sources. (page 7 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
---	Acid/Caustic Transfer Trench	9/2/87	Unknown amount of sodium hydroxide.	Leak in piping was contained in trench.
---	Acid/Caustic Transfer Trench	11/9/87	Approximately 200 gal of sulfuric acid spilled and approximately 15 to 30 gal released to ground.	Leak in piping escaped trench through a dry well. Contaminated soil was removed.
120-N-3	163-N Neutralization Pit and French Drain	12/63 - 3/87	Sulfuric acid and sodium hydroxide.	French drain and vault receiving drainage from 163-N acid and caustic day tank area.
120-N-8	163-N Sulfuric Acid Day Tank Vent French Drain	12/63 - 5/13/88	Sulfuric acid.	Tank overflows are vented to the french drain.
---	Regeneration Waste Transport System	1977 - 1993	Acid and caustic regeneration wastes.	Sump and pipeline delivering wastes from 163-N to 1324-N.
---	Regeneration Waste Transport System	6/14/86	Approximately 6,500 gal of acidic regeneration wastes.	Pipeline leak during transfer. Spill was neutralized and contaminated soil was removed.
---	Regeneration Waste Transport System	6/30/86	Approximately 1,000 gal of acidic regeneration wastes.	Pipeline leak during transfer. Spill was neutralized.
124-N-1	163-N Septic Tank	1963 - present	Sanitary sewage.	Serving 163-N, 183-N, 1127-N, and 1128-N buildings.
Mixed Waste Storage Area Grouping				
116-N-8	Mixed Waste Storage Pad	12/86 - present	Radioactively contaminated oil and miscellaneous process chemicals.	Paved and curbed concrete pad for mixed waste storage in drums and miscellaneous containers.
184-N Plant Service Power House				
---	184-N Plant Service Power House	1963 - Present	Hydrocarbons, particulates, sulfur dioxide, sulfur trioxide, carbon monoxide, nitrogen oxide, and aldehydes.	Routine and systematic releases from boiler stacks.
---	184-N Day Tanks	1963 - Present	No. 6 (Bunker C) fuel oil and diesel oil.	Two 35,000 gal fuel oil tanks and one 8,000 gal diesel oil tank surrounded by a containment wall.
UN-100-N-19	Fuel Oil Day Tank at 184-N	4/84	Approximately 2,000 gal of fuel oil.	Tank overflowed during filling. Oil contained within walls and removed.
UN-100-N-21	Diesel Oil Day Tank at 184-N	4/25/86	Approximately 800 gal of diesel oil.	Tank overflowed during filling. Oil removed from containment area.

Table 3-1. 100 N Area Sources. (page 8 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
---	Diesel Oil Day Tank at 184-N	10/9/87	Unknown amount of diesel oil.	Tank overflowed during filling. Oil was removed.
---	166-N - 184-N Piping	1963 - present	No. 6 fuel oil and No. 2 diesel oil.	Underground fuel supply piping.
UN-100-N-18	Diesel oil supply line between 166-N and 184-N	8/73	Approximately 200 gal of diesel oil.	Line leak caused by external corrosion.
UN-100-N-22	Diesel oil supply line near 184-N	6/23/86	Approximately 1,000 gal of diesel oil.	Line leak caused by external corrosion. Contaminated soil removed. Oil detected in groundwater.
UN-100-N-23	Diesel oil supply line near 184-N	1/10/87	Approximately 200 gal of diesel oil.	Line leak caused by external corrosion. Oil detected in groundwater.
---	Fuel oil pipe fitting at 184-N Annex	10/14/87	Unknown amount of fuel oil.	Oil leaked from loose pipe fitting during transfer to boiler. Oil contained and removed.
---	Diesel oil supply line between 166-N and 184-N	4/26/89	A minimum of 300 gal of diesel oil.	Line leak in three places. 46 drums of contaminated soil removed.
Decontamination Drain Line Leak Grouping				
UN-100-N-6	1.5-in Chemical Decontamination Waste Drain Line between 105-N and 116-N-2	9/10/85	Approximately 1,800 gal of irradiated wastewater with 0.2 Ci - Co-60, 0.04 Ci - Mn-54, 0.003 Ci - Ru-103, and 0.003 Ci - Cs-137.	Four locations along line. Contaminated soil removed.
Nonhazardous and Nonradioactive Storage Area				
120-N-4	Storage area	11/85 - present	Nonhazardous and low level radioactive containerized wastes.	Curbed concrete pad for container storage.
100-N-SS-27 100-N-SS-28	1716-N Service Station Underground Storage Tanks	100-N-SS-27 1967 - Dec. 1990; 100-N-SS-28 1976 - July 1991	Unleaded gasoline.	Two 1,000 to 4,000 gal underground storage tanks associated with service station. Tanks have been removed.
Regeneration/Filter Backwash Waste Disposal Area Grouping				
120-N-2	1324-N Surface Impoundment (formerly North Settling Pond)	1986 - 1988	Corrosive regeneration wastes and filter backwash water.	1977 - 1983 unlined settling pond; 1983 - 1986 out of service; 1986 - 1988 lined surface impoundment.
---	South Settling Pond	1977 - 1983	Corrosive regeneration wastes and filter backwash water. Unlined settling pond.	

Table 3-1. 100 N Area Sources. (page 9 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
120-N-1	1324-NA Percolation Pond	1977 - 1993	Corrosive regeneration wastes and filter backwash water. Received corrosive waste from 1977 to 1986, filter backwash from 1977 to 1983, and nonhazardous effluent from 1986 to 1993.	Unlined percolation pond.
130-N-1 (formerly 126-N-1)	Filter Backwash Discharge Pond	1983 - present	Filter backwash water.	Unlined percolation basin.
---	1143-N Paint Shop	Unknown - present	Paint wastes and associated water, spent thinner, spent garnet sand and paint chips.	Paint shops with water scrubber in the paint booth, a solvent accumulation drum, and an outdoor sandblasting area.
Office Septic Tank Area Grouping				
124-N-5	1117-N Septic Tank (Sewer System V)	1981 - Feb. 1987	Sanitary sewage.	Septic tank and drainfield.
124-N-6	1113-N Septic Tank (Sewer System VI)	1979/80 - Feb. 1987	Sanitary sewage.	Septic tank and drainfield.
124-N-7	1115-N Septic Tank (Sewer System VII)	1984 - Feb. 1987	Sanitary sewage.	Septic tank and drainfield.
124-N-8	1134-N Septic Tank (Sewer System VIII)	1983 - 1987	Sanitary sewage.	Septic tank and drainfield.
N-17 Paint Shop Area Grouping				
---	N-17 Paint Shop	Unknown - present	Waste paint, solvents, and oils.	Two waste accumulation drums (one for waste paint, the other for waste oil); sandblasting area.
1120-N Septic Tank Grouping				
124-N-9	1120-N Septic Tank	1985 - present	Sanitary sewage.	Septic tank and drainfield.
100-N Sewer System Grouping				
124-N-10	100 N Sewer System	Feb. 1987 - present	Sanitary sewage.	Central sewer system with three lagoons, sewer trunk line and other pipelines, and lift stations.
UN-100-N-11	Corner of Route 4 north and access road	10/2/75	Radioactive soil and asphalt.	Valve bonnet fell from truck onto road and rolled into adjacent field. Valve bonnet, asphalt, and soil removed.

Table 3-1. 100 N Area Sources. (page 10 of 10)

WIDS Designation Number	Alias/Location	Operational Dates	Waste Description	Unit or Release Description
		Hanford Generating Plant		
---	Diesel Oil Storage Tank	1965 - present	Diesel oil.	20,000 gal underground diesel oil storage tank.
---	HGP Outfall	1966 - present	Wastewater for cooling of closed-loop condenser water.	Permitted NPDES Discharge Point at the 1908-NE Seal Well for condenser cooling water.
---	Settling Pond	1965 - present	Settling pond for condenser pit and service water sumps, demineralizer backwashes, roof and parking lot runoff.	5 gal oil spill (originating at the N Reactor) to pond was cleaned up by personnel from J.A. Jones and United Nuclear Industries in Feb. 1987.
---	Tile Field	Unknown-present	Sanitary sewage and lab wastes.	Septic system and drainfield receiving sanitary sewage and lab wastes.
---	Transformer Yard	1966 - present	Non-PCB oil.	Transformers dripped non-PCB oil to the soil, contaminating a small (one square yard) area.
---	Bone Yard	Unknown - present	Scrap metal and equipment, sandblasting grit, oils.	Laydown yard for retired equipment and scrap; various oil stains and sandblasting grits are evident.
---	Gasoline Storage Tank	1965 - 1989	Leaded and unleaded gasoline.	1,000 gal underground unleaded gasoline storage tank; site assessment at closure indicated no contamination.
	Gasoline Storage Tank	1976 - present	Unleaded gasoline.	1,000 gal underground unleaded gasoline storage tank.
---	Septic Tanks (3)	1965 - present (2) 1965 - 1989 (1)	Sanitary sewage and wash water.	Septic systems at garage, field office building and gate house.

Ci = Curie
mCi = milliCurie
Mgal = million gallons
NPDES = National Pollutant Discharge Elimination System
PCB = Polychlorinated biphenyls
WIDS = Waste Information Data System
Source: DOE-RL 1991b, WHC 1994, and Bechtel Hanford Inc. personnel.

Table 3-2. Contaminants Detected at 166-N Tank Farm (UN-100-N-17) in Soil Samples from Borehole 199-N-8[A].

Analytes	Sample and Sample Interval (ft bls)									
	B07QB7 15-17	B07SX4 19-21.5	B07WV1 24-26.5	B07WV5 29-31	B07WV7 49-51	B07WX0 54-56	B07WX1 59-61	B07WX2 64-66	B07WX3 69-71	B07WX4 72.4-74
Volatile organic compounds (µg/kg)										
Acetone	8J	11	16	13	-	-	-	-	2800	23
2-Butanone	-	-	-	-	4	-	-	-	-	-
Toluene	-	1J	-	-	-	-	-	-	-	-
Benzene	-	-	-	-	-	190J	-	-	-	-
Ethylbenzene	-	-	-	-	-	-	-	-	330J	-
Xylene	-	-	-	-	-	-	730J	1300J	890J	-
Semi-volatile organic compounds (µg/kg)										
Naphthalene	-	-	-	-	-	-	-	1300	4100	-
2-Methylnaphthalene	-	-	-	-	-	370	5100	1300	13000	44J
Fluorene	-	-	-	-	-	-	1700J	-	-	-
Phenanthrene	-	-	-	-	-	-	2500J	-	-	-
Anthracene	-	-	-	-	-	-	-	3100	6300	-
Pyrene	-	-	-	-	-	-	-	220J	240J	-
Di-n-butylphthalate	78J	71J	140J	93J	-	-	-	-	-	420
Radionuclides (pCi/g)										
Gross alpha	-	-	7.0J	-	-	-	-	7.9J	-	-
Gross beta	6.9J	8.6J	-	-	9.2J	9.5J	7.5J	18	14	12
Uranium-233/234	0.50	0.46	0.40	0.55	0.30	0.22J	0.28J	0.34	0.33	0.36
Uranium-238	0.50	0.41	0.36	0.38	0.42	0.20J	0.35	0.46	0.29J	0.29J
Strontium-90	-	-	-	-	-	-	-	0.61J	0.56J	1.1J
Potassium-40	11	8.9	8.9	9.0	11	15	15	16	15	9.9
Cobalt-60	-	-	-	-	-	-	1.3	0.62	0.26	-
Radium-226	0.36	0.35	0.30	0.37	0.37	0.41	0.44	0.49	0.48	0.26
Thorium-228	0.58	0.49	0.54	0.74	0.48	0.48	0.90	1.0	1.1	0.37
Thorium-232	0.69	0.53	0.53	0.54	0.48	0.77	0.64	1.2	0.73	-

[A] = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limits (UTL) values are shown (DOE-RL 1994g).
J = Detected value is considered to be an estimate due to quality control deficiencies. - = Not detected
Source: DOE-RL 1994c

Table 3-3. Soil Gas Field Screening Results at the 100-NR-1 Fuel Storage Facilities.

Probe Number	Depth (m)	EnSys	GasTech 1314		OVM 580B
		TPH (ppm)	CG (ppm)	O_2 (%)	VOC (ppm)
166N-SG-1	1.5	>1,000	50	17.5	8.4
166N-SG-2	1.7	<100	30	18.5	1.4
166N-SG-3	1.5	<100	25	18.8	0.2
166N-SG-4	1.0	No sample	0	21.0	0
166N-SG-4A	1.2	No sample	<5	20.5	3.8
166N-SG-5	1.6	Not tested	45	18.0	0.2
166N-SG-6	1.6	No sample	45	19.0	0.3
166N-SG-7	1.6	100 - 1,000	50	18.0	0.3
166N-SG-8	2.0	No sample	55	16.5	0.6
166N-SG-9	1.8	100 - 1,000	55	15.8	1.7
166N-SG-10	1.8	<100	50	17.5	0.1
166N-SG-11	1.5	100 - 1,000	40	18.5	0.4

TPH = Total petroleum hydrocarbons
CG = Combustible gas
VOC = volatile organic compounds
Source: WHC 1992a

Table 3-4. Contaminants Detected in 199-N-75 Soil Samples[A].

Analytes	Sample and Sample Interval (ft bls)				
	B06837 2-3	B06838 5-6	B06839 6-9	B06843/RE 56-58	B06845 68-70
Volatile organic compounds (μg/kg)					
Methylene chloride	4J	4J	4	28	5J
Acetone	17J	8J	22	51J	20J
Carbon disulfide	-	1J	-	2J	-
Toluene	2J	-	-	-	-
Semi-volatile organic compounds (μg/kg)					
N-nitrosodiphenylamine	-	-	110J	-	-
Di-n-butylphthalate	51J	42J	-	76J	110J
bis(2-ethylhexyl)phthalate	-	-	-	-	61J
Metals (mg/kg)					
Cadmium	-	0.618	0.49B	-	-
Radionuclides (pCi/g)					
Gross beta	12J	8.7J	37	430	250
Uranium-233/234	-	-	-	0.62	0.69
Uranium-238	0.55	0.50	0.73	0.47	-
Strontium-90	-	-	-	190	120
Potassium-40	10	11	9.4	13	12
Cobalt-60	-	-	-	0.52	0.28
Radium-226	-	0.35	0.49	0.35	0.35
Thorium-228	0.55	0.70	0.67	0.47	0.59
Thorium-232	0.42	0.52	0.72	0.39	0.62
Technetium-99	0.44	-	-	-	-

A = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g)
B = Inorganic analyte concentration is greater than the instrument detection limit (IDL), but less than the contract required detection limit (CRDL).
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
Source: DOE-RL 1994c

Table 3-5. Contaminants Detected in 199-N-76 Soil Samples[A].

Analytes	Sample and Sample Interval (ft bls)					
	B06835 2-3	B06836 5-6	B06840 24-25	B06841 24-25	B06842/RE 55-57	B06844 64.5-66.5
Volatile organic compounds (μg/kg)						
Methylene chloride	3J	8J	3J	4J	55	63
Acetone	12J	-	31J	40J	120J	140J
Carbon disulfide	-	-	-	-	-	8J
4-methyl-2-pentanone	-	-	-	-	-	7J
Toluene	-	-	-	-	-	3J
Semi-volatile organic compounds (μg/kg)						
Di-n-butylphthalate	63J	56J	56J	-	100J	99J
bis(2-ethylhexyl)phthalate	-	-	530J	-	-	63J
Metals (mg/kg)						
Cadmium	-	0.52B	-	-	-	0.9B
Radionuclides (pCi/g)						
Gross alpha	3.5J	-	-	-	-	-
Gross beta	18	8.6J	14J	36	650	-
Americium-241	0.024	-	-	-	-	-
Uranium-233/234	-	-	-	-	1.2	-
Uranium-238	0.82	0.46	0.53	0.52	0.61	0.54
Strontium-90	1.0	-	-	-	320	2.0
Potassium-40	9.4	9.3	8.8	7.6	14	11
Cobalt-60	-	-	-	-	2.0	0.18
Radium-226	0.34	0.26	0.33	0.43	0.46	0.40
Thorium-228	0.62	0.41	0.52	0.59	0.63	0.50
Thorium-232	0.69	0.43	-	-	0.67	0.46
Technetium-99	1.0	-	0.43J	-	-	-

A = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g)
B = Inorganic analyte concentration is greater than the instrument detection limit (IDL), but less than the contract required detection limit (CRDL).
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
Source: DOE-RL 1994c

Table 3-6. Contaminants Detected in 199-N-80 Soil Samples[A].

Analytes	Sample and Sample Interval (ft bls)							
	B06M58 3-5	B06M60 44-46	B06M61 44-46	B06M62 50-52	B072P4 61-63	B072P5 70-72	B072P7 75-77	B072P9 96-99
Volatile organic compounds (μg/kg)								
Methylene chloride	-	6J	-	-	-	-	-	5J
Acetone	-	23J	-	9J	16	-	-	-
Toluene	-	4J	-	-	-	3J	7J	6J
2-Butanone	-	-	-	-	-	-	-	8J
Semi-volatile organic compounds (μg/kg)								
Di-n-butylphthalate	-	44J	-	-	-	-	-	-
bis(2-ethylhexyl)phthalate	-	-	260J	-	-	-	-	-
Radionuclides (pCi/g)								
Gross alpha	NR	NR	NA	6.9	NR	NR	-	-
Gross beta	11J	19	NA	75	130	200	93	20
Uranium-233/234	0.46	NR	NA	0.18	0.33	0.36	0.37	0.33
Uranium-235	-	NR	NA	-	0.017	NR	-	-
Uranium-238	0.52	NR	NA	0.21	NR	0.35	0.35	0.27J
Plutonium-238	-	-	NA	0.015	-	NR	-	-
Plutonium-239/240	-	-	NA	0.002	-	NR	-	-
Strontium-90	-	-	NA	25	52	81	43	1.6
Carbon-14	-	-	NA	4.2	-	-	-	-
Potassium-40	7.4	13	NA	9	12	13	14	12
Cobalt-60	-	-	NA	-	0.41	0.23	0.13	-
Radium-226	0.29	0.51	NA	0.38	0.27	0.34	0.43	0.41
Thorium-228	0.44	1.1	NA	0.47	0.49	0.63	0.75	0.81
Thorium-232	0.43	0.67	NA	-	-	0.59	0.8	0.62

[A] = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g)
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
NR = Not reported
NA = Sample not analyzed for this constituent
Source: DOE-RL 1994c

Table 3-7. Contaminants Detected at 1322-NA in Surface Soil Samples and Samples from Borehole 199-N-86[A].

Analytes	Sample and Sample Interval (ft bls)								
	B085H5 Surface	B085H6 Surface	B085H7 Surface	B085H8 Surface	B085H9 Surface	B085J0 Surface	B07QB8 9-11.5	B07QB9 15-17.5	B07QC0 20-22.5
Volatile organic compounds (µg/kg)									
Toluene	-	-	-	-	-	-	-	2J	-
Methylene chloride	-	-	-	-	-	-	6J	6J	5J
Semi-volatile organic compounds (µg/kg)									
Dimethylphthalate	-	-	-	-	-	46J	-	-	-
Phenanthrene	-	-	-	-	-	95J	-	-	-
Di-n-butylphthalate	-	-	-	21J	-	-	-	-	-
Fluoranthene	-	-	-	-	-	99J	-	-	-
Pyrene	-	-	-	-	-	110J	-	-	-
Benzo(a)anthracene	-	-	-	-	-	63J	-	-	-
bis(2-ethylhexyl)phthalate	36J	-	-	-	-	48J	-	-	-
Chrysene	-	-	-	-	-	62J	-	-	-
Benzo(b)fluoranthene	-	-	-	-	-	69J	-	-	-
Polychorinated biphenyls (µg/kg)									
Aroclor 1260	980J	1500J	440J	460	3000J	590J	-	-	-
Metals (mg/kg)									
Copper	<	<	<	<	<	29.8	<	<	<
Lead	15.6J	15.3J	<	<	<	15.8J	<	<	<
Zinc	<	<	<	<	<	91.6	<	<	<
Radionuclides (pCi/g)									
Gross alpha	9.7	-	-	NA	8J	NR	-	-	11
Gross beta	27	20	9.4J	NA	11	31	21	38	9.1J
Uranium-233/234	0.64	0.35	0.27J	NA	0.63	0.6	0.37	-	0.29J
Uranium-238	0.71	0.52	0.38J	NA	0.73	0.65	0.35J	0.22J	0.29J
Plutonium-239/240	NR	NR	-	NA	-	0.064J	-	-	-
Americium-241	-	-	-	NA	-	0.039J	-	-	-
Strontium-90	2.4	1.7J	-	NA	-	1.1J	-	8	-
Potassium-40	12	12	5.7	NA	13	9.2	17	6.9	9.4
Cobalt-60	0.93	0.95	0.16	NA	0.43	7	0.98	-	-
Cesium-137	1.3	1.2	0.083	NA	0.17	1.5	-	-	-
Radium-226	0.652	0.43	0.24	NA	0.54	0.43	0.54	0.37	0.39
Thorium-228	0.78	0.72	0.36	NA	1.0	0.51	1.2	0.47	0.54
Thorium-232	0.95	0.79	0.28	NA	0.79	0.57	0.9	0.49	0.44

A = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g).
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
< = Concentration less than Hanford Site 95% UTL values of 28.2 mg/kg for copper, 14.17 mg/kg for lead, and 79 mg/kg for zinc (DOE-RL 1994g).
NA = Not analyzed
N = Not reported
Source: DOE-RL 1994c

Table 3-8. Contaminants Detected at 116-N-2 in Soil Samples from Surface and Borehole 199-N-87[A].

Analytes	Sample and Sample Interval (ft bls)						
	B085H2 Surface	B085H3 Surface	B085H4 Surface	B07QD7 0-2	B07QD8 9-11.5	B07QD9 13.5-16	B07QF0 18.5-21
Volatile organic compounds (μg/kg)							
Methylene chloride	-	-	-	2J	2J	-	-
2-Butanone	-	7J	-	-	-	-	-
1,1,1-Trichloroethane	-	-	-	2J	-	-	-
Toluene	-	1J	-	-	1J	-	-
Semi-volatile organic compounds (μg/kg)							
1,4-Dichlorobenzene	51J	-	-	-	-	-	-
Diethylphthalate	-	-	78J	-	-	-	-
Phenanthrene	-	150J	-	-	-	-	-
Anthracene	-	38J	-	-	-	-	-
Fluoranthene	-	260J	99J	-	-	-	-
Pyrene	-	320J	130J	-	-	-	-
Benzo(a)anthracene	-	140J	85J	-	-	-	-
Chrysene	-	120J	78J	-	-	-	-
Benzo(b)fluoranthene	-	120J	73J	-	-	-	-
Benzo(a)pyrene	-	53J	40J	-	-	-	-
Polychlorinated biphenyls (μg/kg)							
Aroclor 1254	35J	-	30J	-	-	-	-
Aroclor 1260	22J	-	-	-	-	-	-
Metals and Anions (mg/kg)							
Lead	171	<	<	<	<	<	<
Sulfate	<	<	<	<	2040J	<	<
Radionuclides (pCi/g)							
Gross alpha	9.5J	-	6.5J	NR	8.5J	NR	3.4
Gross beta	58	18	21	30	14	8.9J	8.9J
Uranium-233/234	0.56	0.39	0.65	0.35	0.46	0.48	0.48
Uranium-238	0.56	0.5	0.46	0.34J	0.59J	0.4J	0.33J
Plutonium-239/240	0.056J	-	-	0.15	-	-	-
Americium-241	0.062	-	-	0.025J	-	-	-
Potassium-40	11	14	13	13	16	7.7	8.3
Cobalt-60	100	5.5	10	81	4.3	-	-
Cesium-137	3.8	-	0.3	0.61	-	-	-
Radium-226	-	0.67	0.45	0.67	0.55	0.36	0.31
Thorium-228	0.68	1.2	0.94	-	1.0	0.6	0.51
Thorium-232	-	0.84	0.72	-	1.1	0.41	0.47
Technetium-99	0.44	-	-	-	-	-	-

[A] = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limits (UTL) values are shown (DOE-RL 1994g).
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
NR = Not reported
< = Concentration less than the Hanford Site 95% UTL values; 14.75 mg/kg for lead, and 1320 mg/kg for sulfate.
Source: DOE-RL 1994c

Table 3-9. Average Annual Concentrations of Radionuclides (pCi/L) Detected in Water Samples from the 1300-N EDB for 1978 through 1985.

Radionuclide	1978	1979	1980	1981	1982	1983	1984	1985
K-40	4.2E1	---	---	---	---	---	---	---
Mn-54	5.1E1	1.5E4	4.1E3	1.0E3	2.7E3	7.1E3	4.1E2	---
Fe-59	---	7.4E3	1.0E3	---	---	---	---	---
Co-58	---	1.1E3	4.8E2	---	---	---	---	---
Co-60	1.1E3	4.8E4	2.0E4	1.3E4	7.5E4	3.4E5	3.6E4	3.1E2
ZrNb-95	---	1.6E3	2.4E3	---	---	---	9.9E1	---
Ru-103	---	2.0E2	6.6E2	---	---	3.5E2	---	---
Sb-124	---	3.4E2	---	---	---	---	---	---
I-131	2.1E2	3.8E3	3.7E2	5.5E2	---	---	2.9E2	---
Cs-137	1.6E2	2.0E2	2.4E2	4.2E2	1.3E3	8.8E3	1.0E3	9.0E1
BaLa-140	5.9E2	4.7E3	1.3E3	5.6E2	---	---	3.3E2	---
Total	2.2E3	8.2E4	3.1E4	1.6E4	7.9E4	3.5E5	3.8E4	4.0E2
Source: Jacques 1985								

Table 3-10. 163-N Demineralization Plant Regeneration Effluent Waste Analysis Cation Regeneration Cycle.

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	0.894	0.936	0.922	0.917
Conductivity (μmhos)	37,000	40,100	35,000	37,367
Mercury (0.0001 ppm)	LD	LD	LD	LD
Ethylene glycol (10 ppm)	LD	LD	LD	LD
Enhanced thiourea (0.2 ppm)	LD	LD	LD	LD
TOC (1 ppm)	0.0013	0.0019	0.0018	0.0016
Cyanide (0.01 ppm)	LD	LD	LD	LD
Barium (0.006 ppm)	0.030	0.023	0.020	0.024
Cadmium (0.002 ppm)	0.003	0.002	0.003	0.003
Chromium (0.01 ppm)	LD	LD	LD	LD
Lead (0.03 ppm)	LD	LD	LD	LD
Silver (0.01 ppm)	LD	LD	LD	LD
Sodium (0.1 ppm)	12.2	16.5	9.6	12.8
Nickel (0.01 ppm)	LD	LD	LD	LD
Copper (0.01 ppm)	LD	LD	LD	LD
Vanadium (0.005 ppm)	0.025	0.027	0.020	0.024
Antimony (0.1 ppm)	LD	LD	LD	LD
Aluminum (0.15 ppm)	0.725	0.842	0.655	0.741
Manganese (0.005 ppm)	0.027	0.035	0.027	0.030
Potassium (0.1 ppm)	12.2	15.5	14.8	14.2
Iron (0.05 ppm)	1.1	1.2	1.0	1.1
Beryllium (0.005 ppm)	LD	LD	LD	LD
Osmium (0.3 ppm)	LD	LD	LD	LD
Strontium (0.3 ppm)	1.3	1.4	1.2	1.3
Zinc (0.005 ppm)	0.016	0.024	0.067	0.036
Calcium (0.05 ppm)	282.6	347.4	324.9	318.3
Nitrate (0.5 ppm)	1.0	0.5	0.8	0.8
Sulphate	2,310	4,271	2,952	3,201
Fluoride (0.5 ppm)	LD	LD	LD	LD
Chloride (0.5 ppm)	2.0	1.8	1.9	1.9
Phosphate (1 ppm)	LD	LD	LD	LD
Phosphorus pesticides (0.005 ppm)	LD	LD	LD	LD
Chlorinated pesticides (0.001 ppm)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 ppm)	LD	LD	LD	LD
Arsenic (0.005 ppm)	LD	LD	LD	LD
Ammoniun ion (0.05 ppm)	LD	LD	LD	LD
Coliform (3 MPN)	LD	LD	LD	LD
Selenium (0.005 ppm)	LD	LD	LD	LD
Thallium (0.01 ppm)	LD	LD	LD	LD
Enhanced VOA (10 ppm)	26	28	26	27

LD = less than detectable
MDL = minimum detection limit
MPN = most probable number.
ppm = parts per million
Data obtained from samples taken August 1985.

Source: WHC 1987c

Table 3-11. 163-N Demineralization Plant Regeneration Waste Analysis Anion Regeneration Cycle.

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	13.72	13.74	13.77	13.74
Conductivity (μmhos)	62,000	60,000	70,000	64,000
Mercury (0.0001 ppm)	0.00018	0.00013	0.00019	0.00017
Ethylene glycol (10 ppm)	LD	LD	LD	LD
Enhanced thiourea (0.2 ppm)	LD	LD	LD	LD
TOC (1 ppm)	462	499	456	472
Cyanide (0.01 ppm)	0.010	0.015	LD	0.013
Barium (0.6 ppm)	LD	LD	LD	LD
Cadmium (0.2 ppm)	LD	LD	LD	LD
Chromium (1 ppm)	LD	LD	LD	LD
Lead (0.2 ppm)	LD	LD	LD	LD
Silver (1 ppm)	LD	LD	LD	LD
Sodium (0.1 ppm)	26,910	28,200	26,330	27,150
Nickel (1 ppm)	LD	LD	LD	LD
Copper (1 ppm)	LD	LD	LD	LD
Vanadium (0.5 ppm)	LD	LD	LD	LD
Antimony (10 ppm)	LD	LD	LD	LD
Aluminum (15 ppm)	LD	LD	LD	LD
Manganese (0.5 ppm)	LD	LD	LD	LD
Magnesium (5 ppm)	LD	LD	LD	LD
Potassium (10 ppm)	26.5	27.2	26.3	26.7
Iron (5 ppm)	LD	LD	LD	LD
Beryllium (0.5 ppm)	LD	LD	LD	LD
Osmium (30 ppm)	LD	LD	LD	LD
Strontium (30 ppm)	LD	LD	LD	LD
Zinc (0.5 ppm)	LD	LD	LD	LD
Calcium (5 ppm)	LD	LD	LD	LD
Nitrate (0.5 ppm)	1.0	1.4	0.9	1.1
Sulphate (0.5 ppm)	30.9	30.6	30.6	30.7
Fluoride (0.5 ppm)	LD	LD	LD	LD
Chloride (0.5 ppm)	2.5	2.3	2.3	2.4
Phosphate (1 ppm)	LD	LD	LD	LD
Phosphorus pesticides (0.005 ppm)	LD	LD	LD	LD
Chlorinated pesticides (0.001 ppm)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 ppm)	LD	LD	LD	LD
Arsenic (0.2 ppm)	LD	LD	LD	LD
Ammoniun ion (0.05 ppm)	2.3	2.7	2.8	2.6
Coliform (2.2 MPN)	LD	LD	LD	LD
Selenium (0.002 ppm)	LD	LD	LD	LD
Thallium (0.4 ppm)	LD	LD	LD	LD
Enhanced VOA (10 ppm)	26	28	26	27

LD = less than detectable
MDL = minimum detection limit
MPN = most probable number.
ppm = parts per million
Data obtained from samples taken August 1985.

Source: WHC 1987c

Table 3-12. 183-N Filtered Water Plant Backwash Effluent Analysis.

Parameters (MDL)	Sample			Average
	1	2	3	
pH (standard units)	7.08	7.65	7.64	7.46
Conductivity (μmhos)	160	150	150	153
Mercury (0.001 ppm)	LD	LD	LD	LD
Ethylene glycol (10 ppm)	LD	LD	LD	LD
Enhanced thiourea (0.2 ppm)	LD	LD	LD	LD
TOC (1 ppm)	0.00277	.002175	0.002257	0.002404
Cyanide (0.01 ppm)	LD	LD	LD	LD
Barium (0.006 ppm)	0.030	0.031	0.030	0.030
Cadmium (0.002 ppm)	0.004	0.002	0.002	0.003
Chromium (0.01 ppm)	LD	LD	LD	LD
Lead (0.03 ppm)	LD	LD	LD	LD
Silver (0.01 ppm)	LD	LD	LD	LD
Sodium (0.1 ppm)	2.202	2.287	2.186	2.225
Nickel (0.01 ppm)	LD	LD	LD	LD
Copper (0.01 ppm)	LD	LD	LD	LD
Vanadium (0.005 ppm)	LD	LD	LD	LD
Antimony (0.1 ppm)	LD	LD	LD	LD
Aluminum (0.15 ppm)	0.392	0.389	0.376	0.386
Manganese (0.005 ppm)	0.020	0.015	0.014	0.016
Potassium (0.1 ppm)	0.799	0.814	0.762	0.792
Iron (0.05 ppm)	LD	LD	LD	LD
Beryllium (0.005 ppm)	LD	LD	LD	LD
Osmium (0.3 ppm)	LD	LD	LD	LD
Strontium (0.3 ppm)	LD	LD	LD	LD
Zinc (0.005 ppm)	LD	LD	LD	LD
Calcium (0.05 ppm)	17.340	17.720	17.020	17.360
Nitrate (0.5 ppm)	0.789	0.500	0.500	0.596
Sulphate (0.5 ppm)	18.900	20.980	19.110	19.663
Fluoride (0.5 ppm)	LD	LD	LD	LD
Chloride (0.5 ppm)	2.846	2.671	2.901	0.2806
Phosphate (1 ppm)	LD	LD	LD	LD
Phosphorus pesticides (0.005 ppm)	LD	LD	LD	LD
Chlorinated pesticides (0.001 ppm)	LD	LD	LD	LD
Enhanced ABN List	LD	LD	LD	LD
Citrus Red (1 ppm)	LD	LD	LD	LD
Arsenic (0.005 ppm)	LD	LD	LD	LD
Ammoniun ion (0.05 ppm)	LD	LD	LD	LD
Coliform (3 MPN)	0.240	2.400	0.2400	1.680
Selenium (0.005 ppm)	LD	LD	LD	LD
Thallium (0.01 ppm)	LD	LD	LD	LD
Enhanced VOA (10 ppm)	---	0.024	0.025	0.025

LD = less than detectable
MDL = minimum detection limit
MPN = most probable number.
ppm = parts per million
Data obtained from samples taken August 1985.

Source: WHC 1987c

Table 3-13. Contaminants Detected at 120-N-1 in Soil Samples from Surface and Test Pit[A].

Analytes	Sample and Sample Interval (ft bls)							
	B07Q52 Surface	B07Q53 Surface	B07Q54 Surface	B07Q58 15	B07Q70 65	B07Q71 65	B07Q72 65	B07Q73 70
Volatile organic compounds (µg/kg)								
Benzene	-	-	-	1J	-	-	-	-
Toluene	7J	8J	-	-	-	-	1J	2J
Chloroform	-	-	-	-	-	2J	-	-
Méthylène chloride	4J	-		-	-	-	-	2J
Semi-volatile organic compounds (µg/kg)								
Di-n-butylphthalate	-	-	90J	-	29J	-	-	-
bis(2-ethylhexyl)phthalate	-	-	58J	-	33J	-	-	-
Metals (mg/kg)								
Copper	<	28.7	<	<	<	<	<	<
Zinc	<	94.4	<	<	<	<	<	<

[A] = All detected concentrations of organic compounds are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g). Samples were not analyzed for radionuclides.
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
< = Concentration less than the Hanford Site 95% UTL value of 28.2 mg/kg for copper, and 79 mg/kg for zinc.
Source: DOE-RL 1994c

Table 3-14. Contaminants Detected at South Settling Pond in Soil Samples from Surface and from Borehole 199-N-88[A].

Analytes	Sample and Sample Interval (ft bls)															
	B07Q87 Surface	B07Q88/RE 4-5	B07Q90 14-16	B07Q91 19-21	B07Q92 24-26	B07Q93 29-31	B07Q94 34-36	B07Q95 39-41	B07Q96 44-46	B07Q97 44-46	B07Q98 49-51	B07Q99 54-56	B07QB0 59-61	B07QB1 64-66	B07QB2 69.5-70.5	B07Q83 76-78
Volatile organic compounds (μg/kg)																
Methylene chloride	23	17	-	3J	3J	10J	9J	3J	3J	-	2J	3J	9J	10J	4J	9J
Acetone	-	-	54	28	25J	-	-	-	-	-	-	-	-	-	-	-
Toluene	3J	2J	52	8J	-	-	-	-	-	-	-	-	-	-	-	-
Semi-volatile organic compounds (μg/kg)																
bis(2-ethylhexyl) phthalate	-	-	-	-	-	-	-	-	-	150J	-	-	-	-	-	-
di-n-butyl phthalate	-	170J	-	-	-	-	-	-	-	150J	-	-	84J	-	-	-
diethyl phthalate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	120J
Metals (mg/kg)																
Manganese	<	<	<	<	<	<	<	<	<	<	<	<	<	702	<	<

[A] = All detected concentrations of organic compounds shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g). Samples not analyzed for radionuclides.
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
< = Concentration less than Hanford Site 95% UTL values of 702 mg/kg for manganese (DOE-RL 1994c).
Source: DOE-RL 1994

Table 3-15. Contaminants Detected at 120-N-2 in Soil Samples from Borehole 199-N-89[A].

Analytes	Sample and Sample Interval (ft bls)														
	B07QB5 0-2	B07QB6 4-6.5	B07SW7 10-11.5	B07SW8 14-16	B07SW9 19-21	B07SX0 24-26	B07SX1 29-31	B07SX2 34-36	B07SX3 39-41	B07WV0 44-46	B07WV2 51-53	B07WV3 55-57	B07WV4 58-60	B07WV8 69-71	B07WV9 74-76
Volatile organic compounds (µg/kg)															
Methylene chloride	2J	2J	-	-	-	-	-	-	-	-	-	-	-	3J	5J
2-Butanone	-	-	-	-	-	-	-	-	4J	-	-	-	-	-	-
2-Hexanone	-	-	-	-	-	-	-	-	1J	-	-	-	-	-	-
Toluene	4J	11	1J	-	-	-	-	-	2J	-	1J	-	2J	-	1J
Xylene	-	-	-	-	-	-	-	-	2J	-	-	-	-	-	-
Acetone	-	-	-	-	-	-	-	-	-	-	-	-	-	16	23
Chloroform	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3J
Semi-volatile organic compounds (µg/kg)															
Di-n-butyl phthalate	-	-	86J	72J	68J	110J	100J	76J	100J	89J	96J	92J	92J	230J	-
bis (2-ethyl hexyl) phthalate	-	55J	-	-	-	-	-	-	-	-	-	-	-	-	-
Diethyl phthalate	-	-	-	-	-	-	-	-	-	-	-	-	-	48J	-
Metals (mg/kg)															
Cadmium	<	<	3.1	<	<	<	<	<	<	<	<	<	<	<	<
Copper	<	<	31.5	<	<	<	<	<	<	<	<	<	<	<	<

[A] = All detected concentrations of organic compounds and radionuclides are shown, only inorganic constituents that exceed the Hanford Site 95% Upper Threshold Limit (UTL) values are shown (DOE-RL 1994g)
J = Detected value is considered to be an estimate due to quality control deficiencies.
- = Not detected
< = Concentration less than the Hanford Site 95% UTL value of 28.2 mg/kg for copper, and 0.24 mg/kg for cadmium.
Source: DOE-RL 1994c

Table 3-16. Summary Statistics - Background Samples (Soil - Total Metals) for the 120-N-1/120-N-2 Area.

Analyte	No. of GT DL Values	No. of LT DL Values	Mean (ppm)	Median (ppm)	Std Dev (ppm)	CV (I)	Minimum (ppm)	Maximum (ppm)
Aluminum	13	0	4902.31	4870	581.165	11.85	3720	6240
Antimony	0	13	BDL	BDL	NA	NA	BDL	BDL
Arsenic	13	0	0.99	0.88	0.302	30.51	0.69	1.78
Barium	13	0	50.22	49.40	4.737	9.43	44.10	58.20
Beryllium*	2	11	0.07	BDL	0.419	98.57	BDL	0.80
Calcium	13	0	7060.77	7230	911.212	12.91	5440	8120
Chromium	13	0	3.57	3.50	0.891	24.96	2.30	5.00
Cobalt	13	0	8.97	9.10	0.646	7.20	8.00	9.70
Cadmium	13	0	7.03	7.10	0.571	8.12	6.10	7.90
Copper	13	0	16.69	16.50	1.019	6.11	15.10	19.10
Iron	13	0	26346.20	27200	2174.710	8.25	21900	29000
Lead	6	0	2.83	2.84	0.200	7.07	2.58	3.15
Lithium	0	13	BDL	BDL	NA	NA	BDL	BDL
Magnesium	13	0	5085.38	5020	348.033	6.84	4590	5700
Manganese	13	0	284.54	290	36.477	12.82	227	350
Mercury	0	13	BDL	BDL	NA	NA	BDL	BDL
Molybdenum	0	13	BDL	BDL	NA	NA	BDL	BDL
Nickel	13	0	7.41	7.30	1.059	14.29	5.70	8.80
Potassium	13	0	681.62	675	128.674	18.88	455	931
Silver	0	13	BDL	BDL	NA	NA	BDL	BDL
Sodium	13	0	298.46	298	46.157	15.47	226	370
Strontium	13	0	20.95	20.00	3.963	18.92	16.30	27.40
Tin	0	13	BDL	BDL	NA	NA	BDL	BDL
Titanium	13	0	2139.23	2270	289.150	13.52	1700	2540
Vanadium	13	0	52.46	56.60	8.487	16.18	41.70	64.60
Zinc	13	0	38.16	38.20	3.305	8.66	33.40	44.80
Zirconium	13	0	27.35	27.70	2.274	8.31	24.20	31.00

Source: Chou 1989

Table 3-17. Summary Statistics - Background Samples (Soil - Non-Metal) for the 120-N-1/120-N-2 Area.

Analyte	No. of GT DL Values	No. of LT DL Values	Mean (ppm)	Median (ppm)	Std Dev (ppm)	CV (%)	Minimum (ppm)	Maximum (ppm)
Ammonium*	4	7	0	BDL	1.386	NA	BDL	2.50
Boron	0	13	BDL	BDL	NA	NA	BDL	BDL
Bromide	0	13	BDL	BDL	NA	NA	BDL	BDL
Chloride	0	13	BDL	BDL	NA	NA	BDL	BDL
Chloride	0	13	BDL	BDL	NA	NA	BDL	BDL
Conductivity	4	0	21.25	21	3.775	17.76	17	26
Cyanide	0	16	BDL	BDL	NA	NA	BDL	BDL
EOX	0	12	BDL	BDL	NA	NA	BDL	BDL
Fluoride	0	17	BDL	BDL	NA	NA	BDL	BDL
Nitrate	0	17	BDL	BDL	NA	NA	BDL	BDL
Nitrite	0	17	BDL	BDL	NA	NA	BDL	BDL
pH	11	0	8.38	8.40	0.108	1.29	8.20	8.60
Phosphate	0	13	BDL	BDL	NA	BA	BDL	BDL
Selenium	0	6	BDL	BDL	NA	NA	BDL	BDL
Silicon	13	0	638.62	647	169.228	26.50	439	1040
Sulfate	0	13	BDL	BDL	NA	NA	BDL	2.51
Sulfide	0	13	BDL	BDL	NA	NA	BDL	BDL
TOC	0	3	BDL	BDL	NA	NA	BDL	BDL

GT = Greater than
LT = Less than
DL = Detection limit
BDL = Below detection limit
NA = Not available
CV = Coefficient of variation
TOC = Total organic carbon
* = Summary statistics are estimated by Cohen's method.

Source: Chou 1989

Table 3-18. Summary Statistics - Background Samples (Radiochemical) for the 120-N-1/120-N-2 Area.

Analyte	No. of GT DL Values	No. of LT DL Values	Mean (pCi/g)	Median (pCi/g)	Std Dev (pCi/g)	CV (%)	Minimum (pCi/g)	Maximum (pCi/g)
Lo-Alpha	3	14	NA	BDL	NA	NA	BDL	1.89
Beta	17	03	6.861	6.800	0.891	12.99	5.520	8.870
Co-60	0	14	BDL	BDL	NA	NA	BDL	BDL
Cs-134	0	14	BDL	BDL	NA	NA	BDL	BDL
Cs-137DA	0	13	NA	BDL	NA	NA	BDL	0.0238
Eu-154	0	14	BDL	BDL	NA	NA	BDL	BDL
Eu-155	1	13	BDL	BDL	NA	NA	BDL	0.205
K-40	14	02	9.256	9.355	1.029	11.12	6.800	11.300
Pb-212	14	07	0.480	0.490	0.066	13.75	0.316	0.595
Pb-214	14	07	0.375	0.382	0.047	12.53	0.282	0.443
Ru-106DA	0	14	BDL	BDL	NA	NA	BDL	BDL
ZnNb-95	0	14	BDL	BDL	NA	NA	BDL	BDL
U-Chem (μg/g)	3	0	0.447	0.444	0.025	5.59	0.424	0.473

GT = Greater than
LT = Less than
DL = Detection limit
BDL = Below detection limit
NA = Not available
CV = Coefficient of variation

Source: Chou 1989

Table 3-19. Summary Statistics - Background Samples for the 120-N-1/120-N-2 Area.

Analyte	No. of GT DT Values	No. of LT DL Values	Mean (ppb)	Median (ppb)	Std Dev (ppb)	CV (I)	Minimum (ppb)	Maximum (ppb)
Aluminum	0	17	BDL	BDL	NA	NA	BDL	BDL
Antimony	0	17	BDL	BDL	NA	NA	BDL	BDL
Beryllium	0	17	BDL	BDL	NA	NA	BDL	BDL
Boron	0	17	BDL	BDL	NA	NA	BDL	BDL
Calcium	17	0	43964.7	44200	10447.1	23.76	25000	62500
Cobalt	0	17	BDL	BDL	NA	NA	BDL	BDL
Copper	0	17	BDL	BDL	NA	NA	BDL	BDL
Arsenic (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Barium (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Cadmium (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Chromium (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Lead (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Mercury (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Selenium (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Silver (EP)	0	17	BDL	BDL	NA	NA	BDL	BDL
Iron	0	17	BDL	BDL	NA	NA	BDL	BDL
Lithium	0	17	BDL	BDL	NA	NA	BDL	BDL
Magnesium	17	0	7315.29	6920	1663.83	22.75	5000	10600
Manganese	17	0	221.65	199	82.29	37.13	140	407
Molybdenum	0	17	BDL	BDL	NA	NA	BDL	BDL
Nickel	0	17	BDL	BDL	NA	NA	BDL	BDL
Potassium	17	0	3342.35	3290	694.95	20.79	2550	4850
Silicon	17	0	4768.24	4020	1533.44	32.16	3480	7700
Sodium*	13	4	2458.04	2340	775.57	31.55	BDL	3710
Strontium*	15	2	158.92	128	72.38	45.54	BDL	285
Tin	0	17	BDL	BDL	NA	NA	BDL	BDL
Titanium	0	17	BDL	BDL	NA	NA	BDL	BDL
Vanadium	0	17	BDL	BDL	NA	NA	BDL	BDL
Zinc	1	16	BDL	BDL	NA	NA	BDL	BDL
Zirconium	0	17	BDL	BDL	NA	NA	BDL	BDL

GT = Greater than
LT = Less than
DL = Detection limit
NA = Not available
BDL = Below detection limit
CV = Coefficient of variation
EP = Extraction procedure EPA, 1986
ppb = parts per billion
* Summary statistics are estimated by Cohen's method
Note: Metals analyzed for total metals unless extraction procedure is identified.

Source: Chou 1989

Table 3-20. 1989 Data from Onsite and Offsite Soil Sampling, Hanford Environmental Monitoring Program.

Parameter	Onsite[a] Average pCi/g (dry weight)[b]	Offsite[a] Average pCi/g (dry weight)[b]
Sr-90	0.25 ± 0.33	0.13 ± 0.03
Cs-137	2.48 ± 9.90	0.74 ± 0.27
Pu-239/240	0.061 ± 0.296	0.013 ± 0.003
U	0.60 ± 0.51	0.73 ± 0.13

[a] = Onsite and offsite are as shown on Figure 3-30; number of onsite samples = 12; number of offsite samples = 23.
[b] = The values given after ± sign are two standard errors of calculated mean.

Source: Adapted from Jaquish and Bryce 1990

Table 3-21. Sitewide Soil Background Threshold Levels Calculated from the Systematic Random Data Set using Lognormal Distribution.

Analyte[a]	80% Dist.[b]	80% UTL[c]	90% Dist.[b]	90% UTL[c]	95% Dist.[b]	95% UTL[c]
Aluminum	10,470	11,320	12,200	13,400	13,800	15,600
Antimony	d	15.7[e]	d	15.7[e]	d	15.7[e]
Arsenic	5.21	5.79	6.41	7.27	7.59	8.92
Barium	118	127	136	148	153	171
Beryllium	1.31	1.39	1.48	1.58	1.62	1.77
Cadmium	d	0.24[e]	d	0.24[e]	d	0.24[e]
Calcium	14,000	15,600	17,230	19,500	20,410	23,900
Chromium	15.4	17.3	19.4	22.2	23.4	27.9
Cobalt	14.5	15.4	16.3	17.5	17.9	19.6
Copper	19.4	20.9	22.5	24.5	25.3	28.2
Iron	29,490	31,180	32,920	35,150	36,000	39,160
Lead	8.35	9.33	10.41	11.88	12.46	14.75
Magnesium	6,380	6,780	7,210	7,760	7,970	8,760
Manganese	461	487	514	549	562	612
Mercury	0.113	0.182	0.287	0.502	0.614	1.25
Nickel	16.8	18.2	19.7	21.6	22.4	25.3
Potassium	1,840	2,040	2,250	22,550	2,660	3,120
Selenium	d	5[e]	d	5[e]	d	5[e]
Silver	0.26	0.41	0.64	1.1	1.4	2.7
Sodium	481	584	705	887	963	1,290
Thallium	d	3.7[e]	d	3.7[e]	d	3.7[e]
Vanadium	74	80.1	86.5	94.9	98.2	111
Zinc	61.5	64.6	67.8	71.8	73.3	79
Molybdenum	d	1.4[e]	d	1.4[e]	d	1.4[e]
Titanium	2,130	2,380	2,580	2,940	3,020	3,570
Zirconium	31.5	35.8	39.4	45.86	47.3	57.3
Ammonia	3.6	5.4	8	12.9	15.3	28.2
Alkalinity	3,880	5,590	7,670	11,800	13,400	23,300
Silicon	30.4	44.5	60.9	95.9	108	192
Fluoride	1.4	2.2	3.3	5.4	6.4	12
Chloride	33.9	62.4	113	233	303	763
Nitrite	d	21[e]	d	21[e]	d	21[e]
Nitrate	17.2	27.8	44.4	78.3	96.4	199
Orthophosphate	0.11	0.3	0.78	2.4	3.7	16
Sulfate	82.8	142	242	459	580	1,320

[a] = Analytes from EPA Contract Laboratory Program (CLP) methods plus selected anions.
[b] = Percentile of the data for a lognormal distribution.
[c] = Percentile confidence limit of the percentile of the data distribution.
[d] = Not reported.
[e] = Limit of detection.
Note: Methodology used in calculating threshold values has not been approved by regulators.
Source: Adapted from DOE-RL 1994g.

Table 3-22. 1980 Select Radionuclide Concentrations Detected in Soil Samples Adjacent to the 116-N-1 Facility and in the 116-N-1 Trench Sediment Samples.

Soil Samples						
Sample Location	Mn-54	Co-60	Cs-134	Cs-137	CePr-144	Eu-155
T-1	0.26	2.62	ND	0.43	ND	0.09
T-2	5.17	33.10	0.29	4.76	1.73	ND
T-3	2.07	8.31	0.24	4.43	0.56	0.16
T-4	1.83	9.93	0.25	4.66	0.48	ND
T-5	2.99	11.40	0.37	6.03	ND	0.12
T-6	0.10	1.00	ND	0.21	ND	ND
T-7	0.37	1.70	ND	0.74	ND	ND
T-8	ND	0.30	ND	0.21	ND	ND
T-9	ND	0.39	ND	0.84	ND	ND
Avg*	1.83	7.64	0.27	2.48	0.92	0.12

Trench Samples					
Sample Location	Mn-54	Co-60	Nb-95	Cs-137	CePr-144
TS-1	4.4×10^6	1.3×107	3.6×10^6	2.7×10^5	1.1×10^7
TS-2	2.8×10^6	8.8×10^6	1.5×10^6	2.1×10^5	4.1×10^6
TS-3	1.4×10^6	8.4×10^6	2.2×10^5	1.2×10^5	1.1×10^6
TS-4	1.0×10^6	5.1×10^6	2.6×10^5	2.2×10^5	8.0×10^5
TS-5	6.1×10^5	3.1×10^6	1.4×10^5	2.6×10^5	5.1×10^5
TS-6	1.1×10^6	5.6×10^6	2.7×10^5	2.1×10^5	8.6×10^5
TS-7	3.5×10^5	1.7×10^6	9.2×10^4	2.4×10^5	4.1×10^5
TS-8	4.3×10^5	7.6×10^6	ND	6.3×10^5	ND
TS-9	7.0×10^5	4.3×10^6	1.2×10^5	3.5×10^5	3.3×10^5
Avg	1.4×10^6	6.4×10^6	7.6×10^5	2.8×10^5	2.4×10^6

ND = Not detected

* = Average determined from samples with detectable results.

Note: In addition to the radionuclides listed, sample TS-1 contained 2.5×10^5 pCi/g of Co-58, 1.98×10^6 pCi/g of Zr-95, and 2.7×10^6 pCi/g of Ru-106; sample TS-2 contained 3.3×10^5 pCi/g of Fe-59, 7.9×10^5 pCi/g of Zr-95, 1.1×10^5 pCi/g of Ru-103, and 8.7×10^5 pCi/g of Ru-106; and sample TS-5 contained 4.1×10^5 pCi/g of Cs-134.

Source: Greager 1980a

Table 3-23. Average Radionuclide Concentrations (Pci/g) Detected in Soil Samples near the 116-N-1 Crib and Trench from 1980 through 1988.

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-238	Pu-239,240
1980	2.5E0	1.3E1	3.5E-1	4.1E0	NR	2.5E-2
1981	6.6E0	4.0E0	7.0E-1	6.1E0	NR	4.4E-2
1982	6.6E-1	6.3E0	2.7E-1	2.7E0	NR	1.8E-2
1983	4.1E-1	5.4E0	1.3E0	3.8E0	NR	4.3E-2
1984	1.8E-1	2.8E0	2.1E-1	1.1E0	NR	1.7E-2
1985	1.5E0	1.3E1	6.5E-1	3.9E0	NR	3.2E-2
1986	1.6E-1	4.5E0	2.2E-1	2.5E0	NR	1.7E-2
1987	3.2E-1	5.1E0	3.4E-1	1.6E0	5.4E-3	2.2E-2
1988	1.4E-1	7.8E0	3.5E-1	2.0E0	2.3E-3	1.7E-2

NR = Not Reported

Source: Perkins 1990

Table 3-24. Hydrophilic Organics in the 116-N-1 Trench Sediments.

Parameter	Sample No. 2 µg/kg	Sample No. 6 µg/kg	Sample No. 9 µg/kg
Tricarboxylic Acids			
Citric Acid	34	159	BD
Dicarboxylic Acids			
Oxalic Acid	13	1971	347
Malonic Acid	8	903	141
Malbic Acid	3	375	31
Succinic Acid	33	1992	328
2-Methyl-Succinic Acid	BD	94	BD
Pentanedioic Acid	BD	282	BD
Hexanedioic Acid	3	193	34
Heptanedioic Acid	20	BD	BD
Octanedioic Acid	41	592	87
Nonanedioic Acid	91	557	163
Carboxylic Acids			
Tetradecanoic Acid	3	66	34
Hexadecanoic Acid	49	292	55
Octadecenoic Acid	45	190	39
Oxygenated Acids			
2-Hydroxy-Propanoic Acid	BD	138	BD
3-Hydroxy-Butanoic Acid	12	BD	BD
4-Methoxy-Butanoic Acid	BD	18	BD
2-Methoxy-2-Butenoic Acid	49	BD	BD
4,4-Dimethoxy-2-Pentenedioic Acid	21	BD	BD
2-Methoxy-Benzoic Acid	BD	274	80
2-OXO-Propanoic Acid	BD	10	3
4-OXO-Pentanoic Acid	2	169	39
Aromatics			
Benzeneacetic Acid	BD	222	79
Furancarboxylic Acid	BD	120	20
Benzoic Acid	BD	362	45
Dimethyl Phthalate	34	188	68
Dibutyl Phthalate	21	BD	BD
Benzaldehyde	BD	86	14
2,5-Pyridinecarboxylic Acid	92	BD	BD
Pyridinecarboxylic Acid	BD	4	BD
Nitrobenzoic Acid	BD	115	BD
Nitro-Hydroxybenzoic Acid (Methyl Ester)	BD	300	57

BD = Below detection limit

Note: All samples taken from dried sediments in manways.

Source: Robertson et al. 1984

Table 3-25. Nonradioactive Air Emissions from 100 N Area.

	Particulates (lbs)	Sulfur dioxide (lbs)	Sulfur trioxide (lbs)	Carbon monoxide (lbs)	Hydrocarbons (lbs)	Nitrogen oxide (lbs)	Aldehydes (lbs)
1971[1]	NR	1,000,000	NR	NR	NR	1,000,000	NR
1972[1]	NR	900,000	NR	NR	NR	900,000	NR
1973[1]	NR	1,500,000	NR	NR	NR	NR	NR
1974[1]	NR	1,600,000	NR	NR	NR	NR	NR
1975[1] (Total Released from 184-N Oil Fire Boilers)	110,000	1,000,000	13,000	20,000	15,000	400,000	5,000
1962[1] (Total Released from 184-N Oil Fire Boilers)	110,000	1,000,000	13,000	19,000	14,000	380,000	4,800
1977[1] (184-N Oil Fire Boilers)	100,000	950,000	12,000	18,000	13,000	360,000	4,700
1978[3]	99,400	1,102,000	14,460	18,000	13,500	360,000	5,000
1979[3]	93,500	1,039,500	3,890	16,900	12,700	336,700	4,640
1980[2]	72,900	814,000	10,270	13,200	9,780	261,400	3,490
1981[2]	130,000	1,530,000	19,400	22,900	17,300	460,000	5,990
1982[2]	100,600	1,168,000	14,960	17,800	13,460	358,000	4,770
1983[2]	114,000	1,320,000	16,800	20,600	15,400	410,000	5,600
1984[2]	92,400	1,032,000	13,460	17,000	12,500	340,000	4,690
1985[2]	82,300	1,142,000	14,590	23,200	4,650	254,000	NR
1986[2]	120,000	16,000,000	21,000	31,000	6,100	360,000	NR
1987[2]	42,100	587,000	7,620	12,800	2,570	132,000	NR

[1] = Identified as chemicals to atmosphere, source unknown.
[2] = Source is identified at 184-N oil fired boilers.
[3] = Does not specify 184-N Oil Fired Boilers, states airborne emissions at the 100 N Area resultant from combustion of No. 6 Fuel Oil and No. 2 Diesel Oil.

NR = Not reported or not measured.

Table 3-26. Radioactive Air Releases from the 100 N Area.

Released Materials	1971[1]	1972[1]	1973[1]	1974	
				116-N Stack	109-N Roof Vent
HTO	40.0	27.0	14	4.2	ND
Ar-41	NR	NR	100,000	50,000	ND
I-131	0.05	.013	0.22	0.3	0.2
I-132	NR	NR	NR	.05	.05
I-133	0.07	0.5	1.2	1.2	1.0
I-135	NR	NR	NR	1.9	1.2
Xe-133	NR	NR	NR	0.1	.05
Xe-135	NR	NR	NR	1.0	.8

[1] = Emissions are assumed to be from the 116-N Stack. The data is presented only as activity released from 100 N Area.
ND = Not detected.
NR = Not reported and/or not measured.

Data compiled from: Dabrowski 1972, Cucchiara 1975

Table 3-27. Air Monitoring at 100 N Area, 1984 - 1988. Average Concentrations of Radionuclides for 100 N Area (pCi/L).

Station	Mn-54	Fe-59	Co-60	As-76	Nb-95	Ru-103	I-131	Cs-137	Ce-141	Ce-144	I-133	Eu-155
A1												
1981	NR	NR	ND	9.0E-2	NR	NR	2.0E-4	NR	NR	NR	3.0E-3	NR
1982	NR	NR	1.1E-4	4.9E-2	NR	NR	2.1E-4	NR	NR	NR	1.8E-3	NR
1983	2.7E-5	NR	6.8E-5	NR	NR	NR	1.5E-4	NR	NR	NR	NR	1.8E-5
1984	6.1E-5	–	1.7E-4	–	4.8E-5	2.7E-5	2.7E-4	NR	3.8E-5	6.3E-5		
1985	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS		
1986	0.39	0.081	.16	NR	0.056	0.024	0.22	NR	NR	0.063		
1987	5.2E-2	NR	2.8E-1	NR	NR	<2.7E-2	1.7E-2	2.6E-2				
1988	<2.1E-2	NR	7.1E-1	NR	NR	<1.7E-2	<1.8E-2	<2.1E-2				
A2												
1981	NR	NR	3.1E-4	ND	NR	NR	6.8E-5	NR	NR	NR	ND	NR
1982	NR	NR	2.8E-5	NR	NR	NR	8.5E-5	NR	NR	NR	NR	NR
1983	NR	NR	2.5E-5	NR	NR	NR	1.1E-4	NR	NR	NR	NR	1.5E-5
1984	ND	ND	7.1E-5	ND	ND	ND	ND	NR		ND		
1985	0.052	ND	0.19	ND	0.043	ND	0.068	NR	ND	0.027		
1986	0.021	NR	0.055	NR	NR	ND	0.067	0.017	NR	NR		
1987	ND	NR	1.3E-1	NR	NR	ND	ND	ND	NR	NR		
1988	ND	NR	6.0E-2	NR	NR	NR	ND	ND	NR	NR		
A3												
1981	NR	NR	ND	ND	NR	NR	NR	NR	NR	NR	ND	NR
1982	NR	NR	3.6E-5	NR	NR	NR	NR	NR	NR	NR	NR	NR
1983	NR	NR	5.3E-5	NR	NR	NR	NR	NR	NR	NR	NR	NR
1984	00S	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS	OOS		
1985	0.040	ND	0.21	ND	ND	ND	ND	ND	NR	ND		
1986	0.020	NR	0.078	NR	NR	0.017	0.054	0.019	NR	NR		
1987	ND	NR	1.0E-1	NR	NR	ND	ND	ND	NR	NR		
1988	ND	NR	4.6E-2	NR	NR	ND	ND	ND	NR	NR		
A4												
1981	NR	NR	ND	ND	NR	NR	ND	NR	NR	NR	ND	NR
1982	NR	NR	1.3E-4	NR	NR	NR	ND	NR	NR	NR	NR	NR
1983	NR	NR	5.5E-5	NR	NR	NR	ND	NR	NR	NR	NR	NR
1984	ND	ND	4.1E-5	ND	ND	ND	ND	NR	ND	ND		
1985	0.024	ND	0.056	ND	ND	0.011	0.048	NR	ND	ND		
1986	0.017	NR	0.062	NR	NR	0.017	0.046	0.019	NR	NR		
1987	ND	NR	1.2E-1	NR	NR	ND	ND	2.4E-2	NR	NR		
1988	ND	NR	9.1E-2	NR	NR	ND	ND	ND	NR	NR		

OOS = Station out of service
ND = Not detected
NR = Not reported or not measured

Fogel 1982, 1983; Rokkan 1984, 1985, 1986, 1987, 1988 and 1990.

Table 3-28. Average Radionuclide Concentrations (pCi/g) Detected in N Springs Vegetation Samples.

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-238	Pu-239,240
1980	4.8E-01	1.0E+00	NR	2.8E-01	NR	NR
1981	1.8E+00	2.5E+01	5.8E-01	7.1E-01	NR	2.1E-02
1982	4.9E-01	1.5E+00	2.0E-01	1.3E-01	NR	7.8E-03
1983	3.6E-01	1.0E+00	2.9E-01	9.0E-02	NR	8.6E-03
1984	1.3E-01	4.6E-01	8.1E-02	9.0E-02	NR	1.3E-03
1985	3.6E-01	1.4E+00	5.1E-02	1.6E-01	NR	8.7E-04
1986	2.6E-01	9.5E-01	2.2E-01	7.9E-01	NR	1.1E-03
1987	1.1E-01	7.0E-01	2.6E-01	9.4E-02	1.3E-04	5.8E-04
1988	1.3E-01	8.0E-01	2.5E-01	1.6E-01	1.7E-04	6.6E-04

Source: Perkins 1990

Table 3-29. Average Radionuclide Concentrations (pCi/g) Detected in Vegetation Samples near 116-N-1 Crib and Trench.

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-238	Pu-238,240
1980	1.4E+00	4.0E+00	NR	1.1E-00	NR	NR
1981	2.5E+00	1.2E+01	1.8E+00	1.8E+00	NR	7.1E-03
1982	4.6E-01	1.6E+00	1.2E-01	2.6E-01	NR	2.6E-03
1983	4.5E-01	1.9E+00	6.0E-01	3.9E-01	NR	3.2E-03
1984	2.9E-01	1.0E+00	1.2E-01	8.3E-02	NR	8.5E-04
1985	5.9E-01	1.7E+00	1.9E+00	1.0E-01	NR	1.5E-03
1986	6.8E-01	3.5E+00	7.3E-02	6.5E-01	NR	2.6E-03
1987	4.9E-01	2.8E+00	6.3E-02	2.0E-01	1.2E-03	5.6E-03
1988	1.5E-01	2.0E+00	1.2E-01	1.3E-01	4.3E-04	1.7E-03

Source: Perkins 1990

Table 3-30. Average Radionuclide Concentrations (pCi/g) Detected in 100 N Area Vegetation Samples.

Year	Mn-54	Co-60	Sr-90	Cs-137	Pu-238	Pu-239, 240
1980	1.5E-01	5.6E+00	NR	4.4E-01	NR	NR
1981	NR	3.3E+00	2.0E+02	NR	NR	3.7E-03
1982	1.5E-01	2.8E+00	4.8E+02	NR	NR	8.3E-03
1983	7.0E-02	3.0E+00	3.3E+02	4.0E-02	NR	8.0E-03
1984	NR	NR	NR	NR	NR	NR
1985	7.6E-02	1.2E+00	4.2E+02	1.7E-01	NR	4.4E-04
1986	1.6E-01	1.1E+00	2.2E+02	2.1E-01	NR	4.2E-04
1987	2.0E-01	9.0E-01	2.9E+02	1.1E-01	< 1.1E-04	7.6E-04
1988	2.4E-01	1.4E+00	1.2E+02	2.0E-01	8.5E-05	2.0E-04

Source: Perkins 1990

Table 3-31. Sampling Results of N Springs Vegetation.

Sample Type	Sample Number	Location	Sr-90 dpm/g[a] wet	Gamma Results bq[b]/g wet (±%)			
				Be-7	K-40	Co-60	Cs-137
Mulberry Samples:							
Mulberries	90182 53289-2	1 (Below 100 N stack on near shorline)	NA	<0.0085	<0.01	<0.0017	<9.2E-4
Mulberry leaves	90185 53289-5	2 (About 50 m upstream of groundwater well 199-N-8 near shorline)	NA	0.024 (8.1)	<0.14	4.40E-4 (37)	1.23E-3 (35)
Mulberries	90183 53289-3	2 (About 50 m upstream of groundwater well 199-N-8 near shoreline)	NA	0.0047 (28)	<0.11	0.0037 (5.9)	<3.0E-4
Mulberry leaves	90181 53289-1	3 (About 50 m downstream of groundwater well 199-N-8 near shoreline)	171	0.025 (9.8)	0.195 (28)	8.59E-4 (23)	8.20E-4 (50)
Mulberries	90184 53289-4	3 (About 50 m downstream of groundwater well 199-N-8 near shoreline)	41.9	0.0046 (26)	<0.091	8.42E-4 (16)	5.08E-4 (50)
Curly Dock Sample:							
Curley dock, plant and root	90186 53289-6	(About 15 m downstream of groundwater well 199-N-8 at shoreline)	181	0.0035 (35)	<0.067	1.21E-3 (18)	<5.0E-4

[a] = Decays per minute.
[b] = bq (becquerel) = 1 decay per second.
NA - Not analyzed
Notes: The above sample analyses were performed by PNL under PNL-MA-70 QA Impact Level III. The analytical uncertainty is the one-sigma value expressed as a percent.

Table 3-32. 1979 Concentrations of Radionuclides in Swallow Nests Compared to N Area and Hanford Soil Sample.
Concentrations are in pCi/g.

Radionuclide	Swallow Nest				Surface Soil	
	#1	#2	#3	#4	N Area	Hanford
Mn-54	1.9	0.14		0.27	0.90	
Co-60	15	1.2	0.64	1.5	2.7	
Nb-95						0.05
Cs-137	5.5	0.28		0.19	0.61	0.70
Nd-147			.45			
Total Activity	22	1.6	1.1	2.0	4.2	0.75

Source: Greager 1980a

Table 3-33. 1985 Radionuclide Concentrations (pCi/g) of Cliff Swallow Nests, Excrement Samples, and Shell/Embryo Samples Collected Near the 1304-N EDB During 1985.

Nuclide	Swallow Nest		Excrement	Shell/Embryo
	#1	#2		
Mn-54	0.26	0.29		
Co-60	1.2	1.1	5.1	4.2
Cs-137	0.31	.29		
Source: Jacques 1985				

Table 3-34. Radionuclides Detected in Rabbits Collected Around the 116-N-1 Facility, 1981 Concentrations in pCi/g (wet weight).
(page 1 of 2)

	Tissue	Mn-54	Co-60	Zn-45	Cs-134	Cs-137	Sr-90	Pu-236	Pu-239/240
Inside 1301-N Security Fence									
#1	Muscle	ND	0.2	ND	0.55	8.9	NA	NA	NA
	Bone	ND	ND	0.46	ND	3.2	73	ND	ND
#2	Muscle	6.1	13	6.2	320	3,700	NA	NA	NA
	Bone	46	13	13	98	1,100	6,000	ND	0.14
	Liver	210	120	ND	160	2,300	5.2	0.07	0.35
#3	Muscle	4.2	2.2	2.1	270	3,400	NA	NA	NA
	Bone	21	5.2	ND	77	1,200	1,300	0.01	0.06
	Liver	330	60	ND	190	3,400	5.6	0.005	0.02
#4	Muscle	1.5	9.0	0.53	9.1	120	NA	NA	NA
	Bone	1.4	0.57	ND	3.0	51	200	ND	0.15
	Liver	11	12	8.7	9.9	160	13	0.13	0.08
#5	Muscle	2.2	3.4	0.42	9.4	140	NA	NA	NA
	Bone	2.5	1.7	ND	3.1	43	180	0.07	0.04
	Liver	26	22	ND	7.8	130	1.4	0.03	0.05
Average	Muscle	2.8	5.6	1.9	120	1,500	NA	NA	NA
	Bone	14	5.1	2.7	30	480	1,600	0.02	0.08
	Liver	140	54	2.2	92	1,500	6.3	0.06	0.13
Rock Pile Outside Fence									
#1	Muscle	ND	0.36	ND	ND	0.07	NA	NA	NA
	Bone	ND	0.29	0.73	ND	0.51	11	ND	ND
	Liver	ND	0.36	ND	ND	0.25	ND	ND	0.005
#2	Muscle	ND	0.06	ND	ND	0.02	NA	NA	NA
	Bone	1.2	0.44	ND	1.9	0.16	1.4	ND	ND
	Liver	ND	0.22	ND	2.7	0.13	ND	ND	ND
#3	Muscle	ND	0.07	ND	ND	ND	NA	NA	NA
	Bone	ND	0.22	0.16	ND	ND	4.9	**	**
	Liver	ND	0.13	ND	0.33	0.15	ND	**	**
#4	Muscle	2.4	**	0.59	ND	9.5	NA	NA	NA
	Bone	ND	0.72	ND	ND	0.19	1.5	ND	ND
	Liver	ND	0.18	ND	ND	0.17	ND	ND	0.02
Average	Muscle	0.60	0.16	0.15	ND	2.4	NA	NA	NA
	Bone	0.30	0.42	0.22	0.48	0.26	1.6	ND	ND
	Liver	ND	0.22	ND	0.76	0.18	ND	ND	0.008

Table 3-34. Radionuclides Detected in Rabbits Collected Around the 116-N-1 Facility, 1981 Concentrations in pCi/g (wet weight).
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Radionuclides Detected in Rabbit Feces Collected Around the 1301-N Facility, 1981 Concentration in pCi/g (dry weight).					
	Mn-54	Co-60	Cs-134	Cs-137	Ce-144
East of Trench	1300	340	63	740	Not detected
West of Trench	650	870	19	270	120

ND = Not detected
NA = Not analyzed
* = Sample lost
** = Cross contamination suspected

Source: Greager 1981

Table 3-35. Concentrations of Gamma-Emitting Radionuclides Detected in Deer Mice Collected Around the 116-N-1 Trench, 1981.

Deer Mouse Number	Cr-51	Mn-54	Co-58	Fe-59	Co-60	Nb-95	Zr-95	Ru-103	Sb-124	I-131	Cs-134	Cs-137	La-140	Ce-144	Eu-154
1	ND	63	12	130	260	ND	ND	ND	ND	58	8.6	78	84	ND	ND
2	74	240	23	440	570	41	42	ND	8.0	39	17	110	140	130	5.9
3	50	510	71	960	1,700	130	110	ND	8.0	340	75	410	ND	130	24
4	ND	32	ND	110	260	ND	ND	ND	ND	390	15	190	ND	ND	ND
5	ND	90	ND	150	340	20	25	ND	8.0	ND	5.9	71	83	44	11
6	470	2,600	250	2,600	11,000	460	430	51	ND	350	230	2,300	84	1,600	ND
7	ND	18	ND	31	54	ND	ND	ND	ND	22	4.8	52	7.1	ND	ND
8	ND	12	ND	21	60	ND	ND	ND	ND	8.4	ND	25	2.1	ND	ND
9	ND	150	18	280	480	23	26	ND	11	18	ND	94	120	37	100
10	110	430	41	530	2,700	69	83	23	15	25	33	380	ND	430	29
11	210	630	120	1,300	2,400	180	160	22	ND	320	110	1,200	820	220	41
12	320	1,000	140	1,800	3,300	97	100	20	51	18	120	1,300	120	190	31
13	ND	15	ND	22	55	ND	ND	ND	ND	9.8	3.5	33	31	ND	ND
14	ND	13	ND	24	98	ND	ND	ND	ND	13	7.1	120	ND	ND	ND
15	ND	270	28	380	1,100	33	ND	ND	ND	24	130	1,700	26	100	ND
16	610	4,000	470	4,900	17,000	1,800	1,600	130	140	220	200	2,000	220	3,600	250
17	ND	37	ND	75	190	ND	ND	ND	11	29	ND	110	22	ND	ND
18	81	360	36	490	1,600	42	38	ND	27	19	26	240	29	160	ND
Avg.*	250	580	110	790	2,400	260	260	50	29	110	52	610	130	590	61

Avg.* = Average
ND = Not detected

Note: In addition to the above, the following radionuclide concentrations were detected: 170 pCi/g of Zn-65, 600 pCi/g of Ru-106, and 5,300 pCi/g of I-132 in deer mouse #6; 180 pCi/g of Ru-106 and 18 pCi/g of Ce-141 in deer mouse #10; 21 pCi/g of Ce-141 in deer mouse #11; 56 pCi/g of Zn-65 in deer mouse #12; and 220 pCi/g of Zn-65, 1,200 pCi/g of Ru-106, and 69 pCi/g of Ce-141 in deer mouse #16.

Source: Greager 1982

Table 3-36. Deer Mice Collected Along the Riverbank Springs, 1982 (pCi/g-wet wt.).

Deer Mouse Number	Mn-54	Co-60	Cs-137	Eu-155
1	ND	2.1	ND	ND
2	ND	2.6	ND	0.59
3	ND	2.9	ND	ND
4	0.78	8.1	ND	ND
5	ND	1.0	1.5	ND
6	ND	2.4	0.55	1.2
7	ND	3.0	ND	ND
8	ND	1.4	ND	1.4
9	ND	0.35	ND	ND
10	ND	4.6	0.39	1.5
11	ND	3.5	ND	ND
12	3.7	14	ND	ND

ND = Not detected

Source: Greager 1983

Table 3-37. Whole Body Radionuclide Concentrations (pCi/g, wet weight) Detected in Deer Mice Collected Near the 1301-N LWDF.

Trap No.	Weight (g)	Sex	Cr-51	Mn-54	Co-58	Fe-59	Co-60	Zr/Nb-95	I-131	Cs-137	Ce-141	Ce-144
1	20.3	M	.82	3.3	.25	3.1	7.1	1.1	.29	2.5	.035	.49
6	16.3	M	.68	1.7	.23	2.1	5.7	.64	.16	.70	.044	.35
9	19.8	F	.98	3.5	.35	3.3	11	1.1	.17	.37	.040	.42
10	16.1	F	.053	.22	.021	.30	.74	.077	.054	.18	.0028	.046
11	15.8	F	.77	2.5	.34	2.6	9.7	.80	.31	.35	.058	.50
12	21.7	M	.23	.47	.075	.65	1.7	.18	.047	.24	.014	.073
14	18.2	F	.26	.95	.081	.75	2.6	.52	.19	.23	.037	.29
25	19.6	M	<.014	<.0019	<.0017	<.0029	.0083	<.0047	<.0026	.0022	ND	<.0097
30	20.1	M	<.021	.041	.0045	.059	.098	.012	.028	.10	<.0025	<.011
39	16.2	F	.019	.10	.011	.11	.24	.019	.037	.053	<.0041	<.017
40	17.4	F	1.2	4.1	.48	4.3	15	1.4	.20	.97	.15	.86
42	14.0	F	2.7	12	.99	13	36	3.6	.25	1.0	.30	1.7
44	19.3	M	.59	2.0	.20	2.5	4	.93	.039	.045	.064	.30
45	14.4	F	<.026	.016	<.0039	.013	.081	<.0097	<.0048	.017	<.0033	<.015
47	17.7	F	.93	4.5	.30	4.7	11	1.6	.23	2.7	.049	.56
50	15.2	M	2.0	9.1	.76	11	23	5.3	.23	.76	.29	1.6
AVG	17.6		.86	3.0	.29	3.2 ±3.9	8.0 ±9.9	1.2	.16	.64	.090	.60
SD	±2.3		±.77	±3.5	±.29			±1.5	±.10	±.83	±.10	±.54

AVG = Average
SD = Standard deviation
ND = Not detected

Note: Underlined values indicate the range (high and low value) for each radionuclide.

Source: Jacques 1986

Table 3-38. Human Health Data and Risk Assessment Summary for Waste Sites with LFI or Historical Data for 0 to 15 ft.

Waste Site with LFI Data 1 to 15 ft	Summary of Data Availability and Data Uncertainty					Human Health Risk Assessment Summary								
						Frequent-Use Scenario			Occasional-Use Scenario			Commercial/Industrial Scenario		
	LFI Data	Data from the Same Medium	Data to Perform a QRA	Uncertainty in Contaminant Identification	Uncertainty in Contaminant Concentrations	Qualitative Risk Estimation[a] 1992	Qualitative Risk Estimation[a] 2018	Risk-Driving Contaminant and Pathway	Qualitative Risk Estimation 1992	Qualitative Risk Estimation 2018	Risk-Driving Contaminant and Pathway	Qualitative Risk Estimation 1992	Qualitative Risk Estimation 2018	Risk-Driving Contaminant and Pathway
116-N-1 Crib and Trench	R,I,O	yes	quantitative	low	low	high	high	R, external	high	high	R, external	high	high	R, external
116-N-3 Crib and Trench	R	yes	quantitative	low	low	high	high	R, external	high	high	R, external	high	high	R, external
120-N-1 Percolation Pond 120-N-2 Surface Impoundment South Settling Pond	I,O[b]	yes	quantitative	low	low	very low	very low		very low	very low		very low	very low	
116-N-2 Treatment Storage Facility	R,I,O	yes	quantitative	low	low	high	medium	R, external	medium	low	R, external	medium	low	R, external
1322-N/1322-N A Sample Building	R,I,O	yes	quantitative	low	low	medium	medium	R, external	low	low	R, external	medium	low	R, external
119-N Cooling Water Drain Line	I,O[c]	yes	quantitative	low	low	very low	very low		very low	very low		very low	very low	

[a] = Very low = Very low qualitative risk; Incremental Cancer Risk (ICR) $< 10^{-6}$.
Low = Low qualitative risk; $10^{-6} < ICR < 10^{-4}$.
Medium = Medium qualitative risk; $10^{-4} < ICR < 10^{-2}$
High = High qualitative risk; $ICR > 10^{-2}$
[b] = Low uncertainty is contaminant concentration is based on limited validated soil data set, usually one boring per site.
[c] = Radionuclide data consisted of field screening for gross radiation; no specific contaminant soil data were available to estimate risk.
R = radioactive I = inorganic O = organic
LFI = limited field investigation QRA = qualitative risk assessment ICR = incremental cancer risk
Source: BHI 1994b

Table 3-39. Human Health Evaluation Summary for 100-NR-2 Operable Unit Groundwater Incremental Lifetime Cancer Risk.

Contaminant Type	Major Contaminants	Identification Confidence	Concentration Confidence	Frequent-Use Scenario			Occasional-Use Scenario		
				Major Exposure Pathway	Percent Total ICR[f]	Qualitative Risk Classification	Major Exposure Pathway	Percent Total ICR	Qualitative Risk Classification
Radioactive	Strontium-90[a]	high	high	Ingestion[b]	90	medium	Ingestion	90	low
	Tritium[c]	high	high		2	medium		2	low
	Cobalt-60	high	high		.3	low		.3	very low
	Ruthenium-106	high	high		.3	low		.3	very low
	Other [d]	high	high		<0.1			<0.1	
Nonradioactive	Arsenic[e]	high	high	Ingestion	8	medium	Ingestion	8	low
				Operable Unit Total[g]		medium	Operable Unit Total[g]		low

[a] = Strontium-90 absorbed by ingestion incorporates into bone and represents risk of bone cancer. Strontium-90 decays with a 29-year half-life.
[b] = Dermal and inhalation exposures contribute <0.2% of total incremental cancer rick (ICR).
[c] = Tritium is incorporated into the entire body as tritiated water. Tritium decays with a half-life of 12.3 years.
[d] = Combined ICR of cesium-137, radium-226, and antimony-125 contribute <0.4% of total ICR.
[e] = Arsenic is classified as a Group A human carcinogen. Increased cancer incidence in internal organs has been reported for populations consuming drinking water containing high oncentrations of arsenic. Skin cancer has also been reported (EPA 1993).
[f] = Values rounded; total may not equal 100 percent.
[g] = Risk estimates are reported for 1993. Radioactive decay of tritium and strontium-90 through 2018 will result in a 38% decrease in ICR; however, the qualitative risk classifications remain unchanged.

Source: BHI 1994c

Table 3-40. Human Health Evaluation Summary for 100-NR-2 Operable Unit Groundwater Noncarcinogenic Hazard Index.

Major Contaminants	Identification Confidence	Concentration Confidence	Frequent-Use Scenario			Occasional-Use Scenario		
			Major Exposure Pathway	Comparison of HQ to 1.0	Percent Total HI	Major Exposure Pathway	Comparison of HQ to 1.0	Percent Total HI
Manganese[a]	high	high	Ingestion	above	23	Ingestion	below	23
Arsenic[b]	high	high		above	21		below	21
Chromium VI[c]	high	high		above	15		below	15
Nitrate[d]	high	high		above	12		below	12
Fluoride[e]	high	high		above	8		below	8
Cadmium[f]	high	high		above	7.5		below	7.5
Nitrite	high	high		below	4.7		below	4.7
2,4-Dichlorophenol	high	high		below	3.6		below	3.6
Nickel	high	high		below	2		below	2
Vanadium	high	high		below	1.8		below	1.8
Barium	high	high		below	0.8		below	0.8
Zinc	high	high		below	0.55		below	0.55
Chloride	NE	NE		NE	NE		NE	NE
Cobalt	NE	NE		NE	NE		NE	NE
Lead	NE	NE		NE	NE		NE	NE
Sulfate	NE	NE		NE	NE		NE	NE
Uranium	NE	NE		NE	NE		NE	NE
4-Chloro-3-methylphenol	NE	NE		NE	NE		NE	NE
2-Nitrophenol	NE	NE		NE	NE		NE	NE
			Operable Unit Total Hazard		Above Human Health Hazard Threshold	Operable Unit Total Hazard		Below Human Health Hazard Threshold

[a] = Manganese is an essential nutrient, but can cause neuromuscular effects at high concentrations (EPA 1993).
[b] = Arsenic has been reported to cause hyperpigmentation, keratosis, and possible vascular effects. The confidence in the oral reference dose (RfD) is listed as medium (EPA 1993).
[c] = Chromium VI has been reported to cause hyperpigmentation, keratosis, and possible vascular effects. The confidence in the oral RfD is listed as low (EPA 1993).
[d] = Methenoglobenemia has been measured in infants exposed to high nitrate concentrations in drinking water. The confidence in the oral RfD is listed as high (EPA 1993).
[e] = The primary health effect of fluoride ingestion is fluorosis.
[f] = Cadmium ingestion in drinking water causes kidney toxicity. The confidence in the oral RfD is listed as high (EPA 1993).
NE = Not evaluated because toxicity data not available.
HI = hazard index
HQ = hazard quotient
Source: BHI 1994b

4.0 RATIONALE AND APPROACH

The RFI/CMS process is the method by which risks are characterized and corrective action alternatives evaluated. There are specific data quality objectives (DQOs) and data needs that must be identified prior to designing a data collection program. The data collected are used as a basis for making an informed risk management decision regarding the most appropriate corrective action. The data needs and DQOs are based in part, on the *Hanford Past-Practice Strategy* (DOE-RL 1991a) described in Section 1.1 and the coordination strategy described in Section 1.3. The coordination strategy has been developed to meet the intent and milestones in Change Number M-15-94-04 and Change Number C-93-08 to the Tri-Party Agreement (Ecology et al. 1994c).

The past-practice strategy and the rescoping efforts of the EPA, DOE and Ecology emphasize a bias for action, by quickly and efficiently implementing ERAs and IRMs, to achieve cleanup actions at high priority areas of contamination. The three parties have not identified any candidate sites within this operable unit for conducting ERAs during the rescoping efforts. Several sites have been identified as potential candidates for conducting an IRM. Although the three parties determined that ERAs are not warranted for the 100-NR-1 Operable Unit, an ERA in process for the 100-NR-2 Operable Unit to address the discharge of groundwater contaminated by strontium-90 to the Columbia River at the N Springs (DOE-RL 1994f). The three parties have also agreed in changer request M-15-94-04 to initiate interim action at the 116-N-1 and 116-N-3 sites to attenuate skyshine (Ecology et al. 1994a).

Change Number M-15-94-04 recognizes the need to ensure consistent, effective, and nonduplicative cleanup actions by coordinating activities at the RCRA TSD sites, RCRA past-practice sites, and at N Reactor. This coordinated effort constitutes the N Area pilot project. Milestones in the M-15-94-04 Change Number include actions presently deemed necessary to address near-term environmental and human health related concerns, and those intended to carry N Area through early cleanup and the deactivation process. The N Springs ERA and interim actions at 116-N-1 and 116-N-3 are part of the N Area pilot project. The N Area pilot project is intended to ensure coordinated efforts in cleanup, closure, and facility deactivation, decontamination, decommissioning. The deactivation, decontamination, and decommissioning activities chiefly involve the N Reactor and its ancillary facilities. Closure specifically applies to the four RCRA TSD units. Closure will first address RCRA TSD sites 116-N-1 and 116-N-3 (1301-N and 1325-N) since they are source terms for contaminated groundwater that is discharging at N Springs and then address RCRA TSD sites 120-N-1 and 120-N-2 (1324-N and 1324-NA). Additional investigation is required at 116-N-1 and 116-N-3 to support the evaluation of engineering alternatives/remedial measures and for closure.

Through Change Number C-93-08 the three parties have agreed that DOE will assume responsibility for regulatory compliance and the lead for cleanup actions under the Tri-Party Agreement for the HGP sites. The three parties also recognize the need to more closely integrate source and groundwater operable unit investigations and remediation, and acknowledge that some environmental media should be investigated on an aggregate-area basis.

To implement the Hanford past-practice strategy (DOE-RL 1991a), data are needed for specific waste sources, groundwater contaminant plumes, and contamination of other environmental media. This information will be used to refine existing conceptual models and to conduct a qualitative risk assessment. To implement the N Area pilot project, data are needed for 116-N-1 and 116-N-3 sites such as the distribution of contamination and the physical and chemical characteristics of the contaminated vadose zone soils. This information will be used to refine existing conceptual models and to conduct a qualitative risk assessment. Data are also needed to complete a quantitative baseline risk assessment and select a final corrective and remedial action for the overall operable unit and the 100 Area NPL Site, respectively. Some

of these data will be collected during the LFI, and other data can be collected as needed when implementing the IRM or preparing the closure plan/CMS documents. The three parties have agreed that a closure plan/CMS report will address the 116-N-1 and 116-N-3 sites and subsequent closure plan/CMS reports will address the remaining sites and contamination in the 100-NR-1 and 100-NR-2 operable units (Ecology et al. 1994c).

Section 4.1 describes the data quality objectives for all these data needs and indicates whether the data will be obtained during source, groundwater, or aggregate area investigations. The approach for collecting, analyzing, and evaluating these data is presented in Section 4.2. The approach presented here is in general terms; the specific RFI/CMS tasks are described in Chapter 5.0.

4.1 RATIONALE

The central rationale for undertaking an RFI at the 100-NR-1 operable unit is to develop needed data that are lacking in the available information. The amount and quality of available information are not adequate to quantify the risk posed by the operable unit and complete the closure plan/CMS documents. This is due to the size of the operable unit, the complexity of past operations, the number of waste management units, the limited information on the nature and extent of contamination from these units, and the impact from activities performed under the reactor shutdown program.

The rationale for the technical approach presented in this RFI/CMS work plan is based on two concepts. First, every activity and effort of the RFI field program shall be justified by producing data for one or more of the following project purposes:

- confirm or revise the conceptual models for specific waste sites and/or areas of contaminated environmental media for the operable unit and aggregate area
- support a qualitative risk assessment
- support development and evaluation of interim remedial measures for individual waste sites, groups of sites or areas of environmental contamination
- support the quantitative baseline risk assessment for the operable unit
- support the CARs evaluation
- support development, evaluation, and selection of alternatives for closure of RCRA TSD sites (116-N-1, 116-N-3, 120-N-1, and 120-N-2)
- support development, evaluation, and selection of a final remedial alternative.

Second, a streamlined approach with a bias for action will be followed and incorporate the N Area pilot project. This approach will focus on obtaining data sufficient to implement IRMs and provide data to evaluate remedial alternatives and support closure of RCRA TSD sites (116-N-1, 116-N-3, 120-N-1, and 120-N-2). It will use the observational approach during implementation of the remedy to reduce the amount of data required before beginning cleanup and integrate with the 100 N deactivation, decontamination, decommissioning, and closure activities. The emphasis in this work plan is on describing those data that will be obtained at high-priority areas of contamination to determine whether to implement an IRM and to support closure of the RCRA TSD sites. However, general data needs for the quantitative risk assessment and final remedy selection are also addressed in this chapter.

Section 4.1.1 discusses the data quality objectives process that was used to develop this work plan. Section 4.1.2 describes the data needs identified as a result of this process.

4.1.1 Data Quality Objectives Process

In accordance with the Tri-Party Agreement (Ecology et al. 1990a), this work plan was developed consistent with EPA's DQO process (CDM Federal Programs Corporation 1987), McCain and Johnson (1990), and the Streamlined Approach For Environmental Restoration (SAFER) process and resulting agreements documented in the *Description of Work for Vadose Drilling at the 1301-N and 1325-N Facilities, 10-NR-1 Operable Unit* (DOE-RL 1994h). In addition, the work plan has been developed based on the *Hanford Past-Practice Strategy* (DOE-RL 1991a), 100 Area rescoping efforts by the EPA, Ecology, and DOE, Change Number M-15-94-04 and Change Number C-93-08 to the Tri-Party Agreement of January 1994 (Ecology et al. 1994a, 1994b, 1994c). The manner in which the three stages of the DQO process are used for the RFI/CMS is briefly outlined below to provide an understanding of the logic behind the development of this work plan. The three stages of the DQO process are: (1) decision types identification (Section 4.1.1.1), (2) data uses and needs identification (Section 4.1.1.2), and (3) data collection program design (Section 4.1.1.3).

4.1.1.1 Stage 1-Identification of Decision Types. The first stage of the DQO process is the identification of decision types. There are four steps within this stage: (1) the identification and involvement of data users; (2) the evaluation of available data; (3) the development of an operable unit conceptual model; and (4) the specification of project objectives and decisions.

Identification and involvement of data users has been arranged on a programmatic level for all Hanford Site environmental restoration activities through the Tri-Party Agreement (Ecology et al. 1990a) and associated program plans. On the project level, primary data users maintain close involvement in the DQO process through the opportunity to review and comment on project plans and reports. Previous drafts of this work plan have been reviewed and the three parties have recognized that, to expedite the ultimate goal of cleanup, more emphasis needs to be placed on initiating and completing waste site cleanup through interim measures. The parties have therefore agreed to a streamlined approach that is intended to: a) accelerate decision-making by maximizing the use of existing data, consistent with data quality objectives, and b) undertake ERAs and/or IRMs, as appropriate, either to remove threats to human health and welfare and the environment or to reduce risk by reducing toxicity, mobility, or volume of contaminants. This draft of the work plan reflects the rescoping efforts conducted by the primary data users, Change Number M-15-94-04 and Change Number C-93-08 to the Tri-Party Agreement of January 1994 (Ecology et al. 1994b), the DOW for vadose drilling at the 1301-N and 1325-N facilities (DOE-RL 1994h).

Steps 2 and 3, evaluation of available data and development of an operable unit conceptual model, respectively, are presented in Chapters 2.0 and 3.0 of this work plan. These data have been evaluated and during the rescoping efforts were the basis for prioritizing sites for conducting limited field investigations, which will potentially lead to interim remedial measures. The existing information has also been used to determine data that will be obtained for the final remedy selection for the operable unit, including information that can be obtained through 100 Area aggregate investigations.

The final step of the Stage 1 DQO process is the specification of project objectives and decisions. The overall project objectives and decisions that will be made based on the RFI were presented previously in Section 4.1. The specific objectives for each task are presented in Chapter 5.0.

4.1.1.2 Stage 2-Identification of Data Uses and Needs. The second stage of the DQO process consists of the identification of data uses and needs. This stage can be viewed as occurring in six steps: (1) the identification of data uses; (2) the identification of data types; (3) the identification of data quality needs;

(4) the identification of data quantity needs; (5) the evaluation of sampling and analysis options; and (6) the review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters.

Each work plan task and its component activities were developed to provide data for one or more of the specific project uses presented in Section 4.1. Concise objectives statements for data needed for each of these project uses are provided in Section 4.1.2 and Chapter 5.0 to document the justification for each task and activity.

The identification of data types required in the RFI/CMS evolved from the identification of project-specific data gaps upon review of the current understanding of the operable unit as presented in Chapters 2.0 and 3.0 of this work plan. The scope of work presented in this plan was specifically developed to collect data to a degree sufficient to identify and implement appropriate IRMs, to evaluate remedial alternatives for 116-N-1 and 116-N-3, and to support closure activities for RCRA TSD sites. The results of the LFIs and IRMs, work at analogous facilities at other operable units, and aggregate area investigations will all be used for completing the operable unit CMS. The investigation will be modified and updated throughout the RFI/CMS process as additional technical information becomes available.

Data quality needs were identified upon consideration of integrated factors such as prioritized data uses, appropriate analytical levels, contaminants of concern, contaminant levels of concern, analytical detection limits, and critical sample locations. The RFI/CMS approach presented in Section 4.2, and the required tasks presented and described in Chapter 5.0, are organized such that data will be collected in an efficient and cost-effective manner that will provide information for high-priority overall project needs. Analytical methods and investigational techniques were selected using appropriate analytical levels (e.g., screening methodologies versus fully validated laboratory methodologies), in accordance with McCain and Johnson (1990), to help maximize efficiency and cost effectiveness. Data quality needs based on conducting LFIs and implementing IRMs using the observational approach were agreed to by the three parties during 100 Area rescoping meetings, and during the SAFER process as documented in the DOW for 1301-N and 1325-N facility investigation (DOE-RL 1994h). Chapter 5.0 describes tasks for the characterization of critical locations and operable unit conditions based on these agreements. Data quality needs for low priority sites will be agreed to by the three parties after implementation of the IRMs.

Due to uncertainties in regard to the extent of contamination in various environmental media, it is impossible to identify data quantity needs exactly. This problem is addressed, in part, through use of the observational approach. At the high-priority sources, a limited amount of data will be collected, analyzed, and evaluated to determine whether an IRM is warranted and can be selected, and also to support closure activities for the RCRA TSD sites. The observational approach will be employed during implementation of the remedy to complete any additional characterization of the extent of contamination. Data collected from the LFIs and during implementation of IRMs will be provided so that the three parties can jointly participate in decision making.

The emphasis in this work plan and the rescoping efforts had been on evaluating high-priority waste sites for implementing IRMs. Change Number M-15-94-04 (Ecology et al. 1994c) has added additional goals, including the evaluation of remedial alternatives and closure of 116-N-1 and 116-N-3, high-priority sites that are RCRA TSD units. Therefore, detailed sampling activities are not proposed for the low-priority sites. A generalized approach for investigations to be conducted at these sites will be described. All waste sites and environmental media will be addressed as part of the cumulative risk assessment and for selection of the final remedy for the operable unit.

Sampling and analysis options, excluding the RCRA TSD units 116-N-1, 116-N-3, were evaluated in accordance with McCain and Johnson (1990) and agreed to during rescoping meetings, these options are

presented in Section 4.2.2. Sampling and analysis options for 116-N-1 and 116-N-3 were evaluated using the SAFER process and are presented in the DOW for these facilities (DOE-RL 1994h) and in Section 4.2.2. Selections were made on the basis of the data quality needs outlined above, and the applicability of relevant PARCC parameters, which are documented in the QAPjP.

4.1.1.3 Stage 3-Design of Data Collection Program. The third and final stage of the DQO process consists of the design of a data collection program. Section 4.2 describes the general approach to the data collection program, and Chapter 5.0 of this work plan presents the task-specific activities in greater detail. The associated QAPjP provides the mechanism by which the data collection program is implemented, controlled, and documented.

4.1.2 Data Needs

Considerable general information for the 100-NR-1 operable unit is presented in Chapter 2 and Section 3.1 of this work plan. However, the specific data necessary to complete the closure plan/CMS report for 116-N-1 and 116-N-3 are lacking. Specific data necessary to complete closure plan/CMS reports for the 100-NR-1 and 100-NR-2 Operable Units also are lacking. For most of the engineered waste disposal units, there is information regarding location, design, and construction of the unit, and indications of the major types of wastes disposed therein. For some of the potential contaminant sources, the information is much less complete. For example, it is not certain whether hazardous substances were even disposed at some of the low priority sites.

What is known about the contamination at many of the 100-NR-1 operable unit waste sites and RCRA TSD sites is largely based on nonvalidated data (i.e., the available data are generally not validated to current standards for acceptable quality and reliability). In addition, the detailed information that will be needed to complete the closure plan/CMS reports, and to select appropriate remedies for the operable unit, is not available. However, existing data are sufficient to identify high-priority waste sites for conducting LFIs.

The categories of project purposes listed in Section 4.1 are discussed in the following sections. The types of data that will need to be collected to meet these purposes and where the data will be collected are presented in Table 4-1.

4.1.2.1 Refining the Conceptual Waste Site and Operable Unit Model. Data will be collected to test and refine the conceptual models for individual waste sites and the operable unit. The conceptual model for individual waste sites or areas of contamination will be the basis for determining whether concentrations of contaminants pose an unacceptable risk and warrant implementing an IRM. Data collected for individual waste sources will be important in establishing the interaction between the sources and the groundwater. Therefore, it will be important to coordinate data-gathering activities and share data between the 100-NR-1 Source Operable Unit, the 100-NR-2 Groundwater Operable Unit, and the deactivation, decommissioning, decontamination and closure of 100 N facilities, which are the goals of the 100 N pilot project. Refinement of the conceptual models will require data collection for each of the data types shown on Table 4-1, including source, geologic, vadose zone, groundwater, surface water, air, ecological, and cultural resource data. Some of these data will be obtained during implementation of this work plan, some through the 100-NR-2 Groundwater Operable Unit work plan, some through the N Reactor deactivation program, some through RCRA closure activities, and some through the 100 Area aggregate investigations. A summary of some of these data needs and where the data will be obtained includes:

- location, disposal history, and construction of all identified and newly discovered contaminant sources (100-NR-1 Source Operable Unit)

- quantity, nature, and extent of contamination in surface soils and the vadose zone and aquifer matrix, especially from disposal of radioactive and nonradioactive liquid wastes in the cribs and trenches (100-NR-1 Source Operable Unit)

- quantity, nature, and extent of contamination in the lower vadose zone and capillary fringe from the leakage of contaminated cooling waters from the fuel storage basin, pipelines, and the resulting mound of groundwater that developed during operation of the reactor (100-NR-1 source and 100-NR-2 Groundwater Operable Units)

- geochemical, geologic, and physical characteristics of the vadose zone, especially in relation to the fate and transport of contaminants from waste sites to the groundwater (all 100 Area source operable units and 100 Area aggregate investigations)

- quantity, nature, and extent of contaminants in the groundwater system (100-NR-2 Groundwater Operable Unit)

- an understanding of the relationship between water-table fluctuations (especially related to fluctuations in levels in the Columbia River) and release and transport of contaminants from the lower vadose zone and capillary fringe to groundwater (100-NR-2 Groundwater Operable Unit)

- the nature and geometry of the hydrogeologic system, including the thickness, areal extent, and intrinsic properties (e.g., hydraulic conductivity) of the various hydrostratigraphic units (100-NR-2 Groundwater Operable Unit and 100 Area aggregate investigations)

- horizontal and vertical gradients in contaminated hydrostratigraphic units (100-NR-2 Groundwater Operable Unit)

- information on the nature of contamination in water emanating from seeps and springs along the shoreline of the Columbia River in the 100 Area, and the nature and extent of contamination in seep and spring sediments and adjacent river water (100 Area aggregate study to meet Tri-Party Agreement Milestone M-30-01, as described in the Surface Water/Sediment Investigation for the 100 Area, Appendix D-1 of the 100-NR-2 work plan)

- information on the nature and extent of contamination in the terrestrial, riparian, and aquatic biota adjacent to and in the vicinity of the 100 N Area (100 Area aggregate investigations)

- information on the potential for airborne contamination from fugitive dust (100-NR-1 Source Operable Unit)

- information on the groundwater recharge and discharge, and contaminant transport from off-site sources to the 100 N Area (100-NR-2 Groundwater Operable Unit and 100 Area aggregate investigations to meet Tri-Party Agreement Milestones M-30-04 and M-30-05)

- the impact of fluctuations in river stage on shallow groundwater flow (100-NR-2 Groundwater Operable Unit).

4.1.2.2 Qualitative Risk Assessment. A qualitative risk assessment is performed as part of the LFI. This assessment provides a semi-quantitative assessment of risk, and is focussed on the principle risk drivers in the operable unit. The results of this assessment will be used to help determine the need for an IRM, to select the IRM, and to determine risk-based cleanup levels for the IRM. The qualitative risk assessment

will be conducted using HSRAM (DOE-RL 1994b) as a guide. During rescoping meetings, the three parties agreed that determining the nature and vertical extent of contamination in the vadose zone and the upper portion of the aquifer soils should be sufficient for conducting a QRA at individual waste sites. The QRA for the groundwater operable units will be based primarily on the nature and extent of contaminated groundwater and the risk posed by discharge to the Columbia River.

4.1.2.3 Development and Evaluation of Interim Corrective Measures. Data needs for developing and evaluating the interim measures can be reduced by focusing only on a limited range of probable IRMs, as described in Section 3.4, and by employing the observational approach. For example, a detailed understanding of the lateral extent of contamination at source areas may not be needed if excavation is the preferred remedy and the volume of contaminated materials is not critical to selection of this remedy. Field screening could be used during implementation of the remedy to determine where and how much to excavate, and sampling conducted for laboratory analysis could verify completion of the cleanup. Preliminary data needed for developing and evaluating IRMs, developing the IRM ROD, and where the data will be collected, include:

- nature and vertical extent of contamination (100-NR-1 Source Operable Unit)
- information on the location, design, construction, uses, and decommissioning of the waste disposal units (100-NR-1 Source Operable Unit)
- hydrogeologic properties of the aquifer (100-NR-2 Groundwater Operable Unit)
- nature and extent of groundwater contamination discharging to the Columbia River (100-NR-2 Groundwater Operable Unit)
- nature and extent of contamination of surface water, sediment and biota (100 Area aggregate investigations)
- treatability study information relevant to the limited range of interim actions that may be considered (100-NR-1 Source Operable Unit and 100 N Area FS).

If additional data are needed at the completion of the LFI to evaluate interim remedial alternatives, the data needed will be identified and collected during the focused corrective measures study.

4.1.2.4 Baseline Risk Assessment. Data collected to conduct the quantitative baseline risk assessment will include input parameters for fate and transport models, vadose zone characteristics, and contaminant information required to evaluate the threats to human and environmental receptors posed by releases of contaminants. The baseline risk assessment will require input of data from the source, geologic, vadose zone, groundwater, surface water, air, terrestrial biota, and ecological data types, as shown on Table 4-1.

Specific computer programs for describing the flow of contaminants in the vadose zone will be identified and used following the evaluation of the above data. It is anticipated that PORFLOW (e.g., Version 2.10) (Runchal and Sagar 1990), or other programs mandated by DOE, with consultation with EPA and Ecology, will be used in evaluating mass flux in the vadose zone.

Many of the input parameters to the vadose zone and air transport modeling will be ranges of values, based on the results of recent studies at the Hanford Site, drilling and sampling in the 100 N Area, and laboratory testing of selected samples from this RFI. The need to further refine these parameters will be assessed based on the findings and results of the RFI, and any IRMs that are implemented. Specific data and

information requirements to support the baseline risk assessment, and the plan(s) that describe data collection activities include the following:

- information on the nature of contamination from specific waste sources (100-NR-1 Source Operable Unit)
- nature and extent of contamination in the surface soil (including airborne particulates) and shallow vadose zone are needed to evaluate current and future potential risk from external radiation, direct contact, and soil ingestion or inhalation pathways of exposure (100-NR-1 Source Operable Unit)
- nature and extent of vadose zone contamination are needed to predict flux of contaminants to the groundwater (100-NR-1 Source Operable Unit)
- soil geochemical, physical and hydrogeologic properties are needed as input parameters to fate and transport models (100 Area source operable units and 100 Area aggregate investigations)
- physical characteristics of site contaminants are needed as input parameters to fate and transport models (100 Area source operable units)
- nature and extent of contaminants in the groundwater system (100-NR-2 Groundwater Operable Unit)
- information on the nature and extent of soils contaminated by seeps at the river edge and the human and environmental risks posed by this soil (100 Area aggregate investigations)
- information on the nature and extent of contamination in the surface water and river sediments adjacent to the 100 Area (100 Area aggregate investigations)
- information on the nature and extent of contamination in the terrestrial, aquatic and riparian biota adjacent to the 100 Area (100 Area aggregate investigations)
- the nature of contamination associated with airborne particulates (100-NR-1 Source Operable Unit).

4.1.2.5 CARs Assessment. Identification of potential CARs will assist in identifying remedial alternatives. The CARs assessment will require data from the source, geologic, vadose zone, groundwater, surface water, air, ecological, and cultural resources data types, as shown on Table 4-1. Specific information needed to assess CARs includes:

- nature and extent of contamination in the various environmental media to determine contaminant-specific CARs (source, groundwater and aggregate area studies)
- determination of the presence of threatened or endangered species or the presence of critical habitats within the operable unit (100 Area aggregate investigations)
- determination of the presence of any archaeological or historic resources that may be considered eligible for inclusion on the National Registry of Historic Places (100 Area aggregate investigations).

4.1.2.6 Developing and Analyzing Final Corrective Measures Alternatives. Information needed to develop and analyze corrective measures alternatives during the final closure plan/CMS includes operable

unit characteristics and engineering data required for the development, screening, and detailed analysis of such alternatives. Sufficient information is needed at this time only for feasibility-level conceptual designs and order-of-magnitude cost estimates. The final closure plan/CMS will require input of the same data types identified in Section 4.1.2.3 for IRMs. These data needs are also shown on Table 4-1. It is anticipated that much of the data for completing the final closure plan/CMS will be provided during concurrent characterization conducted while implementing IRMs. In addition, since some of the reactor areas may have analogous facilities, information provided from investigations and interim actions at other operable units will be evaluated when selecting final corrective measure alternatives for this operable unit.

Detailed design information generally is not collected until the final corrective measures alternative(s) are selected. The RFI will not emphasize collecting design-level information. However, results of treatability studies and technology demonstration testing that may be conducted will be used, as appropriate, to design the full-scale remediation alternative.

4.1.2.7 Other Data Uses. Although not the primary objective, data collected for the previously described project purposes (Sections 4.1.2.1 through 4.1.2.6) will also be used for health and safety planning, design of alternatives, and environmental monitoring during the implementation of the remedial action.

The RFI/CMS data can be used to establish a pre-implementation baseline data set. Environmental monitoring, after implementation of the selected corrective action, can be performed to allow for comparison of the selected interim and final corrective actions with the baseline data to evaluate the effectiveness of the corrective measures alternative. The RFI/CMS data can also be used to determine the needs and best methods for any post-implementation monitoring that may be required. If the selected corrective measures alternative has the potential to cause adverse environmental impacts during the construction or operations phases, monitoring will be essential. Sufficient information will be generated to establish contaminant-specific action levels on which remedial monitoring efforts can be focused.

4.2 APPROACH

The overall approach to the 100-NR-1 Operable Unit investigation is based on the past-practice strategy (DOE-RL 1991a),and on Change Number M-15-94-04, and Change Number C-93-08 to the Tri-Party Agreement (Ecology et al. 1994b and 1994c). The past-practice strategy (DOE-RL 1991a) recognizes that to expedite the ultimate goal of cleanup, much more emphasis needs to be placed on initiating and completing waste site cleanup through interim measures. The 100 N Area pilot project will coordinate actions at RCRA past practice sites, RCRA TSD sites, RCRA TSD closure, 100 N facility decontamination, deactivation, decommissioning and the 100-NR-1 and 100-NR-2 operable unit CERCLA activities. One goal of the Change Number M-15-94-04 is an expedited LFI of the 116-N-1 and 116-N-3 sites so that remedial alternatives can be evaluated and to support closure under RCRA without deferral to CERCLA.

The following sections describe the basic concepts of the approach used in this work plan (Section 4.2.1) and the 100-NR-1 operable unit sampling and analysis approach that will be used (Section 4.2.2).

4.2.1 Basic Concepts of Approach

The past-practice strategy (DOE-RL 1991a) is briefly addressed in Section 4.2.1.1 and the investigation strategy for the 100-NR-1 operable unit sites is described in Section 4.2.1.2.

4.2.1.1 Hanford Site Past-Practice Strategy. The past-practice strategy (DOE-RL 1991a) is a streamlined approach to address environmental contamination from past-practice work at the 100 Area that

is intended to maximize efficiency, maintain project schedules, and achieve earlier remedial action. Figure 1-4 is a decision flow chart that shows the streamlined Hanford Site RI/FS (RFI/CMS) process.

Following the agreement on the past-practice strategy, the three parties began rescoping the current 100 Area work plans with a bias toward interim remedial action, and with the initial focus of the limited intrusive investigations placed on the highest-priority waste sites within each operable unit. The collective knowledge and judgment of the three parties and the information contained in the existing work plans were used to identify the high-priority waste sites and the paths to be followed to implement the new, streamlined strategy. The decisions made during joint meetings with the three parties are documented by meeting minutes that are part of the administrative record.

The near-term strategy agreed to by DOE, EPA, and Ecology for the 100 Area source operable units focuses on two preferred decision-making paths that will lead to interim remedial measures:

- LFIs will be performed at high-priority waste sites where existing data are considered insufficient to make decisions for conducting an IRM

- IRMs have been determined appropriate along the IRM path, without additional field investigations, at waste sites where existing data are considered sufficient to indicate that the site poses a risk through one or more pathways, based on information in existing work plans, data collected from analogous facilities, and the collective knowledge of the three parties.

The 100-NR-1 Operable Unit work plan approach described below focuses on these two preferred decision-making pathways.

4.2.1.2 Investigation Strategy for the 100-NR-1 Operable Unit. This work plan describes the approach for implementing the investigation strategy for past-practice and TSD sites that are currently identified contaminant sources at the 100-NR-1 Operable Unit. N Reactor shutdown program activities for those sites that are directly connected to the reactor building or nearby will be integrated into the operable unit schedule to meet objectives of the N Area pilot project as defined in Change Number M-15-94-04 and Change Number C-93-08. Investigations at low-priority sites will be deferred for long-term action for the final remedy selection process (see Figure 4-1), as deemed necessary.

Table 4-2 lists the 100 N Area facilities to be addressed by the past-practice investigation strategy, facilities to be deferred to decommissioning and facilities to be deferred to the final remedy selection. The table also describes, in general terms, the number and location of boreholes where limited intrusive field investigations are to be performed to define the nature and vertical extent of contamination, and lists those facilities where the three parties have determined that data are sufficient to determine that an IRM is appropriate without further field investigations. At these sites, further characterization will be performed concurrently with remediation, using the observational approach.

Options for contingencies have also been developed as part of the past-practice strategy, which include the option for:

- performing treatability studies or technology demonstrations at selected facilities and using data from analog 100-NR-1 Operable Unit or 100 Area facilities; the decision as to which waste sites will ultimately be selected as candidates for these studies must be agreed upon by the three parties at future unit managers' meetings

- collecting additional data during a focused corrective measures study
- deferring a waste site to the final remedy selection process.

Table 4-2 provides the details on the facilities in the 100-NR-1 Operable Unit and the investigation strategy. The proposed investigations shown on Table 4-2 may require modification as data are collected and evaluated from other 100 Area analogous sites. Changes of scope to the investigative strategy and limited field investigations described in this work plan will be documented by minutes to the monthly unit managers' meetings.

4.2.1.2.1 Site Investigations Required to be Integrated with N Reactor Shutdown. Both IRM and LFI pathways have been proposed for the high priority waste sites where the investigative action will be integrated with N Reactor shutdown program activities to meet objectives of the N Area pilot project. The 118-N-1 spacer storage silo, 1304-N EDT, 1300-N EDB, and 105-N reactor spent fuel storage basin will all be closed under the decontamination and decommissioning program. The silo and spent fuel storage basin are directly connected to the reactor building. The emergency dump tank and basin were designed to receive emergency blowdown of thermally hot reactor cooling water. Figure 4-2 illustrates the decision process for implementing IRMs at these facilities.

The LFI pathway is proposed for soils adjacent to the 1314 LWLS. This transfer station was used for loading spent radioactive reactor cooling system decontamination solution into rail cars for transport to the 200 Area. There have been two documented unplanned releases at this location. Investigation of the site will follow the LFI pathway illustrated in Figure 4-2, after closure of the 107-N spent fuel basin recirculation system. Site evaluation includes one vadose zone boring, one surface sample and one sample at the bottom of the valve pit.

4.2.1.2.2 Investigations at RCRA Facilities. There are the four RCRA TSD facilities within the 100-NR-1 Operable Unit; two are considered high-priority sites; the 116-N-1 crib and trench and 116-N-3 crib and trench. The decision process for high-priority sites is illustrated in Figure 4-3. These facilities received radioactive effluent from the reactor coolant system, spent fuel storage basins, and various radioactive drain systems. These areas may also have received small amounts of cooling system cleaning process wastes. Discharge to the 116-N-1 facility ceased in 1985. Discharge to the 116-N-3 facility ceased in August of 1993.

The 116-N-1 and 116-N-3 sites will be investigated by drilling, sampling, and geophysically logging three boreholes. Borehole 1301-N-1 will be located in the 116-N-1 crib. Borehole 1301-N-2 will be located in the 116-N-1 trench. Borehole 1325-N-1 will be located in the 116-N-3 crib. The data from chemical and radiochemical analyses of soil samples, physical properties analyses, and borehole geophysical logs will be used to evaluate remedial alternatives for the sites and to support closure activities. In addition, data have been obtained from analysis of soil samples collected during the construction of new RCRA monitoring wells 199-N-75, 199-N-76, and 199-N-80 that are located downgradient from the 116-N-1 trench (DOE-RL 1994c).

Investigation of the other two RCRA facilities; the 120-N-2 surface impoundment and 120-N-1 percolation pond followed the LFI pathway shown in Figure 4-4, and was completed as part of the 100-NR-1 LFI (DOE-RL 1994c) as summarized in Section 3.1.1.20.1. These surface impoundments received corrosive regeneration wastes from the demineralization plant and filter backwash waters from the water treatment plant. Characterization of these two sites consisted of the drilling, sampling, geophysical logging, and the analysis of samples one vadose zone boring, at each site. The investigation of the 120-N-1 percolation pond incorporated the site of the former south settling pond where an additional vadose zone boring was drilled, sampled, geophysically logged, and samples were analyzed (DOE-RL 1994c).

4.2.1.2.3 Investigations at High-Priority Waste Disposal Facilities. Investigations at high priority sites will follow the LFI path leading to the IRM path as shown in Figure 4-3. The contamination resulting from leaks in the decontamination waste drain line between the 105-N and 116-N-2 facilities (UN-100-N-6) will be evaluated during remediation. Leaks have been reported at four locations along the line and records indicate that contaminated soils were removed. Due to the quantity of radioactively contaminated water released, site remediation is assumed to be necessary.

4.2.1.2.4 Investigations at High-Priority Waste Disposal Facilities Where LFIs are Planned. The LFI pathway for a few high-priority waste sites will follow the LFI path leading to the IRM as shown by the logic diagram in Figure 4-4.

The high-priority sites, 1322-N and 1322-NA sample buildings housed sampling equipment which was plumbed directly to the radioactive waste treatment facility. Two documented unplanned releases are known to have occurred. Six surface soil samples were collected and three soil samples from the 199-N-86 vadose borehole and analyzed during the 100-NR-1 LFI (DOE-RL 1994c).

Investigation of the 116-N-2 radioactive chemical waste treatment and storage facility will also follow the LFI pathway for high-priority sites. The facility was used to treat radioactive waste decontamination solution and there were three reported unplanned releases, including a 340,650 L (90,000 gal) release of low level radioactive waste. Seven soil samples were collected from borehole 199-N-87 and submitted for analysis as part of the 100-NR-1 LFI (DOE-RL 1994c). The borehole was situated to investigate the 340,650 L (90,000 gal) release.

The 166-N tank farm and the diesel collection trench are also high-priority sites where LFIs are planned. The trench was constructed following an 302,800 L (80,000 gal) unplanned release of diesel fuel. There have been two other reported unplanned releases from this facility. Soil gas surveys were performed within the bermed area of the 166-N tank farm and at other sites where petroleum contamination was suspected (WHC 1992a). Ten soil samples were collected from borehole 199-N-95 and submitted for analysis as part of the 100-NR-1 LFI (DOE-RL 1994c).

Investigation of two unplanned releases associated with the 119-N cooling water drain line will follow the LFI pathway for high-priority sites illustrated in Figure 4-4. Three soil samples were collected from borehole 199-N-84 and submitted for analysis as part of the 100-NR-1 LFI (DOE-RL 1994c).

4.2.1.2.5 Investigations at Low Priority Waste Facilities and Unplanned Release Sites. There are numerous low priority sites located at the 100-NR-1 Operable Unit. Under the past-practice strategy, investigations proposed at these facilities will be limited to evaluation of existing data and site inspections using field screening instruments and soil sampling as deemed necessary. The decision process for investigation of low priority sites listed below is illustrated in Figure 4-5.

- Spring 1983 unplanned release of 100 gal sodium hydroxide
- 108-N chemical unloading facility
- 120-N-8 sulfuric acid day tank vent french drain
- reported drum storage area between 166-N oil unloading and 166-N tank farm
- 120-N-7 unloading station french drain
- 120-N-6 sulfuric acid french drains
- 181-N waste oil tank
- 184-N day tanks
- 166-N to 184-N piping
- 128-N-1 burning pit
- 120-N-4 nonhazardous and nonradioactive storage area

- construction debris sump
- UN-100-11
- N-17 paint shop.

Soil samples form the 128-1 burn pit were analyzed for VOCs, heavy metals, TPH, and PCBs using field screening methods as part of the 100-NR-1 LFI (DOE-RL 1994c).

The proposed RFI pathway for active septic and sewer systems includes one vadose zone boring in the approximate area of the drainfield. Test pits will be excavated across the drainfields of inactive systems. Sampling of septic tank and lagoon sludges will be deferred until the system is no longer in use. Septic and sewage systems located at the 100 N Area are listed below:

- 124-N-4 septic tank and drainfield
- 124-N-3 septic system
- 124-N-1 septic tank
- 124-N-5 septic tank
- 124-N-6 septic tank
- 124-N-7 septic tank
- 124-N-8 septic tank
- 124-N-9 septic tank
- 124-N-10 sanitary sewer system
- 124-N-2 septic tank.

Field investigations at the remainder of the facilities listed in Table 4-2 will be deferred until the cumulative risk assessment for the 100 Area site is considered.

4.2.2 100-NR-1 Operable Unit Sampling and Analysis Approach

A primary assumption made for this work plan was that investigations can be limited in scope by employing the observational approach during implementation of interim actions. During the rescoping effort, it was agreed that limited data on the nature and vertical extent of contamination is needed for priority sources areas. It was agreed that, for most sites, one borehole, at a location likely to represent "worst case" contamination, such as near locations of effluent discharge to the facility, or near the center of the facility if the discharge points cannot be determined was sufficient to determine the nature and vertical extent of contamination. These investigations, including the number and locations of boreholes, were identified in Section 4.2.1.2. Lateral extent of contamination and complete characterization may not be required, since these data can be obtained as needed during the focused feasibility study or during implementation of the IRM.

4.2.2.1 Source Sampling and Analysis. Depth of vadose zone borings will be based on field screening results, where screening techniques are available for the contaminants expected to be present (i.e., radioactive and volatile organic contaminants). At these sites, borings will extend to 1.5 m (5 ft) below detectable contamination to permit the collection of one sample to verify that the vertical extent of contamination has been defined. If screening continues to indicate detectable contamination to the water table, the boring will go below the water table to permit collection of at least one sample of the aquifer matrix. If screening techniques are not available or adequate relative to criteria to trace the extent of contamination for chemicals of concern, the boring will extend into the aquifer.

In the borings, except for 1301-N-1, 1301-N-2, and 1325-N-1 to be drilled at 116-N-1 and 116-N-3, samples will be collected at 1.5 m (5 ft) intervals. Source samples will also be collected at lithologic changes. Analysis will be conducted for the full suite of CERCLA Target Compound List (TCL) and

Target Analyte List (TAL) constituents, specific anions that may be present, and for radionuclides unless a refined list has been defined by results of previous investigations at other 100 Area sites. Chemical analysis will be conducted using EPA Contract Laboratory Program (CLP) methods. Standard methods will be used for radionuclide analysis. Routine analytical detection, quantitation limits, precision and accuracy will be specified in the QAPjP. As information is obtained from initial borings, and for borings at analog facilities, a project-specific list of analytes will be determined.

In boreholes 1301-N-1, 1301-N-2, and 1325-N-1 the 12 ft interval beginning at the base of the crib or trench surface will be continuously sampled. Samples will then be collected at 5 ft intervals to a depth of 20 feet, then at 10 ft intervals until groundwater is reached. The boreholes will extend into the saturated zone no more than 5 ft. Samples will be analyzed for CERCLA TAL constituents, anions, other chemical characteristics, e.g., total carbonate, radionuclides, and for selected physical properties. Chemical analysis will be conducted using EPA methods, both CLP and non-CLP. Standard methods will be used for radionuclide analysis. Physical properties will be measured using American Society for Testing and Materials (ASTM) methods. Additional details regarding drilling at the 116-N-1 and 116-N-3 facilities are provided in the DOW (DOE-RL 1994h). Routine analytical detection, quantitation limits, precision and accuracy will follow those specified in the QAPjP.

A plan for analyzing selected physical properties of soils has been recommended by EPA. The physical property data will be obtained on a 100 Area aggregate basis during groundwater operable unit investigations including the 100-NR-2 RFI/CMS. Physical property testing is proposed for the limited field investigation at the 116-N-1 and 116-N-3 sites (DOE-RL 1994h).

4.2.2.2 Data Validation Requirements. Data validation will be done in accordance with Section 8.2 of the QAPjP.

Figure 4-1. Final Remedy Selection Process.

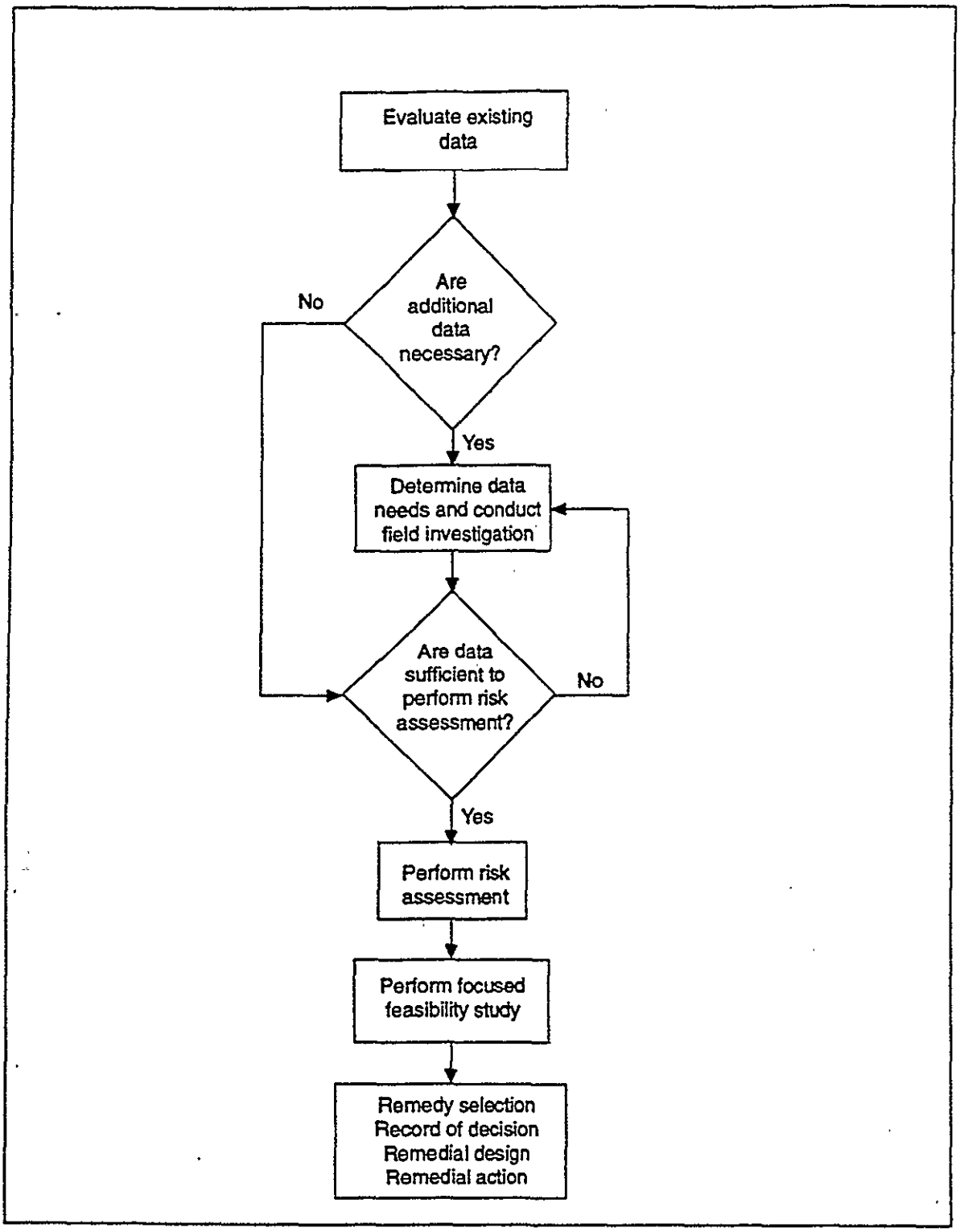

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Figure 4-2. Decision Process for Investigations Deferred Until After Reactor Shutdown.

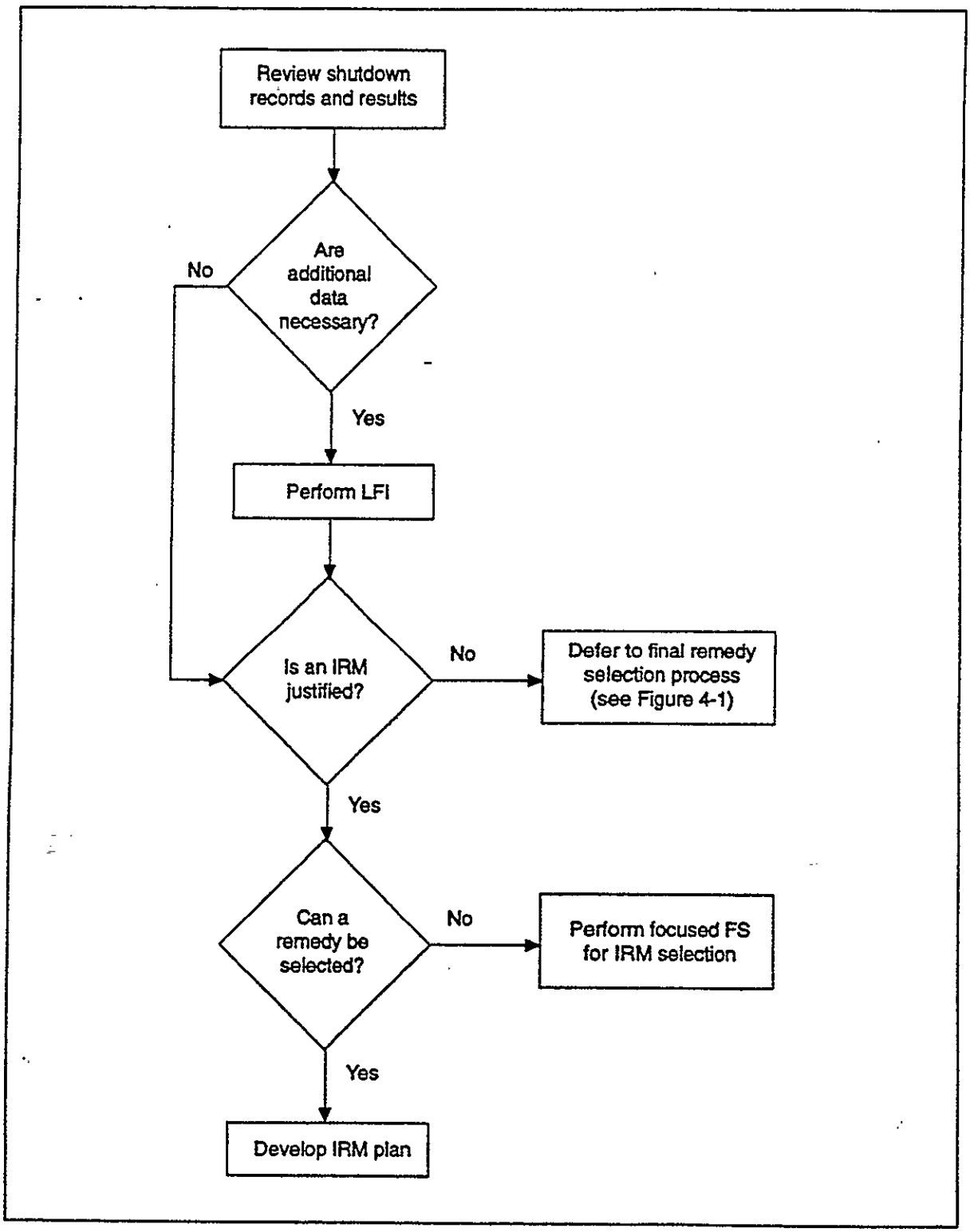

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Figure 4-3. Decision Process for High Priority Facilities and Waste Sites.

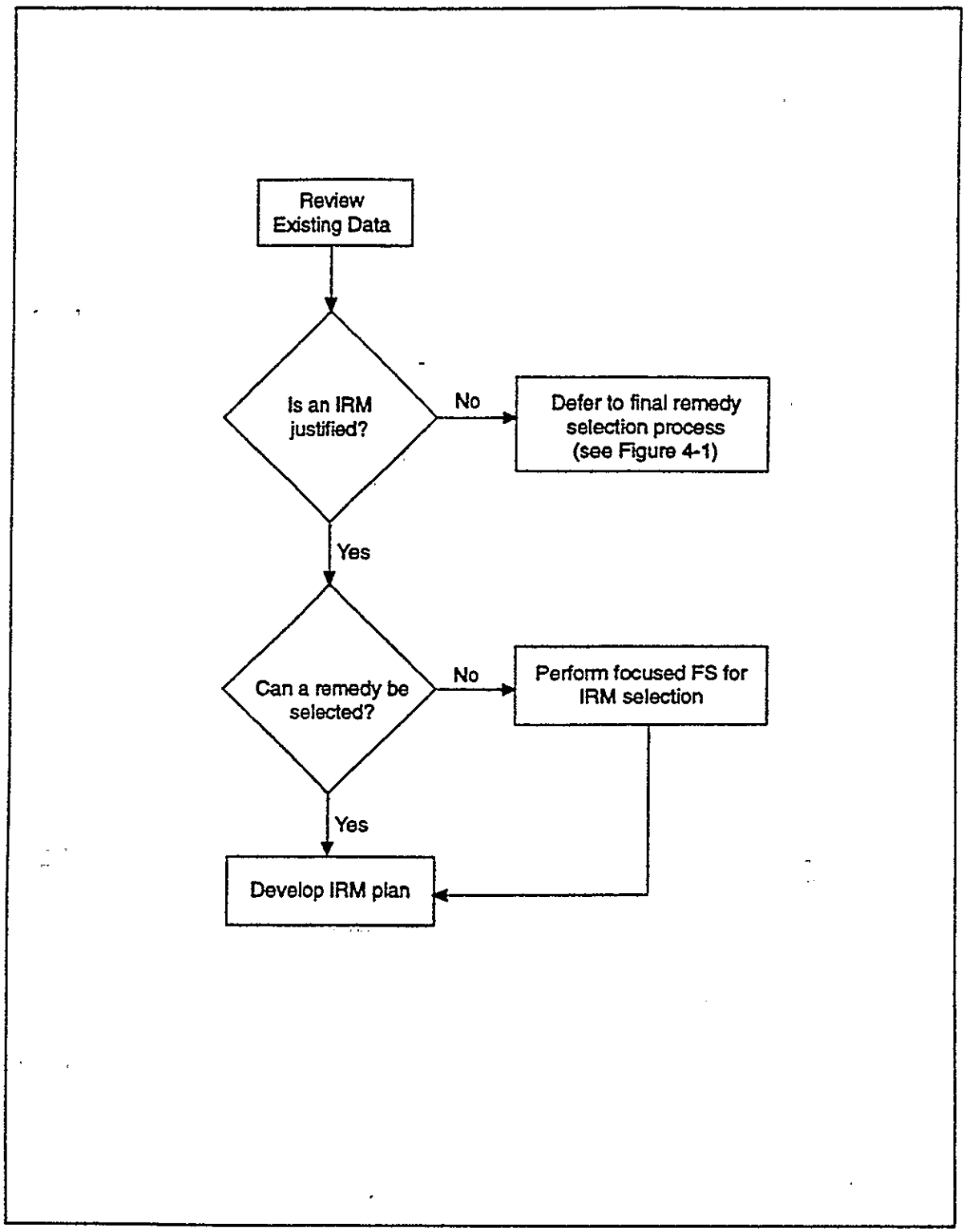

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Figure 4-4. Decision Process for Investigation at High Priority Facilities and Waste Sites Where LFIs are Planned.

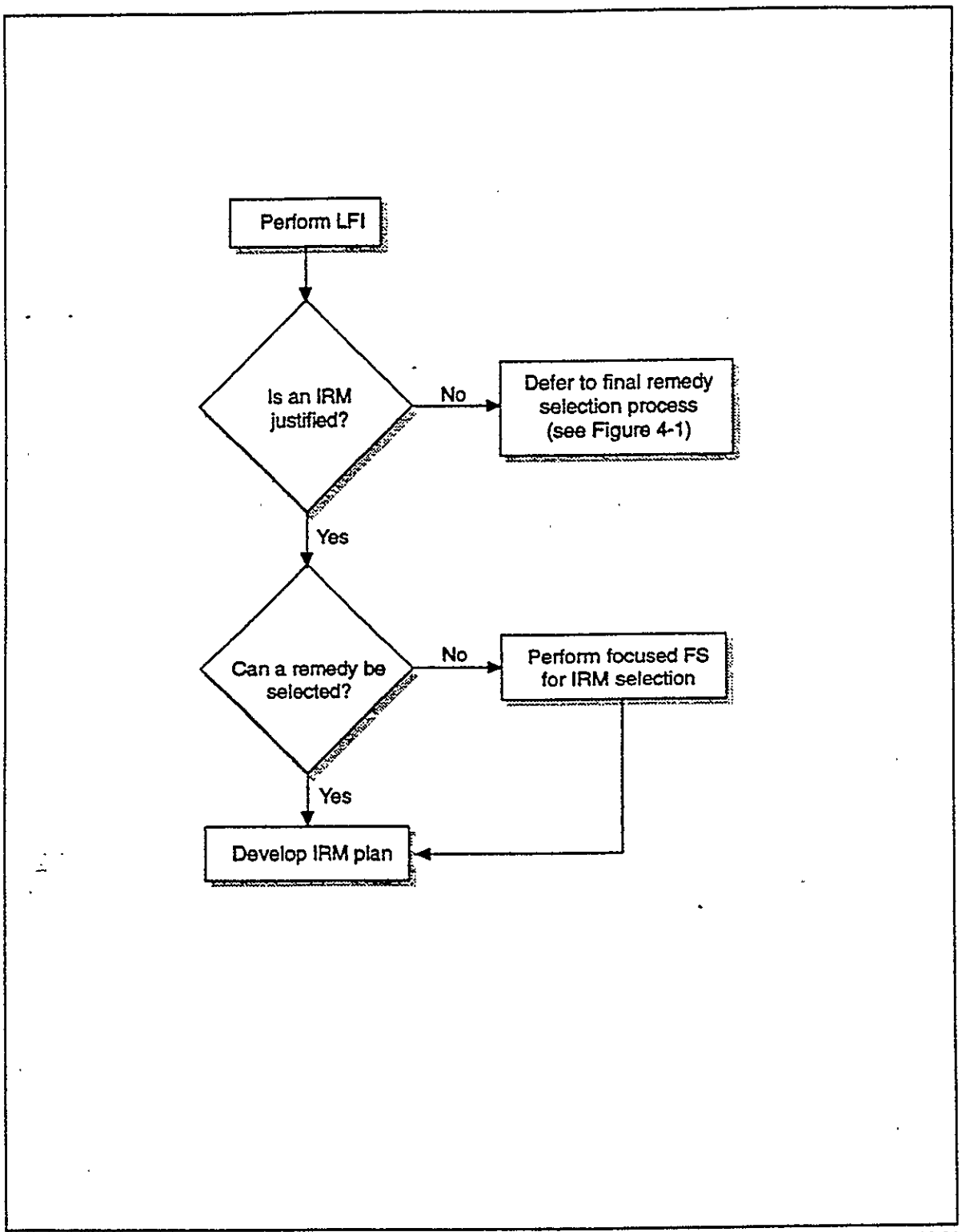

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Figure 4-5. Decision Process for Investigations at Lower Priority Facilities and Waste Sites Where Data From Analog Facilities Are Used.

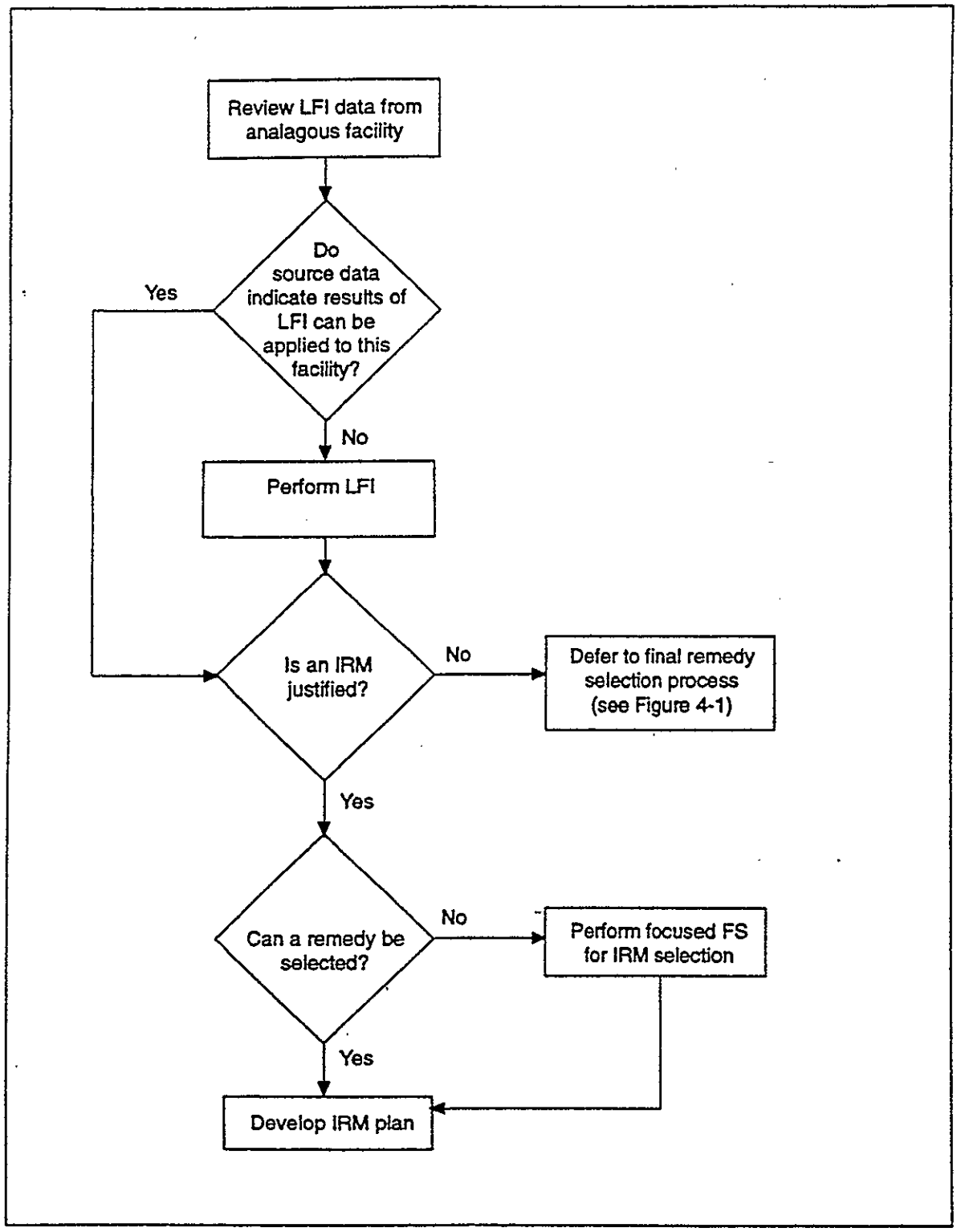

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Table 4-1. Data Needs Summary. (page 1 of 3)

Data needs	Purpose of Data					
	Refine conceptual operable unit model	Conduct final quantitative risk assessment	Conduct qualitative risk assessment	Evaluate CARs	Conduct focused corrective measures study for IRM	Conduct corrrrective measures study for operable unit
Source Data:						
• Locations and dimensions of all contaminant sources	S	S	S	S	S	S
• Types, quantities, and concentrations of contaminant sources	S	S	S	S	S	S
• Waste chemical and physical properties	S	S		S		S
Geologic Data:						
• Geological unit thickness and areal extent	S,G	S,G		S,G		S,G
• Soil mineralogy		H			H	H
• Stratigraphic features	S,G	S,G		S,G		S,G
Vadose Zone Data:						
• Soil/sediment types (classification)	S,G	S,G		S,G		S,G
• Saturated and unsaturated hydraulic conductivity[a]	A,G	A,G		A,G		A,G
• Moisture content	A,G	A,G				A
• Physical properties (grain-size distribution, and bulk density)	A,G	A,G				A,G
• Soil chemistry and pH	S,G	S,G		S,G		S,G
• Contaminant concentrations and extent	S,G	S,G	S,G	S,G	S,G	S,G
• Soil/sediment lithology	S,G					S,G
• Depth to water table/thickness of vadose zone	S,G	S,G			G	S,G
• Infiltration[b]	H	H				H

Table 4-1. Data Needs Summary. (page 2 of 3)

Data needs	Purpose of Data					
	Refine conceptual operable unit model	Conduct final quantitative risk assessment	Conduct qualitative risk assessment	Evaluate CARs	Conduct focused corrective measures study for IRM	Conduct corrrrective measures study for operable unit
Groundwater Data:						
• Nature and extent of contaminants in groundwater system	G	G	G	G	G	G
• River/aquifer interactions	A	A			A	A
• Hydraulic head in selected stratigraphic units	G	G			G	G
• Hydraulic properties	A, G, S	A, G, S			A, G, S	A, G, S
Surface Water and Sediment Data:						
• Nature and extent of contaminants in riverbank seeps, Columbia River and river sediments	A	A	A	A	A	A
Air Data:						
• Precipitation (annual and monthly averages and extremes; 1-hr and 24-hr max.; PMP)	H	H		H		H
• Temperature (annual and monthly averages and extremes; days per year below freezing)	H	H		H		H
• Wind velocity and direction (monthly/seasonal averages and extremes)	A	A		A		A
• Barometric pressure	H	H				H
• Relative humidity	H	H				H
• Evaporation rate (monthly averages)	H	H				H
• Atmospheric stratification and inversions (duration and frequency)	H	H				H
• Magnitudes and frequencies of extreme weather events	H	H				H
• Air quality	S[e]	S[e]	S[e]	S[e]		S[e]

Table 4-1. Data Needs Summary. (page 3 of 3)

Data needs	Purpose of Data					
	Refine conceptual operable unit model	Conduct final quantitative risk assessment	Conduct qualitative risk assessment	Evaluate CARs	Conduct focused corrective measures study for IRM	Conduct corrrrective measures study for operable unit
Ecological Data:						
• Terrestrial vegetation and wildlife potentially affected by source or groundwater contamination	A	A	A	A	A	A
• Presence of critical habitats	A	A	A	A	A	A
• Biocontamination	A	A	A	A	A	A
• Receptor demographics	A	A	A	A	A	A
• Land use characteristics; existing and potential future uses	A	A	A	A	A	A
• Water use characteristics; existing and potential future uses	A	A	A	A	A	A
Cultural Resource Data:						
• Location of surficial archaeological sites	A			A		A
• Presence of historic or archaeological sites that may be eligible for the National Register of Historic Places	A			A		A

[a]A range of unsaturated hydraulic conductivity values will be developed bounded by the saturated hydraulic conductivity and laboratory values of unsaturated hydraulic conductivity from tests on selected vadose zone samples.
[b]A range of infiltration values will be developed using current Hanford literature, studies such as the Hanford Protective Barrier Program, and actual site surface conditions.
[c]No field activities other than routine health and safety monitoring are planned.

Notes:
CAR = Corrective action requirement
PMP = Probable Maximum Precipitation
S = Source operable unit investigation
G = Groundwater operable unit investigation
H = Hanford Site-wide studies
A = Aggregate area studies

Table 4-2. 100-NR-1 Investigation. (page 1 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
RCRA TSD Facilities					
116-N-1	Effluent Crib 290 ft long 125 ft wide 12 ft deep Trench 1600 ft long 50 ft wide 12 ft deep	Received radioactive effluent from reactor and spent fuel storage basin. Also disposal area for various laboratory chemicals. Effluent enters Columbia River through N Springs. One unplanned release of 1,000 gal of radioactive effluent contaminating approximately 2,000 ft^2 of soil.	IRM	2	High-priority remediate. 2 borings, one in the crib area and one in the trench area.
116-N-3	Effluent Crib 250 ft long 240 ft wide 12 ft deep Trench 3000 ft long 55 ft wide 7 ft deep	Received radioactive effluent from reactor and spent fuel storage basin. Also disposal area for various laboratory chemicals. Effluent enters Columbia River through N Springs.		1	1 boring will be placed in the crib area.
120-N-2	Surface Impoundment 140 ft long 75 ft wide 15 ft deep	Received corrosive regeneration wastes and filter backwash water. Used as an unlined settling pond 1977-1983. Used as a lined impoundment 1986-1988.	LFI	1	One vadose zone boring.
120-N-1	Percolation Pond 270 ft long 80 ft wide 15 ft deep South Settling Pond 110 ft long 50 ft wide 15 ft deep	Received corrosive regeneration wastes and filter backwash water. Currently receives nonregulated neutralized regeneration wastewater. Unlined pond. Was an unlined pond which received corrosive regeneration wastes and filter backwash water. The site was closed and backfilled between 1983 and 1986.	LFI	2	One vadose zone boring (or test pit) in the Percolation Pond and one placed in the area where the South Settling Pond was located.[a,b,c]

Table 4-2. 100-NR-1 Investigation. (page 2 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
High Priority Sites					
118-N-1	Spacer Storage Silos (3) 20 ft deep	Contained irradiated fuel spacers. Three unplanned releases with soil removal documented for two of them.	IRM	NA	Integrate action with 105-N basin draining.
1304-N	Emergency Dump Tank 1.3 million gal	Received emergency dumpings of radioactive coolant water. Six documented unplanned releases with five documenting soil removal.	IRM	NA	Remediate area following reactor decommissioning.
116-N-4	Emergency Dump Basin 1 million gal	Received cooling and blowdown water and sludge containing radionuclides. Received emergency dumpings of radioactive coolant water.	IRM	NA	Remediate soils after basin has been drained and residual materials removed.
105-N	Spent Fuel Storage Basin	Containment basin for storage of spent fuel rods and spacers. Two unplanned releases with one soil removal.	IRM	NA	Integrate action with 105-N basin draining.
UN-100-N-6	Decontamination Waste Drain Line	Leaks at four locations along line released approximately 1,800 gal of radioactive wastewater.	IRM	NA	Concurrent characterization during remediation.[a,c]
High-Priority Sites Where LFIs are Planned					
1322-N and 1322-NA	Sample Buildings	Sump overflow releases at pilot plant treatment facility. One unplanned release at 1322-N of 1,500 gal of radioactive wastewater. One unplanned release at 1322-NA of 100 gal of radioactive wastewater.	LFI	1	Three surface soil samples and one vadose zone boring.[a,b,c]
116-N-2	Treatment and Storage Facility 900,000 gal	Temporary storage of radioactive waste decontamination solution from N reactor. One unplanned release of 90,000 gal of radioactive chemical waste. One unplanned release of 500 gal of primary loop water and decontamination solution. No details on a third unplanned release.	LFI	1	One surface soil sample, a radiation survey, and one vadose zone boring.[a,b,c] Pipelines will be investigated for potential leaks.
119-N	Cooling Water Drain Line	Drained reactor coolant. One unplanned release of 70 gal contaminating 800 ft^2 of ground, soil >1000 cpm was removed. One unplanned release of 2,200 gal.	LFI	1	One vadose zone boring at unplanned release site if needed.[a,b,c]

Table 4-2. 100-NR-1 Investigation. (page 3 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
High-Priority Sites Where LFIs are Planned (Cont)					
166-N Tank Farm and Diesel Collection Trench	Diesel fuel	Site of a 80,000 gal and two other unplanned releases. (UN-100-N-17)	LFI	1	One vadose zone boring is planned. Soil gas surveys will be performed within bermed area of 116-N tank farm, at the loading and loadout manifolds and at the location of UN-100-N-17 collection trench. Additional soil sampling may be performed as indicated by soil gas survey results.[a,b,c]
Low Priority Sites					
Unplanned Release Site Spring 1983		Approximately 100 gal of NaOH spilled.	RFI	0	Records review, site inspection with field screening instruments (when appropriate), and soil sampling as needed.[a]
108-N	Chemical Unloading Facility	Unloading area for chemicals. Three aboveground H_2SO_4 tanks, one aboveground NaOH tank and six french drains. Various unplanned releases have occured.			
120-N-7	Unloading Station French Drain	Received spills of 93 percent H_2SO_4 and 50 percent NaOH during railcar or tank truck unloading. Unknown amount of unplanned release.			
120-N-6	Sulfuric Acid Tank French Drains	Received unknown amount of 93 percent H_2SO_4 and 50 percent NaOH.			
120-N-8	Sulfuric Acid Day Tank Vent French Drain	Received drainage from tank overflow containing H_2SO_4.			
Drum Storage Area	Reported Drum Storage Area	Area between 166-N fuel oil unloading station and 166-N tank farm.			
181-N	Waste Oil Tank 260 gal	Managed waste oil from pump oil changes.			
184-N	Day Tanks two 350,000 gal one 8,000 gal	One unplanned release of 2,000 gal fuel oil. One unplanned release of 800 gal diesel oil. One unplanned release of an unknown amount of diesel oil. Oil was removed in all cases.	RFI	0	Records review, site inspection with field screening instruments (when appropriate) and soil sampling as needed.[a]

Table 4-2. 100-NR-1 Investigation. (page 4 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
Low Priority Sites (Cont)					
UN-100-N-11	Unplanned Release	Valve bonnet, radioactive soil and asphalt were dropped onto area and subsequently removed.	RFI	0	Defer to cummulative risk phase. Records review, site inspection with field screening instruments (when appropriate), and soil sampling as needed.[a]
120-N-5	Acid/Caustic Transfer French and Neutralization Unit	Carried H_2SO_4 and NaOH. Various releases have occured.			
120-N-3	Neutralization Pit and French Drain	Received drainage from 163-N acid and caustic day tank area consisting of H_2SO_4 and NaOH. Various releases have occured.			
Regeneration Waste Transport System		Received acid and caustic regeneration waste from 163-N. One unplanned release of 6,500 gal and one unplanned release of 1,000.			
166-N - 184-N	Piping	Carried fuel oil. Two unplanned releases of 200 gal. One unplanned release of 300 gal. One unplanned release of 1,000 gal. One unplanned release of an unknown amount.	RFI	0	Continue monitoring for oil in existing wells. Records review, site inspection with field screening instruments (when appropriate), investigation of potential pipeline leaks and soil sampling as needed.[a]
Septic Tanks and Sanitary Waste Disposal Facilities					
124-N-4	Septic Tank and Drain Field 14,000 gal tank 8,900 ft^2 field	Primary septic system for 100-N Area handling approximately 30,000 gal/day of sanitary sewage. Radioactive contamination has been detected at the surface.	RFI	0	One sample of contents of each tank, samples from trench across leach field after reactor shutdown.[a,c]
124-N-5 124-N-6 124-N-7	Septic Tanks	Septic tank and drain field.			
124-N-1	Septic Tank	Septic tank and seepage pit for 163-N, 183-N, 1127-N, and 1128-N buildings.	RFI	1 for each drainfield.	One vadose zone boring in approximate area of the drainfield after reactor shutdown.[a,b,c]
124-N-2	Septic Tank	Septic tank and drain field serving 182-N building personnel.			

Table 4-2. 100-NR-1 Investigation. (page 5 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
Septic Tanks and Sanitary Waste Disposal Facilities					
124-N-3 124-N-8 124-N-9	Septic System 500 gal Septic Tank Septic Tank	Cesspool for 107-N and construction personnel.	RFI	1 for each drainfield.	One vadose zone boring in approximate area of the drainfield after reactor shutdown.[a,b,c]
124-N-10	Sewer System	Lift stations and three lagoons handling sanitary sewage.	RFI	0	One sample from each of the two lined ponds and one surface sample from the unlined pond after reactor shutdown.[a,c]
Other Low Priority Sites					
1314-N	Liquid Waste Loadout Facility 80 ft long 30 ft wide	Transfer station for spent radioactive internal decontamination solution. One unplanned release of 175 gal. One unplanned release of 1,000 gal.	RFI	1	Integrate action with closure of 107-N spent fuel-regenerant waste system. One vadose zone boring.[b] One surface sample. One contents sample of valve pit.[a,b,c]
1143-N HGP Burn Pit	Paint Shop	Contained paint wastes annd associated water, spent thinner, spent garnet sand and paint chips. Trash burning pit. Approximate area - 10 yd^2	RFI	0	Defer to cummulative risk phase. Records review, site inspection with field screening instruments (when appropriate), and soil sampling as needed.[a]
120-N-4 128-N-1 N-17	Storage Area Burning Pit Paint Shop	Curbed concrete pad that held nonhazardous and nonradioactive oils and aqueous liquids. Site of undetermined area for burning of office and lunchroom trash and tumbleweeds using fuel oil as starter. Contained waste paint, solvents, and oils.	RFI	0	Records review, site inspection with field screening instruments (when appropriate), and soil sampling as needed.[a]

Table 4-2. 100-NR-1 Investigation. (page 6 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
Other Low Priority Sites (Cont)					
116-N	Air Stack	Released gaseous and particulate radionuclides from reactor operations to the atmosphere.	Decom-missioning	0	Defer to decommissioning and continue to monitor.
184-N	Plant Service Power House	Routinely and systematically released hydrocarbons, particulates, sulfur dioxide, sulfur trioxide, carbon monoxide, nitrogen oxide, and aldehydes from boiler stacks.			
105-N Lift Station UST	Underground Storage Tank 5,000 gal	Stored diesel fuel.	RFI	0	Defer to cumulative risk phase. Records review, site inspecton with field screening instruments (when appropriate), and soil sampling as needed.[a]
102-in	Outfall Line	Discharged secondary cooling water to the Columbia River.			
181-N	Inlet Screen Backwash-Water Outfall	Discharged to the Columbia River, backwash water and solids from raw water intake.			
182-N	Under-Ground Storage Tanks (3) 10,000 - 19,000 gal	Contained diesel oil.			
116-N-8	Mixed Waste Storage Pad	Paved and curbed concrete pad for storing drums containing radioactively contaminated oil and miscellaneous process chemicals. RCRA satellite accumulation area.			
Grass Dump		Pit for dumping grass clippings. Unknown if other materials were disposed of. Approximate size - 10 yd^2			
Tank Farm Overflow		Overflow water analyzed for temperature, pH, total suspended solids, oil and grease, and chlorine.			
Drain System		Water analyzed for temperature, pH, total suspended solids, and oil and grease.			

Table 4-2. 100-NR-1 Investigation. (page 7 of 7)

Site	Waste/Type	Comments	Pathway	Proposed Boreholes	Investigative Approach
Other Low Priority Sites (Cont)					
Construction Debris Dump		Indeterminate area along roads south and east of HGP where construction debris (e.g., dirt, cement, asphalt, metal and wood) were disposed.	RFI	0	Defer to cumulative risk phase. Records review, site inspecton with field screening instruments (when appropriate), and soil sampling as needed.[a]
Unplanned Release		Lube oil line leak of 5 gal of turbine oil to river.			
1716-N	Underground Storage Tanks (2) 1,000 - 4,000 gal	Contained unleaded gasoline. Evidence of unplanned release found during removal of one tank	UST Program	0	Removal/Treatment of soil to be handled under UST Program

[a] = Field screening techniques will be used where screening techniques and equipment are available for the contaminants expected to be present. The equipment may include; radiation detection monitors, pH meters, gas chromatography, thin layer chromatography, volatile organic monitors, chemical detection tubes, chrome or other chemical specific detection kits.

[b] = If screening continues to indicate detectable contamination to the water table, the borehole will be extended to below the water table to permit the collection of at least one sample of the aquifer matrix.

[c] = Analysis will initially be conducted for full suite CERCLA TCL and TAL constituents, anions that may be present, and radionuclides unless a refined list has been defined.

NA - Not applicable.

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5.0 RCRA FACILITY INVESTIGATION/CORRECTIVE MEASURES STUDY PROCESS

This chapter describes the RFI/CMS process through the final RFI and final CMS for the operable unit. Section 5.1 outlines the tasks to be implemented during the LFI and the 100 Area aggregate and Hanford Site studies, and during the final RFI. Tasks are designed to provide information needed to meet the DQOs identified in Chapter 4. The detailed information needed to carry out these tasks will be presented in one or more DOWs for the operable unit (see Subtask 1e). Environmental monitoring requirements for protecting the health and safety of onsite investigators are described in the HSP (Appendix B).

The feasibility and corrective measures studies that will be conducted in support of remedy selection during the RFI/CMS process are described in Section 5.2. A detailed analysis of remedial alternatives for IRMs will be conducted as part of the focused FS, and an analysis for operable unit corrective actions will be conducted as part of the final CMS. Both the focused FS and final CMS will use information provided by the analysis of generic remedial alternatives completed as part of the 100 Area FS.

Following approval, this work plan will not be modified. Any changes to the scope of work that may be needed will be documented through change requests in accordance with the procedures identified in the QAPjP (Appendix A).

5.1 RCRA FACILITY REMEDIAL INVESTIGATION PROCESS

5.1.1 Limited Field Investigation and the 100 Area Aggregate and Hanford Site Studies

To satisfy the data needs and DQOs specified in Chapter 4.0, the following tasks will be performed during the RFI:

- Task 1--Project Management
- Task 2--Source Investigation
- Task 3--Geological Investigation
- Task 4--Surface Water and Sediments Investigation
- Task 5--Vadose Zone Investigation
- Task 6--Groundwater Investigation
- Task 7--Air Investigation
- Task 8--Ecological Investigation
- Task 9--Other Tasks
- Task 10--Data Evaluation
- Task 11--Risk Assessment
- Task 12--Verification of CARs
- Task 13--LFI Report.

The tasks and their component subtasks and activities are outlined in the following sections. Information is provided on each task to allow estimation of the project schedule (see Section 6.0) and costs.

5.1.1.1 Task 1--Project Management. The project management objectives throughout the course of the 100-NR-1 RFI/CMS are to direct and document project activities so that the data and evaluations generated meet the goals and objectives of the work plan, and to ensure that the project is kept within budget and schedule. The initial project management activity will be to assign individuals to roles established in Chapter 7.0. Specific subtasks that will occur throughout the LFI/focused FS and RFI/CMS include the following:

- Subtask 1a--General Management
- Subtask 1b--Meetings
- Subtask 1c--Cost Control
- Subtask 1d--Schedule Control
- Subtask 1e--Work Control
- Subtask 1f--Data Management
- Subtask 1g--Progress and Final Reports
- Subtask 1h--Quality Assurance
- Subtask 1i--Health and Safety
- Subtask 1j--Community Relations.

Each of these subtasks is described in the following sections. Further detail on schedule control, cost control, meetings, and reporting can be found in the *Environmental Restoration Field Office Management Plan* (DOE-RL 1989b) and the Action Plan in the Tri-Party Agreement (Ecology et al. 1990a).

5.1.1.1.1 Subtask 1a--General Management. This subtask includes the day-to-day supervision of, and communication with, project staff and subcontractors. Throughout the project, daily communications between office and field personnel will be maintained, along with periodic communications with subcontractors, to assess progress and to exchange information. This constant exchange of information will be necessary to assess the progress of the project and to identify potential problems soon enough to make necessary corrections to keep the project focused on its objectives, on schedule, and within budget.

5.1.1.1.2 Subtask 1b--Meetings. Meetings will be held, as necessary, with members of the project staff, subcontractors, regulatory agencies, and other appropriate entities (particularly those involved with the nearby 100 Area operable units and reactor shutdown project) to communicate information, assess project status, and resolve problems. Monthly unit mangers' meetings will be held to report progress, resolve problems, and address changes in work scope, as necessary.

Operable unit project coordinators for this and other operable units will meet periodically to share information and to discuss progress and problems. The frequency of other meetings will be determined based on need and on schedules published in the Tri-Party Agreement Action Plan (Ecology et al. 1990a).

5.1.1.1.3 Subtask 1c--Cost Control. Project costs, including labor, other direct costs, and subcontractor expenses, will be tracked monthly. The budget tracking activity will be computerized and will provide the basis for invoice preparation, review and for preparation of progress reports.

5.1.1.1.4 Subtask 1d--Schedule Control. Scheduled milestones will be tracked monthly for each task for each phase of the project. This will be done in conjunction with cost tracking.

5.1.1.1.5 Subtask 1e--Work Control. The level of detail provided in this work plan is adequate for initial planning purposes. Detailed information needed to carry out the investigative tasks discussed in this chapter will be provided in the 100-NR-1 Source Operable Unit DOWs. The DOWs will be provided to the lead regulatory agency for review and approval. Where appropriate the DOWs will reference WHC Environmental Investigation Instructions (EIIs) from the *Environmental Investigations and Site Characterization Manual* (WHC 1991a) rather than listing the entire procedure for a task. Environmental investigation instructions for field activities and laboratory analysis are also referenced in the QAPjP (Appendix A). Any reference to the DOWs or QAPjP as a source of additional information is inclusive of the EIIs they reference.

The DOW shall be prepared in accordance with the procedures listed in QAPjP. The DOW must satisfy the following requirements:

- Include a scope of work introductory section.
- Include the data quality objectives, as specified in the work plans, for each type of activity.
- Identify the proposed locations for sampling and the criteria for selecting those locations. A map, at a scale appropriate to locate the sites in the field, should be included.
- Identify any field screening activities not described in the work plan or in the relevant EIIs. Identify any field screening equipment to be used which is not described in the relevant EIIs.
- Include the frequency of measurement (e.g., five foot intervals and lithology breaks).
- Identify the applicable EIIs needed to conduct the work. If an EII includes several different ways to accomplish the work, then the DOW should specify the method of choice or reference the specific EII section.
- Identify any calibrating standards and frequencies not included in the relevant EIIs.
- Describe any data collection procedures, chain of custody procedures, sample container size and preparation, holding times, type of analysis, number of split samples, number of duplicate samples, number of blank samples and data reporting requirements not included in the relevant EIIs.
- Provide an estimate of the proposed field activity schedule, including sampling periods.
- Include provision to document any field changes using a project change form and to submit the form to EPA/Ecology within 10 working days of the change.

5.1.1.1.6 Subtask 1f--Records Management. The project file will be kept organized, secured, and accessible to the appropriate project personnel. All field reports, field logs, health and safety documents, QA/QC documents, laboratory data, memoranda, correspondence, and reports will be logged into the file upon receipt or transmittal. This subtask is also the mechanism for ensuring that data management procedures documented in the IMO (Appendix C) are carried out appropriately. Other reporting requirements (e.g., DOE quarterly progress reports) are discussed in Chapter 7.0.

5.1.1.1.7 Subtask 1g--Progress and Final Reports. Monthly progress will be documented at unit managers' meetings. Meeting minutes will be prepared, distributed to the appropriate personnel and entities (e.g., project and unit managers, coordinators, contractors, subcontractors), and entered into the project file. Other reporting requirements (e.g., DOE quarterly progress reports) are discussed in Chapter 7.0.

All LFI/focused FS and RFI/CMS reports and plans will be categorized as either primary or secondary documents. The process for document review and comment is covered by the Tri-Party Agreement Action Plan (Ecology et al. 1990a). Administrative records must be maintained, as described in Section 9.4 of the Action Plan.

5.1.1.1.8 Subtask 1h--Quality Assurance. The specific planning documents required to support the RFI/CMS have been developed within the overall QA program structure mandated by the DOE for all activities at the Hanford Site. Within that structure, the documents are designed to meet current EPA guidelines for format and content and are supported and implemented through the use of standard operating procedures drawn from the existing program or that have been developed specifically for environmental investigations. To ensure that the objectives of this RFI/CMS are met in a manner

consistent with the DOE Order, all work conducted by WHC will be performed in compliance with existing QA manuals and the Westinghouse Hanford QA program plan that specifically describe the application of manual requirements to environmental investigations. The 100-NR-1 QAPjP (Appendix A) supports the LFI described in this chapter. The QAPjP defines the specific means that will be used to ensure that the sampling and analytical data are defensible and will effectively support the purposes of the investigation. The QAPjP will be implemented by this subtask.

5.1.1.1.9 Subtask 1i--Health and Safety. The HSP (Appendix B) will be used to implement standard health and safety procedures for WHC employees and contractors engaged in RFI/CMS activities in the 100-NR-1 Operable Unit.

5.1.1.1.10 Subtask 1j--Community Relations. Community relations activities will be conducted in accordance with the CRP for the Hanford Site (Ecology et al. 1990b). All community relations activities associated with the 100-NR-1 Operable Unit will be conducted under this overall Hanford Site CRP.

5.1.1.2 Task 2--Source Investigation. The source investigation for the LFI at the 100-NR-1 Operable Unit is composed of five subtasks and their component activities:

- Subtask 2a--Source Data Compilation and Review
- Subtask 2b--Surveying
- Subtask 2c--Field Activities
  - Activity 2c-1--Site Walkover
  - Activity 2c-2--Surface Radiation Survey
  - Activity 2c-3--Ground Penetrating Radar Survey
  - Activity 2c-4--Source Sampling
  - Activity 2c-5--Soil Gas Sampling
- Subtask 2d--Laboratory Analysis and Data Validation
- Subtask 2e--Source Data Evaluation.

These subtasks will be conducted to identify sources, locations, and potential contamination associated with each high-priority facility and identified low priority sites as agreed to by the three parties. Additional activities described under Task 5, Vadose Zone Investigation, will be conducted to define the nature of soil contamination. As described in the following subtasks, not all activities will be conducted at each facility.

The source investigation performed as part of the 100-NR-1 Source Operable Unit investigation will be integrated with similar investigations to be performed as part of the 100-NR-2 Groundwater Operable Unit investigation to avoid duplication of effort and maximize use of the data obtained. The source investigation task will be deferred at facilities associated with reactor shutdown activities.

5.1.1.2.1 Subtask 2a--Source Data Compilation and Review. A search for 100-NR-1 Operable Unit documents, photographs, and drawings is being conducted. Review of this material will provide additional information about source units or potential source areas in order to focus all subsequent investigative tasks and subtasks. The source data compilation subtask consists of reviewing the existing information on 100-NR-1 Operable Unit facilities to more accurately and completely characterize the potential sources of contamination within the operable unit. Table 5-1 lists source data gaps identified in this work plan.

The source data compilation will provide additional information on the history of operations of the reactor and support facilities, as well as the waste generation processes, solid and liquid waste streams, waste facility characteristics, radioactive and hazardous waste storage volumes and inventories, and exact location and construction specifications for facilities for which information is currently lacking. Some or all of this information is needed to supplement information for facilities listed on Table 2-1 or 100 N Area sources listed on Table 3-1 of the work plan that are identified as known or suspected to have received or produced radioactive or hazardous wastes, or for which waste receipt or production is currently unknown. The source data compilation will also provide additional data on the physical and ecological characteristics of the operable unit. The above information is necessary to more accurately and completely characterize the potential sources of contamination at the operable unit and to further characterize the physical and ecological setting. The information obtained in this subtask will be evaluated and subsequently used to refine the 100-NR-1 Operable Unit conceptual model, and to focus subsequent LFIs.

The available historical documents, including aerial photographs, engineering plans, shutdown reports, effluent discharge reports, daily and monthly reactor operating logs, environmental release reports, and any existing geological and ecological data not evaluated during this scoping process will be reviewed. This subtask may also include interviews with those personnel having knowledge of past activities at the 100-NR-1 Operable Unit, including former and current operations, maintenance and shutdown personnel. Records from the PCB program, performed under manual *Environmental Compliance Manual, Part Y, Asbestos and Polychlorinated Biphenyls* (WHC 1991b), in accordance with 40 CFR 761, will be reviewed to investigate potential past-practice PCB leaks.

Any data gathered during LFIs at analogous waste units within the 100-NR-1 Operable Unit or in other 100 Area operable units will be compiled. These data will be evaluated to determine its applicability to analogous waste units in the 100-NR-1 Operable Unit and will be used to focus subsequent LFIs.

5.1.1.2.2 Subtask 2b--Surveying. The objectives of this activity are to provide horizontal and vertical control for sampling points and to document all sample-point locational data on an operable-unit-wide basis. A topographic base map for the operable unit has been developed using computer aided design at a scale of 1:2000 that shows elevation contours at 0.5-m (1.5 ft) intervals. Horizontal control will be provided for sampling points established for completing the following activities:

- Activity 2c-4--Source Sampling
- Activity 5b-3--Borehole Soil Sampling.

Locations of soil boring samples collected during Task 5 vadose zone sampling will be surveyed for both horizontal coordinates and vertical elevations. The National Geodetic Vertical Datum of 1929 will be used for vertical alignment and the North American Datum of 1983 will be used for horizontal coordinates. The topographic base map will provide adequate vertical control for source samples. A list of supporting procedures for surveying is presented in Table QAPjP-2 of the QAPjP.

5.1.1.2.3 Subtask 2c--Field Activities. Field activities planned for the 100-NR-1 Operable Unit are:

- Activity 2c-1--Site Walkover
- Activity 2c-2--Surface Radiation Survey
- Activity 2c-3--Ground Penetrating Radar Survey
- Activity 2c-4--Source Sampling
- Activity 2c-5--Soil Gas Sampling.

These activities are described in the following sections.

Activity 2c-1--Site Walkover. The objectives of this activity are to identify and locate additional sources and areas of disturbed and/or unnatural appearance, to locate known (but mislocated) sources, and to obtain a general understanding of the site with emphasis on those facilities deferred to the long-term final remedy selection process. The entire operable unit will be walked, and areas of disturbance, monuments, and so forth, will be mapped. This activity will be conducted during the RFI at low-priority facilities deferred to the final remedy selection process. The walkover will be extended outside the operable unit boundary if it is determined that previously unidentified source units are present near the operable unit. Available aerial photographs will be used by the crew performing the walkover. The crew will note areas of potential interest on the photographs and will ground-truth unusual areas noted on the photographs. All areas of potential interest will be flagged and surveyed as part of Subtask 2b--Surveying. Data from the 100-NR-1 Operable Unit walkover will be made available to persons coordinating 100-NR-2 Operable Unit field investigations.

Activity 2c-2--Surface Radiation Survey. The objective of this task is to develop a map of surface radiation levels throughout the 100-NR-1 Operable Unit. The surface radiation survey will be used to identify areas of surface and potentially subsurface sources that can be detected at the surface and possibly require further study. Figure 5-1 identifies areas where surface radiation surveys are planned. The following sites are not included in the surface radiation survey:

- HGP and BPA facilities
- areas inside of known radiation zones and areas that undergo routine radiation surveys (e.g., areas within 100 N support facility fence)
- employee parking areas and main (asphalt) access roads
- the HGP burn pit and the grass dump.

Surface radiation surveys are currently performed as part of the standard operating procedure for the site and will continue through the implementation of the reactor shutdown program. This ongoing survey practice will be incorporated into this work plan so as not to duplicate existing activities. Existing site data and data collected as part of this work plan will be used in the development of the site radiation map.

A radiological field survey consisting of a determination of radiological baseline operable unit-specific background and a radiological survey was conducted for the 100-NR-1 Operable Unit. The purpose of the survey was to identify any unknown areas of surface and, potentially, subsurface radioactive contamination that would require further investigation.

Procedures used in the conduct of the survey are contained in the *Health Physics Procedures Manual* (WHC 1992b) and consisted of mobile transects using both digital counter rate meters and dose rate meters. The survey areas were partitioned off in a grid system. The low background site was located between the 100-DR-1 and the 100-NR-1 Operable Units in an area considered representative of the undisturbed soil surfaces in the 100 Areas of the Hanford Site.

The survey results are summarized in the *100-NR-1 Surface Radiation Survey* (WHC 1993b). The background survey results indicate that for 5,796 survey data points the maximum cpm was 3,960 with a mean count of 2,394 cpm. For the 100-NR-1 surface radiation survey, a threshold was established where readings above the threshold value could be considered for further investigation. The threshold value established was 3,900 cpm.

The survey area included only those areas of the 100-NR-1 Operable Unit where elevated radiation readings and "skyshine" from past 100 N Reactor operations did not impact the survey results. Skyshine results from contaminated sediments that emit gamma photons which are scattered downward due to interaction with atmospheric constituents. Grid locations where levels were detected above the threshold were primarily at the edges of the survey area where readings were affected by existing facilities; primarily the area north of the 116-N-1 crib and trench, the area south of the 116-N-3 crib, and the area south and east of the 116-N-2 treatment and storage facility. These results are summarized in the 100-NR-1 LFI report (DOE-RL 1994c). Only one grid location indicated elevated readings that were not located near existing facilities, grid number 377. This location will be studied further to determine the source of the elevated surface radiation reading under Task 5, Vadose Zone Investigation.

Activity 2c-3--Ground Penetrating Radar Survey. Surveys using ground penetrating radar will be conducted as necessary to determine the location of septic tanks and septic system drainfields.

Activity 2c-4--Source Sampling. Source sampling is proposed to be conducted at three facilities within the 100-NR-1 Operable Unit to determine the presence of contamination. If contamination is detected, borings may subsequently be conducted in order to determine the extent of any contamination found. Soil samples will be collected at the depth of 2 m (5 ft). If no contamination is detected in the first 1.5 m (5 ft) using field screening equipment, additional samples may be taken at a depth representative of undisturbed soils, due to the likelihood that clean backfill has been placed at the site. Table 5-2 is a summary of proposed source sampling locations, numbers of samples and types of analysis. Specific sampling locations and procedures for sampling will be documented in the DOW.

1322-N and 1322-NA Sample Buildings. Six samples of surface soils were collected and analyzed as part of the 100-NR-1 LFI (DOE-RL 1994c). Sampling locations were based on field screening.

116-N-2 Radioactive Chemical Waste Treatment and Storage Facility. Seven soil samples were collected from borehole 199-N-87 and submitted for analysis as part of the 100-NR-1 LFI (DOE-RL 1994c). The borehole was situated to investigate the 340,650 L (90,000 gal) release.

1314 Liquid Waste Loadout Facility. After closure of the 107-N spent fuel recirculation basin directed by the reactor shutdown program, a surface soil sample will be taken at the location of UN-100-N-13. Also, one sample will be taken from the bottom of the facility valve pit, location of UN-100-N-26.

Septic Tanks and Sewer Systems. Source sampling of septic tanks and sewer systems will be deferred until the sanitary waste system is no longer in use, at which time, sample of the content will be taken from tank sludges. Drainfields will be investigated as part of the vadose zone task. If the sludge is found to contain harmful contaminants, a tank removal plan may be developed and implemented. If possible, sludge in the septic tanks will be accessed through cleanout ports.

Facilities Where Waste is Known or Suspected. Source sampling will be conducted at other 100-NR-1 Operable Unit facilities and waste disposal sites as deemed necessary based on results from activities conducted at analogous 100 Areas, available site data reviewed in Subtask 2a, the reactor shutdown program, and investigative activities directed by this work plan. Table 4-2 contains a complete listing of facilities and waste sites identified for the 100-NR-1 Source Operable Unit and identifies potential sites where additional source sampling may be performed.

Activity 2c-5--Soil Gas Survey. A soil gas survey consisting of a series of probes installed near fuel storage and transfer facilities in the 100-NR-1 Operable Unit was conducted to determine the presence of VOC and petrochemicals in the vicinity of these facilities. The purpose of the survey was to identify of surface and subsurface hydrocarbon contamination that would require further investigation.

Procedures used in the conduct of the survey are contained in the *100-NR-1 Operable Unit Soil-Gas Report* (WHC 1992a). The survey areas included the following four facilities (Figure 3-33).

- 1715-N diesel oil storage and unloading station
- 166-N fuel oil storage tank
- 166-N pump station
- 1900-N fuel oil unloading trench.

None of the VOCs typically associated with fuel products were detected in any of the soil-gas samples (Table 3-3). The presence of methane and depleted oxygen levels, characteristic of biodegradation, indicates that petroleum products have had sufficient time to biodegrade into other forms. Evidence of petroleum hydrocarbons was detected by field immunoassay tests conducted on drill cuttings obtained during installation of the soil gas sampling points. The elevated levels of TPH at the west end of the 1900-N fuel trench, inside the 1715-N tank berm, and at the diesel oil unloading station indicate that soils in these areas are potentially contaminated with petrochemicals.

The soil-gas results also indicate the presence of trace concentrations of PCE, a fuel oil additive, in areas where Number 6 fuel oil was unloaded or transferred. Operators and supervisors at 100 N confirmed that this additive was occasionally spilled at the unloading areas. Because these spills were probably small, the resulting contamination is likely limited to the soil in the vicinity of the unloading trench. It is unlikely that these materials have been transported to the underlying groundwater (WHC 1992a).

5.1.1.2.4 Subtask 2d--Source Sample Laboratory Analysis and Data Validation. Source samples will be analyzed as defined in Section 4.2.2.

5.1.1.2.5 Subtask 2e--Source Data Evaluation. Additional existing information compiled under Subtask 2a, Source Data Compilation, will be evaluated, and any changes required to the work plan based on the information will be made. This compilation will include descriptions of each source with levels and types of contamination in the source. The information collected during Subtask 2c, Field Activities, will be compiled and evaluated to identify areas for more detailed soil investigation. Sampling locations will be plotted on the site topographic maps. Source sampling data will be evaluated in the risk assessment.

5.1.1.3 Task 3--Geologic Investigation. The geologic investigation will further characterize the geology of the operable unit. The geological data needs overlap with those of the 100-NR-2 Groundwater Operable Unit investigation, and the geological investigation requires an integrated compilation of geologic information from both the source and groundwater operable units. For this reason, the geologic investigation will be performed as part the 100-NR-2 Groundwater Operable Unit, and is described in Section 5.1.3 of that work plan.

5.1.1.4 Task 4--Surface Water and Sediments Investigation. The goal of Task 4 is to evaluate the impact on the quality of the Columbia River water and sediments from facility operations and waste disposal activities in the 100 Area. The objectives of the investigation are to characterize, to a limited extent, the distribution and levels of contaminants present in the Columbia River water and sediments as a result of seepage of contaminated groundwater from the 100 Area into the river especially in the area of the N Springs. The subtasks for the surface water and sediments investigation for the 100-NR-1 Operable Unit will be performed as part of an aggregate area study for the 100 Area, and is further described in Appendix D-1, Surface Water and Sediments Investigation, of the 100-NR-2 Groundwater Operable Unit work plan (DOE-RL 1994a). The 120-N-1 neutralization pit and 120-N-2 percolation pond are addressed in Task 5, Vadose Zone Investigation. Investigation of the 124-N-10 Sewage Lagoon is addressed in Task 2-Source Sampling.

5.1.1.5 Task 5--Vadose Zone Investigation. The objectives of this task are to provide information on the nature and vertical extent of contamination related to waste disposal facilities at the 100-NR-1 Operable Unit, and to define relevant migration paths between the disposal units and potentially contaminated media, especially groundwater and to support the selection of IRMs. Data obtained during the LFIs will be used for the following purposes:

- refining the operable unit conceptual model
- supporting quantitative baseline risk assessment to determine cleanup levels for implementing IRMs
- supporting a focused FS for developing and evaluating IRM alternatives
- supporting closure activities for 116-N-1, 116-N-3, 120-N-1, and 120-N-2.

To implement the *Hanford Past-Practice Strategy* (DOE-RL 1991a) with a bias for action, the investigation has been designed with an emphasis on the primary data needs for supporting the qualitative risk assessment, and implementing IRMs. This emphasis has been expanded by Change Number M-15-94-04 to the Tri-Party Agreement (Ecology et al. 1994c) to include actions to support closure of the RCRA TSD sites, i.e., 116-N-1, 116-N-3, 120-N-1 and 120-N-2. The proposed investigation of 116-N-1 and 116-N-3 sites is described in the *DOW for Vadose Drilling at the 1301-N and 1325-N Facilities, 100-NR-1 Operable Unit* (DOE-RL 1994h). The investigation proposed in the DOW emphasizes the primary data needs for supporting a QRA, implementing IRMs, and for closure. The investigations will also provide some of the data needed for the quantitative risk assessment the definition of ARARs and the final closure plan/CMS.

The approach to the vadose zone investigations is to obtain information both from drilling conducted in this investigation and from drilling conducted for installation of monitoring wells in the 100 Area groundwater operable units. Information on the nature and vertical extent of contamination will be obtained from borings in the priority sites identified in Table 4-2. Additional vadose zone information will be obtained during drilling of the groundwater monitoring wells in the 100-NR-2 Operable Unit by screening samples and cuttings and collecting samples if contamination is indicated. Samples will also be collected near the water table to determine contamination remaining as a result of past groundwater mounding or fluctuating groundwater levels. Physical properties of the vadose zone soils required to model fate and transport for the quantitative baseline risk assessment will be obtained from source borings in other operable units and boreholes for monitoring well installations throughout the 100 Area. This approach is described in more detail in Section 5.1.1.5.2. Physical properties of the vadose zone soils from 116-N-1 and 116-N-3 are required for the evaluation of remedial alternatives and for potential treatability tests as discussed in the DOW (DOE-RL 1994h).

The vadose zone soils investigation will consist of the following subtasks:

- Subtask 5a--Data Compilation
- Subtask 5b--Borehole Soil Sampling and Logging
- Subtask 5c--Test Pit Sampling
- Subtask 5d--Soil Sample Analysis
- Subtask 5e--Geophysical Logging
- Subtask 5f--Data Evaluation.

5.1.1.5.1 Subtask 5a--Data Compilation. Data from the source data compilation task described in Task 2 and data from vadose zone investigations at other 100 Area operable units will be reviewed to determine

whether any modifications are needed to the drilling and sampling activities. The Task 2 activities may identify additional facilities where boring is necessary to determine the need for an IRM, or to complete the quantitative risk assessment and final remedy selection for the operable unit. In addition, results of the characterization of the natural chemical composition of Hanford Site soil presented in *Hanford Site Background: Part 1, Soil Background for Nonradioactive Analyses* (DOE-RL 1994g) will be used to assess inorganic analytical results from 100-NR-1 investigations.

Table 3-21 presents the lognormal distribution of the 80, 90, and 95th percentile of the data for a lognormal distribution and the upper 95% confidence limit of the 80, 90, and 95th percentile of the data distribution for inorganic analyses of Hanford Site soils (DOE-RL 1994g). The 95% confidence limit is a method to define an UTL. Concentrations of a constituent greater than a specified UTL value may represent contamination. The table presents concentrations corresponding to the 80% UTL, 90% UTL, and 95% UTL, recognizing that UTL values are one of many ways to define threshold levels.

The soil background data for inorganic analyses (DOE-RL 1994g) are based on the chemical analysis of inorganic constituents from 170 samples. The characterization included an analysis of physical properties and factors that might affect the natural soil chemical composition, as determined by regulatory protocols. Hanford Site soils have not been characterized sufficiently to establish the natural concentrations of the following types of constituents: VOC, semi-VOL, pesticides and PCB, and radionuclides. Characterization of the Hanford Site background radionuclide concentrations is in process. When results of that characterization are available they will be utilized to assess radionuclide analytical results from 100-NR-1 investigations.

Table 5-1 lists vadose zone data gaps.

5.1.1.5.2 Subtask 5b--Borehole Soil Sampling and Logging. Objectives of the boring and soil sampling activities include determining the nature and vertical extent of contamination associated with the high-priority liquid waste disposal facilities in the 100-NR-1 Operable Unit. Facilities where boreholes will be initially drilled (or alternatively test pits) are shown on Figure 5-2. Specific locations will be chosen to represent the "worst case" contamination, such as near locations of effluent discharge to the facility, or near the center of the facility if the discharge points can not be determined. Final borehole locations will be documented in the DOW, and final borehole coordinates will be established by a plane survey following completion. Table 5-3 is a summary of the proposed vadose zone sampling locations, number of boreholes, number of samples and types of analyses. Boreholes are either proposed or have been drilled at the following facilities:

- 116-N-1 crib - proposed borehole 1301-N-1
- 116-N-1 trench - proposed borehole 1301-N-2
- 116-N-3 crib - proposed borehole 1325-N-1
- 120-N-2 - boreholes 199-N-89 and 199-N-77 completed
- 120-N-1 - borehole 199-N-77 completed
- South settling pond - boreholes 199-N-88 and 199-N-77 completed
- 1322-N/1322-NA - borehole 199-N-86 completed
- 116-N-2 - borehole 199-N-87 completed in the area of UN-100-N-5
- UN-100-N-17 - borehole 199-N-85 completed
- 119-N cooling water drainline -borehole 199-N-84 completed.

The completed boreholes were drilled sampled and logged as part of the 100-NR-1 LFI (DOE-RL 1994c)

Additional borings may be necessary later to support the final operable unit ROD at some of the low-priority facilities based on the results of Task 2 activities. Borings are currently anticipated at 1314-N and

active septic systems, however, these will be deferred until the cumulative risk assessment and final operable unit remedy selection phase activities.

Boreholes will be advanced and sampled using cable tool drilling methods and split-spoon or core barrel samplers. Cable tool drilling will be used for this task because of the gravels, cobbles and boulders common to the operable unit, and because the quantity of drilling residuals is minimal and can be easily controlled compared to other drilling methods. Procedures for borehole drilling, sample collection, handling, and analysis are listed in Table QAPjP-2 in the QAPjP.

Depth of the vadose zone borings will be based on field screening results for radionuclides, and where appropriate, volatiles, hexavalent chromium or other specified contaminants. The use of field screening instruments will be detailed in the DOW. Radiological screening is expected to be effective in determining the extent of contamination and depth of drilling for only a few of the facilities identified for the initial boring activities at this operable unit (1322-N/NA, 119-N and 116-N-2). Organic vapor monitors, hexavalent chromium test kits or other appropriate methods, including visual screening, may also be used for field screening. At these facilities, sampling will begin at 1.5-m (5 ft) intervals at the point borehole cuttings fail screening criteria. Drilling and sampling will continue until one sample is screened clean of contamination. One additional sample will be taken for laboratory analysis to verify that the vertical extent has been defined. If screening continues to indicate detectable contamination to the water table, the boring will extend below the water table to permit collection of at least one sample of the aquifer matrix.

Screening techniques may not be available for the contaminants of concern, or may not have adequate detection limits relative to threshold criteria for some of the low-priority facilities where vadose zone boring and sampling will be needed. At these facilities, the borings will extend into the aquifer to permit collection of one sample of the aquifer matrix for laboratory analysis. Samples will be collected at 1.5-m (5 ft) intervals for laboratory analysis the entire length of the borehole.

All boreholes will be geologically logged, based on drill cuttings and the split-spoon or core samples taken at specified intervals. Borehole geologic logs will be prepared in accordance with procedures specified in the QAPjP and will be documented in the DOW. Drill cuttings and core samples will be continually screened with hand-held instruments for radiation, volatile organic compounds and other compounds as appropriate using techniques and procedures defined in the DOW. Screening results and general observations as to drilling progress and problems will be included in each borehole log.

Soil cuttings containing unknown, low-level mixed radioactive waste and/or hazardous waste will be contained, stored, and disposed of according to WHC procedures specified in Table QAPjP-2 in the QAPjP and will be documented in the DOW.

All boreholes will be abandoned following completion of the geophysical logging described in Section 5.1.1.5.5. All steel casing will be removed and transferred to an appropriate disposal facility or controlled decontamination facility and each boring will be pressure-grouted from the bottom up, using a Portland cement/bentonite slurry. Specific WHC procedures for borehole abandonment are identified in Table QAPjP-2 in the QAPjP and documented in the DOW. These procedures are written to comply with EPA requirements and Chapter 173-160 WAC.

5.1.1.5.3 Subtask 5c--Test Pit Sampling. The objective of using test pits is to provide a fast and relatively inexpensive method to characterize near-surface soil contamination. A test pit was dug at 120-N-1 as part of the 100-NR-1 LFI (DOE-RL 1994c) and 14 samples were obtained for analysis at 5 ft intervals to a total depth of 70 ft below grade. Additional test pits are planned to be excavated across the drainfields of inactive septic systems listed, however, these will be deferred until the cumulative risk assessment and final operable unit remedy selection phase activities. Final test pit

locations will be approved by the unit manager's, and final test pit coordinates established by survey following completion of excavation.

The test pit will be excavated with a backhoe or similar equipment that will permit excavation to a depth of 12 m (40 ft) or more depending upon the equipment used and the site conditions. Procedures for test pit sampling are identified in the QAPjP and the DOW. Samples will be obtained from the bucket of the backhoe, with care being taken to ensure that the sample does not include slough material scraped from the sides of the pit. The test pit and all samples will be screened with hand-held instruments for radiation, volatile organic compounds and other compounds as appropriate using the techniques and procedures defined in the DOW. Field logbooks will be maintained to record all observations and activities. Depths of all test pit samples will be measured from the surface and recorded in the field logbook. No personnel will be permitted to enter a test pit. The test pit will be backfilled and properly compacted after sampling has been completed, covered with clean soil, and graded to the original contour as necessary.

The need for further vadose zone sampling at the drainfields will be determined based on initial sampling results.

5.1.1.5.4 Subtask 5d--Soil Sample Analysis. For the initial borings and test pits, a comprehensive suite of analysis will be conducted to determine the nature of the contamination. A comprehensive suite of analysis is justified, because only a limited number of borings will be completed, and data collected will be used for making critical decisions for conducting IRMs. Samples collected for chemical analysis will be analyzed for the full suite of CERCLA CLP, TCL and TAL constituents, specific anions that may be present, and for radionuclides. However, a reduced or investigation-specific analyte list may be used if specified in the description of work that is approved by the three parties for the investigation. Chemical analysis will be conducted using CLP methods. Analytical methods, routine analytical detection and quantitation limits, and precision and accuracy specified for the methods are listed in Table QAPjP-1 in the QAPjP and will be documented in the DOW.

5.1.1.5.5 Subtask 5e--Geophysical Logging. Geophysical logging will be performed in existing wells that may be located in contaminated areas, and the data will be used to determine if additional logging in new boreholes is justified. Prior to borehole abandonment, boreholes may be geophysically logged to provide additional characterization information to supplement the soil sampling data. The following logging techniques may be used:

- gross-gamma logging to identify confining layers and for stratigraphic correlation
- spectral-gamma logging for measuring the distribution of selected radionuclides.

The existing equipment and procedures for gross-gamma and spectral-gamma logging in use at the Hanford Site provide acceptable data. The procedures are specified in Table QAPjP-2 in the QAPjP and will be documented in the DOW. Gross-gamma logging will be used when spectral-gamma equipment is not available or when site conditions do not allow its use.

5.1.1.5.6 Subtask 5f--Data Evaluation. This task will include evaluating all the information collected during the vadose zone investigation. The emphasis of the evaluation will be to determine whether an IRM should be conducted at the high-priority sites. The data may also be used to determine what is to be done at analogous facilities at other operable units. Chemical data will be evaluated and compared to soil background data, CARs, and threshold concentrations. Borehole logs will be evaluated to confirm or refine the conceptual geologic model of the site. Geophysical logs will be compared with data from soil sampling and will fill in data gaps between sampling locations. The data collected from the vadose zone

investigation will be used in conjunction with data collected from other tasks for completing the quantitative risk assessment and selecting a final remedy for the operable unit. A description of data evaluation for all tasks is provided in Section 5.1.1.10.

5.1.1.6 Task 6--Groundwater Investigation. The groundwater investigation is being performed as part of the 100-NR-2 Operable Unit RFI, and is described in that work plan.

5.1.1.7 Task 7--Air Investigation. Although the proposed 100-NR-1 field sampling activities include actions that may expose waste and potentially contaminated soil to the atmosphere, it is expected that there will be minimal disturbance of significant volumes of contaminated materials during these activities. Because air is therefore not anticipated to be a significant contaminant transport medium for the 100-NR-1 Source Operable Unit, no field activities other than routine health and safety air monitoring are planned for the air investigations (see the HSP, Appendix B). However, if the need for additional air investigation becomes apparent during the course of the project or because of experience at other projects, additional air investigations will be performed as required.

5.1.1.8 Task 8--Ecological Investigation. The ecological investigation will determine the potential biocontamination transport pathways through the environment, the critical habitat for major species and conceptual models of human and environmental risk. The ecological investigation will provide information necessary to complete the risk assessment and to develop and evaluate a full range of remediation alternatives. These tasks will be performed as part of an aggregate area investigation for the 100 Area, in accordance with the activities addressed in Appendix D-2 of the 100-NR-2 Operable Unit work plan (DOE-RL 1994a). Aquatic sampling will be performed on the 100-NR-2 and 100-HR-3 Operable Units to determine if further testing is necessary for the other operable units of the 100 Area.

5.1.1.9 Task 9--Other Tasks. This task has been reserved in the event that additional tasks are identified during the course of the project. Currently, one subtask has been identified: Subtask 9a--Cultural Resource Investigation.

5.1.1.9.1 Subtask 9a--Cultural Resource Investigation. The cultural resource investigation will deal with the entire 100 Area and the 600 Area north of the Gable Mountain and south of the Columbia River, rather than individual operable units. Details of this investigation are presented in Appendix D-3 of the 100-NR-2 Groundwater Operable Unit work plan. The task includes review of available existing data on historic land uses by local Indian tribes, as well as early 20th century land use by pioneer farmers and settlers. Results of a field conducted by a qualified archaeologist are presented in Chatters et al. (1992).

5.1.1.10 Task 10--Data Evaluation. Data generated during the LFI will be integrated and evaluated, coordinated with CMS activities, and presented in an ongoing manner to allow decisions to be made regarding any necessary rescoping during the course of the project. The results of these evaluations will be made available to project management personnel to keep project staff informed of progress being made. The interpretations developed under this task will be used in Task 11--Risk Assessment, which will evaluate the overall risk to human health and the environment posed by the 100-NR-1 Operable Unit.

5.1.1.11 Task 11--Risk Assessment. Both qualitative and baseline risk assessments will be conducted during the course of the RI/FS and RFI/CMS processes for the 100 Area. Qualitative risk assessments based on available site data will be used to support IRMs following the initial data evaluation and LFIs. The 100-NR-1 QRA has been completed (BHI 1994b). Baseline risk assessments will be conducted after evaluation of data from ERA, IRM, and LFI paths, the corrective measures and feasibility studies, and when necessary, the completion of additional field investigations.

The 100-NR-1 Operable Unit risk assessment process will determine the magnitude and probability of potential harm to human health and the environment by the threatened or actual release of hazardous substances from the 100-NR-1 Operable Unit in the absence of an action-oriented corrective measure. Both the qualitative and baseline risk assessments will be developed in accordance with HSRAM (DOE-RL 1994b) when finalized. This methodology addresses both human health and environmental assessments in accordance with appropriate federal and state guidance, including the *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A* (EPA 1989a), *Risk Assessment Guidance for Superfund, Volume II: Environmental Evaluation Manual* (EPA 1989b), *EPA-Region 10 Supplemental Guidance for Risk Assessment* (EPA 1991), and MTCACR (WAC 173-340). Only an overview of the risk assessment process is presented here; refer to the HSRAM (DOE-RL 1994b) for additional information.

The risk assessment task will be divided into two subtasks:

- Subtask 11a--Human Health Evaluation
- Subtask 11b--Environmental Evaluation.

5.1.1.11.1 Subtask 11a--Human Health Evaluation. The human health evaluation is comprised of four elements:

- identification of contaminants of potential concern
- exposure assessment
- toxicity assessment
- risk characterization.

Identification of Contaminants of Potential Concern. Contaminants of potential concern for the risk assessment will be identified using a data evaluation process presented in the *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual, Part A* (EPA 1989a), and supplemented by Hanford-Site-specific considerations for the process as presented in the HSRAM (DOE-RL 1994b). This process will be used to screen the field of contaminants to provide a list of contaminants of potential concern for which the subsequent risk assessment activities are focused. A set of contaminants will be identified that are likely to be site-related and concentration information will be obtained that is of acceptable quality for use in the quantitative risk assessment.

The basis for selecting contaminants will include their intrinsic toxicological properties, including radiological properties, presence in large quantities, and/or presence in media of potentially critical exposure pathways, such as drinking water. Contaminant selection for the risk assessments are those contaminants that have significant combinations of the following attributes: toxicity, abundance, mobility, persistence, have a propensity for bioaccumulation, and for which quality documentation in terms of toxicological and environmental properties is available.

Exposure Assessment. The objective of the exposure assessment is to estimate the type and magnitude of exposures to contaminants of potential concern that are present at or migrating from the site. This objective will be achieved by identifying potential and actual exposure pathways, characterizing potentially exposed populations, and estimating both present and future exposure levels. Exposure information developed in the qualitative risk assessment will be refined for the baseline risk assessment. The exposure assessment will proceed in five steps.

The first step of the exposure assessment is a contaminant release analysis, which involves identifying exposure pathways. Each exposure pathway consists of four elements: (1) a source and mechanism of chemical release to the environment; (2) an environmental transport medium; (3) a potential point for

receptor contact with the contaminated medium (i.e., exposure point); and (4) an exposure route at the contact point.

The second step is the analysis of contaminant transport and fate - a description of the extent and magnitude of environmental contamination, including the estimation of future conditions. Data gathered during the preliminary assessment/site inspection, environmental monitoring activities, and/or LFIs for the 100-NR-1, and 100-NR-2 Operable Units, as well as any other data sources will be used to identify the potential release sources and release mechanisms from the sources. As the release mechanism(s) for contaminants are identified (or postulated), the transport medium for the contaminants will also be identified.

The third step of the exposure pathway analysis is identifying the potential exposure points and exposure routes for human receptors. This analysis involves identifying and characterizing various populations for which an exposure potential exists. The analysis will be used to identify exposure points for short- and long-term exposures. In addition to existing exposure points, credible future exposure points will be postulated.

Next is an integrated exposure analysis. In this step, information will be assembled to determine the exposure pathways that have all of the elements that make them complete from contaminant to receptor. After potential exposure pathways are determined, environmental concentrations for each contaminant of potential concern will be estimated at each of the identified exposure point locations. Concentrations will be estimated for each environmental medium through which potential exposures could occur as a function of time to assess short- and long-term exposures. These concentrations will be estimated by combining environmental monitoring and characterization data with analytical or numerical modeling to predict the release rates from the various waste sources. Then, the fate and transport of the contaminants (e.g., through groundwater migration), contaminant transformation (e.g., through biodegradation), and mechanisms for transfer of a contaminant from one transport medium to another (e.g., through sorption or volatilization). The predicted environmental concentrations and exposure route information will then be used to estimate the amount of contaminant that the various receptors potentially could intake (i.e., the dosage rate).

The final exposure assessment step is an uncertainty analysis. The exposure assessment process involves several necessary estimates. These estimates are reviewed to identify uncertainties and to evaluate their separate and cumulative impacts on the results of the assessment.

Toxicity Assessment. The toxicity assessment will:

- gather toxicity information (qualitative and quantitative) for contaminants being evaluated
- identify exposure periods for which toxicity values are necessary
- determine toxicity values for noncarcinogenic effects
- determine toxicity values for carcinogenic effects
- summarize toxicity information
- evaluate uncertainty in toxicity assessment.

Risk Characterization. In this element, the toxicity and exposure assessments are summarized and integrated into quantitative and qualitative expressions of risk. To assess the risks associated with the

release of contaminants, the contaminant intakes for human receptors, as identified in the exposure assessment, are evaluated using:

- the reference dose (RfD) for noncarcinogens
- the slope factor for carcinogens.

A summary of the carcinogenic and noncarcinogenic risks will be generated. Such factors as the weight-of-evidence associated with toxicity information, estimated uncertainties associated with the previous subtasks, and assumptions contained within the estimates used will be incorporated into the summary.

5.1.1.11.2 Subtask 11b--Environmental Evaluation. The environmental evaluation is a qualitative and/or quantitative appraisal of the actual or potential effects of a hazardous waste site on plants and animals other than people or domesticated species. The process for conducting environmental evaluations is analogous to that for conducting human health evaluations. Although most of the elements of the environmental evaluation are similar to the human health evaluation, the environmental evaluation process is not currently as well developed as that for human health evaluations. The environmental evaluation also addresses considerations not addressed in human health evaluations.

The primary interest in environmental evaluations is the identification of contaminant impacts on the environment. Both assessment and measurement endpoints are used in these evaluations. Assessment endpoints are those describing the effects that drive decision making, such as a reduction of key populations or disruption of community structure. Whereas the human exposure assessment centers on individuals, an environmental evaluation is generally concerned with the health and viability of whole populations. Environmental evaluations are generally concerned with individual members of a population only when that population becomes very small (e.g., is threatened or endangered). Environmental evaluations are performed "to assess threats to the environment, especially sensitive habitats and critical habitats of species protected under the Endangered Species Act" (40 CFR 300.430(e)(2)(i)(G)).

Investigators must also identify effects requiring further study. Measurement endpoints are those used in the field to approximate, represent, or lead to the assessment endpoint. These are ways to measure or assess the impacts of contaminant concentrations on ecological receptors. Finally, the toxicity data for environmental evaluations are not as clearly defined as those for human health evaluations.

The process for conducting environmental evaluations for Hanford Site risk assessments is presented in the HSRAM (DOE-RL 1994b).

5.1.1.12 Task 12--Verification of Contaminant- and Location-Specific CARs. The formulation of operable-unit-specific CARs is an ongoing process throughout the RFI/CMS. Preliminary CARs were identified and discussed in Section 3.2. In addition, potential ARARs for the 100 Area have been developed in the *100 Area Feasibility Study, Phases I and II* (DOE-RL 1992). Following the evaluation of analytical data under Task 10, contaminant-specific and location-specific CARs will be reviewed and identified, based upon the new knowledge of contamination at the site and the site setting. Once the potential CARs for the 100-NR-1 Operable Unit have been properly identified, EPA and Ecology will be asked to verify the contaminant- and location-specific CARs. Project staff will work with the regulatory agencies and, taking operable unit-specific conditions into account, will decide which promulgated environmental standards, requirements, criteria, and limitations are actually applicable or relevant and appropriate to the 100-NR-1 Operable Unit.

5.1.1.13 Task 13--Limited Field Investigation Report. An interim report will be prepared upon completion of the limited field investigations. This report will consist of a preliminary summary of the characterization activities described in Tasks 1 through 12. Information pertinent to the operable unit

conceptual model will be refined, as necessary. The report will include the results of groundwater investigations, identify the nature and extent of groundwater contamination, identify impacts to the Columbia River and ecological systems, identify the contaminant- and location-specific CARS, and provide a qualitative assessment of the risks associated the operable unit. The report will include an assessment of whether contaminant concentrations pose an unacceptable risk that warrant action through IRMs. The *Limited Field Investigation Report for the 100-NR-1 Operable Unit* (DOE-RL 1994c) has recently been completed.

5.1.2 Final RCRA Facility Investigation

The final RFI provides any additional data and characterization needed to support selection, design and implementation of a final corrective action for the operable unit, i.e., the CMI/final closure. The final RFI is performed at remaining low-priority sites where existing data are considered insufficient by the unit managers, and at any remaining high-priority sites where final cleanup criteria were not achieved during the IRM. The final RFI may consist of data compilation, non-intrusive investigations, intrusive investigations, and data evaluation. Analyses conducted during the final RFI will use data collected during the LFI, during IRM implementation, RCRA TSD site closure certification, and in previous investigations.

A baseline risk assessment is performed as part of the final RFI. This assessment provides a quantitative evaluation of residual risk at the operable unit after completion of the IRMs, and is conducted according to HSRAM (DOE-RL 1994b). The results of this assessment are used to help determine the need for corrective actions, to select the corrective action, and to determine risk-based cleanup levels for the corrective action.

The final RFI is conducted in parallel with the final closure plan/CMS, permitting the collection of any additional data that may be identified when conducting the final closure plan/CMS. The final RFI and the baseline risk assessment are documented in the final RFI report, which is a secondary document.

5.2 CORRECTIVE MEASURES STUDY PROCESS

In accordance with the *Hanford Federal Facility Agreement and Consent Order Change Packages* (Ecology et al. 1991), the FS and CMS process for the 100 Area will be conducted on both an aggregate area and operable unit basis. The EPA published *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA 1988a) will be used as the guidance document for the content and approach to each of the feasibility and corrective measures studies performed. This process includes preparation of a 100 Area FS, completed on an aggregate area basis and a focused final FS completed on an operable unit basis. The IRM process takes place between the focused FS and final closure plan/CMS. A description of the IRM process and each of the corrective measures and feasibility studies is provided in the following sections. The emphasis in this work plan is placed on the focused FS. Because a final closure plan/CMS is necessary, the tasks outlined for the focused FS would be repeated. This process is intended to reduce the level of effort required for any one individual study and allow initiation of corrective action activities based on known data and previously tested/demonstrated technologies.

5.2.1 100 Area Feasibility Study

The 100 Area FS will use existing data to identify and screen remedial alternatives for the 100 N Area, and generic alternatives for the remainder of the 100 Area. The 100 N Area is treated separately due to the recent operation of the N Reactor, and the relatively unique design of the reactor and its ancillary facilities. The results of this study provide a foundation for all subsequent feasibility studies to be performed for

IRM selection, and for selection of the operable unit remedial action. The 100 Area FS consists of four primary tasks:

1. Identify preliminary contaminants of concern for the media of concern (solid waste, soil, river sediments, and groundwater).

2. Refine potential ARARs identified in the work plan pertinent to all general response actions including the removal, treatment, and disposal of groundwater.

3. Develop remedial alternatives (Phase I) applicable to the 100 Area, including development of remedial measures objectives, development of general response actions, identification and screening of technologies and process options, and assembly of remedial alternatives from representative technology types.

4. Screen alternatives (Phase II) developed for advancement to the detailed analysis steps (focused FS), and identify treatability studies necessary to support the detailed analysis.

5.2.2 Focused Feasibility Study

The basis for this evaluation will be summarized from the results of the 100 Area FS, treatability studies, 100 Area aggregate studies, high-priority site LFIs, and the qualitative risk assessment. The alternatives selected and the results of the screening process will be included in the summary of the focused FS.

The detailed analysis of IRM alternatives follows the development and screening of alternatives in the 100 Area FS and precedes the actual selection of the IRMs to be implemented at the operable unit. The results of the detailed analysis provide the basis for identifying a preferred alternative and preparing the operable unit IRM plan. The detailed analysis of alternatives consists of the following components:

- further definition of each alternative, if appropriate, with respect to the volumes or areas of contaminated environmental media to be addressed, the technologies to be used, and any performance requirements associated with those technologies

- an assessment and a summary of each alternative against evaluation criteria specified in EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988a)

- a comparative analysis of the alternatives that will facilitate the selection of the operable unit IRMs.

The brief summary of the detailed analysis process presented below is derived from EPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA 1988a). The focused FS consists of the following four tasks:

- Task 1--Definition of IRM Alternatives
- Task 2--Detailed Analysis of IRM Alternatives
- Task 3--Comparison of IRM Alternatives
- Task 4--LFI/Focused FS Report.

Also presented for information is the IRM ROD, IRM design report, and IRM implementation.

5.2.2.1 Task 1--Definition of IRM Alternatives. The IRM alternatives that remain after initial screening may need to be defined more completely prior to the detailed analysis. If data is obtained from the high-priority LFI which had not been considered, or was in conflict with assumptions from the 100 Area FS, then additional alternative screening would be performed. During the detailed analysis, each alternative will be defined sufficiently to apply the evaluation criteria and to develop order-of-magnitude cost estimates (-30 to +50%). Information developed to further define alternatives at this stage may include preliminary design calculations, process flow diagrams, sizing of key process components, preliminary layouts, and a discussion of limitations, assumptions, and uncertainties concerning each alternative. Information collected from treatability investigations, if conducted, will also be used to further define applicable alternatives.

5.2.2.2 Task 2--Detailed Analysis of IRM Alternatives. Nine evaluation criteria will serve as the basis for conducting the detailed analysis and for subsequent selection of IRMs. The evaluation criteria include the following subtasks:

- Subtask 2a--Overall protection of human health and the environment
- Subtask 2b--Compliance with CARs
- Subtask 2c--Long-term effectiveness and permanence
- Subtask 2d--Reduction of toxicity, mobility, or volume of contaminants
- Subtask 2e--Short-term effectiveness
- Subtask 2f--Implementability
- Subtask 2g--Cost
- Subtask 2h--State acceptance
- Subtask 2i--Community acceptance.

These criteria encompass technical, cost, and institutional considerations, compliance with specific promulgated requirements, and environmental and health protection and are described further below. The last two criteria, although discussed below, will be addressed in the responsiveness summary and ROD documents following the focused FS report, rather than in the detailed analysis of alternatives.

5.2.2.2.1 Subtask 2a--Overall Protection of Human Health and the Environment. This evaluation criterion provides a final check to assess whether each alternative meets the statutory requirement that it be protective of human health and the environment (CERCLA 121 (d)(1)). The overall assessment of protection is based on a composite of factors discussed under long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs. The analysis will address how each specific alternative achieves protection over time and how operable unit risks are reduced. A discussion will be included of how each source of contamination is to be eliminated, reduced, or controlled for each alternative.

5.2.2.2.2 Subtask 2b--Compliance with Applicable or Relevant and Appropriate Requirements. This evaluation criterion is used to determine how each alternative complies with CARs. The detailed analysis will summarize which federal and state environmental standards, requirements, criteria, or limitations may be applicable, relevant and appropriate, or TBC information. How the alternative meets these contaminant-, location-, and action-specific requirements will be described. The CARs evaluation will provide the basis for invoking any of the CARs waivers provided under 300.430(f)(1)(i)(c) of the NCP, if appropriate.

5.2.2.2.3 Subtask 2c--Long-Term Effectiveness Analysis. This criterion will address the results of potential IRMs in terms of any risk that would remain at the operable unit after interim action objectives have been met. The following components will be addressed to evaluate the extent and effectiveness of controls that may be required to manage residual or untreated wastes:

- magnitude of remaining risk
- adequacy of controls
- reliability of controls.

The evaluation of these components will include an assessment of residual risk, the adequacy of containment systems, long-term environmental monitoring networks, institutional controls, and the potential need to replace components of the IRM.

5.2.2.2.4 Subtask 2d--Analysis of Reduction in Waste Toxicity, Mobility, and Volume. This evaluation criterion addresses the statutory preference for selecting remedies that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of hazardous substance as their principal element (CERCLA 121(b)(1)). The following specific factors will be addressed:

- treatment processes, the remedies they will employ, and the materials they will treat
- amount of hazardous materials that will be destroyed or treated
- degree of expected reduction in toxicity, mobility, or volume of contaminants as a percentage
- degree to which treatment will be irreversible
- degree of permanence
- type and quantity of treatment residuals that will remain.

Alternatives that treat a site through destruction of toxic contaminants, reduction of the total mass of toxic contaminants, or irreversible reduction of total volumes of contaminated media will be deemed to satisfy the preference for permanent treatment.

5.2.2.2.5 Subtask 2e--Short-Term Effectiveness Analysis. This evaluation criterion addresses the effects of the alternative during the construction and implementation prior to remedial action objectives being attained. The following factors relating to effects on human health and the environment will be addressed for each alternative:

- protection of the community during construction and implementation
- protection of workers during construction and implementation
- environmental impacts during construction and implementation
- time until remedial action objectives are achieved.

The evaluation of these factors will include a discussion of any increased risks posed by the IRM alternative being evaluated and an evaluation of the effectiveness and reliability of protective measures that could be taken for any worker protection or environmental impact mitigation that may be needed.

5.2.2.2.6 Subtask 2f--Implementability. The implementability criterion addresses the technical and institutional feasibility of implementing an alternative and the availability of various services and materials required during its implementation. In evaluating this criterion, the following factors will be analyzed:

- ability to construct and operate the technology
- reliability of the technology
- ease of undertaking additional remedial actions, if necessary

- ability to monitor the effectiveness of the remedy
- ability to obtain approval from other agencies
- availability of off site treatment, storage, and disposal services
- availability of prospective technologies
- availability of materials
- institutional feasibility.

5.2.2.2.7 Subtask 2g--Cost Analysis. Cost consideration will be an important evaluation criterion at the Hanford Site because of the large number of sites competing for limited funds. Costing procedures outlined in the *Remedial Action Costing Procedures Manual* (EPA 1985) and other procedures appropriate to the Hanford Site will be used in this analysis. Both capital costs and annual operation and maintenance costs will be considered. Costs will be developed to an accuracy of -30 to +50%. In addition, a present-worth analysis will be conducted so that all alternatives can be compared on the basis of a single figure in a common base year. A discount rate of 5% will be used for a period of performance of 30 yr. If there exists sufficient uncertainty concerning specific assumptions of the cost estimate, sensitivity analysis will be performed. The results of the sensitivity analysis will be included with the comparison of remedial actions.

5.2.2.2.8 Subtask 2h--EPA Acceptance. A preliminary assessment of EPA acceptance will be limited to formal comments made in earlier phases of the RI/FS. EPA comments on the remedial action analysis and proposed plan will be specifically addressed in a responsiveness summary prior to the selection of the remedial action and completion of the IRM ROD.

5.2.2.2.9 Subtask 2i--Analysis of Community Acceptance. A preliminary assessment of community acceptance will be limited to formal comments made in earlier phases of the RI/FS. The potentially impacted community, special interest groups, the general public, and other interested governmental agencies will have an opportunity to review and comment on the focused FS report. Community concerns will also be addressed in the responsiveness summary and IRM ROD.

5.2.2.3 Task 3--Comparison of IRM Alternatives. Once the alternatives have been individually assessed against the first seven criteria, a comparative analysis will be conducted to evaluate the relative performance of each alternative in relation to each specific evaluation criteria. An assessment of whether the alternative provides adequate overall protection of human health and the environment and whether the alternative complies with CARs, or provides grounds for invoking a statutory waiver, will be provided with each alternative. The key tradeoffs or concerns among alternatives will generally be based on the evaluations of short-term effectiveness; long-term effectiveness and permanence; reduction of toxicity, mobility, and volume of contaminants; implementability; and cost.

The comparative analysis will include a narrative discussion describing the strengths and weaknesses of the alternatives relative to one another with respect to each criterion. The potential advantages in cost or performance of innovative technologies and the degree of uncertainty in their expected performance will also be discussed. The differences between all of the alternatives will be summarized in matrix form to facilitate direct comparisons.

5.2.2.4 Task 4--LFI/Focused FS Report. The analysis of individual alternatives against the seven criteria will be presented as a narrative discussion accompanied by a summary matrix. The alternatives discussion will include data on technology components, quantity of hazardous materials handled, time required for implementation, process sizing, implementation requirements, and assumptions. The key CARs for each alternative will also be incorporated into those discussions. The discussion will focus on how, and to what extent, the various factors within each of the criteria are addressed. A summary matrix will highlight the assessment of each alternative with respect to each of the first seven criteria. Based on

the results of the comparison of alternatives, the LFI/focused FS report will indicate which IRM alternative is preferred.

5.2.3 IRM Process

The choice of IRMs will be based upon the results of the focused FS and identified in the LFI/focused FS report. The public will be informed of the selection via one or more proposed IRM plans. Following public comment on the plan(s) an IRM ROD and an IRM design report will be written, and the IRMs implemented. Interim remedial measure implementation will involve concurrent collection of data using the observational approach. Data collected in this manner will guide the IRM implementation, and will be used by the final CMS to help select a corrective action for the operable unit. These steps in the IRM process lead to the final CMS, and are discussed in greater detail below.

5.2.3.1 Proposed IRM Plan(s). The proposed IRM plan(s) is a primary document which provides the public with a summary of the focused FS and identifies the IRMs selected. A single proposed IRM plan may be prepared for all IRMs, or multiple plans may be prepared for grouped and/or individual IRMs.

5.2.3.2 IRM ROD. The IRM ROD summarizes the LFI/focused FS report as well as any changes to the selected IRM(s) occurring as a result of public comment on the proposed IRM plan(s). The IRM ROD is a primary legal document certifying that the IRM selection process was carried out in accordance with CERCLA, and committing the three parties to perform the IRM(s) in accordance with its specifications. The IRM ROD presents a technical description of the IRM(s); the interim engineering, institutional, and remediation goals; and information regarding the site. The IRM ROD is written and issued by the regulators. A single IRM ROD may be prepared for all IRMs, or multiple RODs may be prepared for grouped and/or individual IRMs.

5.2.3.3 IRM Design Report. The IRM design report is a secondary document and provides engineering and technical specifications for implementing the IRMs identified in the IRM ROD.

5.2.3.4 IRM Implementation. All IRMs are implemented in a construction and operations phase. This phase varies in scope and complexity depending upon the IRM. Any data collected during IRM implementation may be used in the final RFI. Although the IRM primarily addresses high-priority sites, adjacent low-priority sites may be incorporated into the implementation. Completing IRM implementation concludes the IRM phase of site remediation. Any further actions needed to achieve final cleanup objectives are addressed during the final CMS.

5.2.4 Closure Plan/Corrective Measures Study

In order to comply with the new milestones in the Tri-Party Agreement Change Number M-15-94-04, a combined closure plan/CMS document will be prepared that incorporates the applicable aspects of the following:

- RCRA closure plans, detailed in WAC 173-303-610
- RCRA corrective measures studies, detailed in 40 CFR 264.524 and 264.535 (proposed Subpart S)
- CERCLA feasibility studies, detailed in 40 CFR 300.

Table 5-4 is a comparison of the requirements for closure plans, CMS, and FS documents. The table is separated into three main sections; the report, selection criteria, and range of alternatives. The outline of the closure plan/CMS that is presented in the following section is a blending of these requirements.

While there are many similarities between the closure plan, CMS, and FS documents, there is one major discrepancy. Both the CMS and FS are designed to evaluate alternative remedial technologies, they do not decide on a remedial approach or detail the steps necessary for remediation. The closure plan, on the other hand, is required to provide detailed descriptions of any remedial activities to be performed for closure. Therefore, more detailed descriptions of the steps necessary to complete remediation and closure will be included in the closure plan/CMS, Volumes 1 and 3 to meet specific RCRA closure requirements.

The closure plan/CMS document will employ a format similar to the past-practice format, but will include WAC requirements for RCRA closures. This section is to provide a general outline and synopsis of the proposed closure plan/CMS.

5.2.4.1 Closure Plan/CMS Section 1.0 - Introduction. The introduction section will include a brief discussion of the purpose and scope of the plan. In addition the introduction should include:

- A history of operations including a discussion of waste generating process, spill/release history, discussion of previous response actions, and compilation of existing data.
- A discussion of the interaction between this remediation and other remediations, expedited response actions, and interim response actions.
- A summary discussion of the investigation results.
- A list of potential contaminants of concern.
- A preliminary identification of ARARs.

This information can be compiled to present the conceptual model of the waste site. Information for Section 1.0 will be incorporated by reference to existing documents such as operable unit work plans, limited field investigations, and feasibility studies.

5.2.4.2 Closure Plan/CMS Section 2.0 - Identification and Screening of Technologies. This section should include the following information:

- Development of remedial action objectives and remedial goals, including contaminants of concern and ARARs.
- Development of general response actions.
- Identification of technology types and process options; initial screening of the technologies and process options.

Descriptions of each process option should be included.

5.2.4.3 Closure Plan/CMS Section 3.0 - Development and Screening of Alternatives. The technologies and process options developed in Section 2.0 would be further screened and combined as necessary into alternatives. Alternatives would be screened based on effectiveness, implementability, and

relative cost. The number of alternatives would be reduced by the screening process: selected alternatives would be carried to Section 4.0 for detailed analysis.

5.2.4.4 Closure Plan/CMS Section 4.0 - Detailed Analysis of Alternatives. The detailed analysis is performed for each screened alternative. The alternatives would be evaluated against a combination of RCRA and CERCLA criteria presented in Table 5-4. Following are the combined criteria:

- protect human health and the environment (WAC, CMS, FS)
- attain media cleanup standards (ARARs) (WAC, CMS, FS)
- long-term reliability, effectiveness, and permanence (WAC, CMS, FS)
- reduce toxicity, mobility or volume through treatment (CMS, FS)
- short term effectiveness (CMS, FS)
- implementability (CMS, FS)
- return land to appearance and use of surrounding land areas (WAC)
- cost (CMS, FS)
- state and community acceptance (FS)
- natural resource concerns (CERCLA).

5.2.5 Final Closure Plan/Corrective Measures Study

A final closure plan/CMS will be performed for the operable unit to provide a detailed analysis of alternatives to meet corrective action objectives at the low-priority sites and, if necessary, re-evaluate selected high-priority sites. This reevaluation would be necessary if insufficient data obtained from the high-priority site LFI prevented detailed analysis for particular contaminants or if during implementation of the IRMs there were contaminant concentrations or volumes not anticipated by the focused FS. The final closure plan/CMS will be based upon data from the 100 Area FS, treatability studies, the IRMs, and the final RFI. The baseline risk assessment will provide the levels of clean up required to remediate this operable unit. The content of the final closure plan/CMS will be very similar to that of the focused FS, however, the emphasis of the final closure plan/CMS will be on remediation of the remaining low-priority sites. Alternatives will be developed against the first seven criteria listed in Section 5.2.2. The final remedy for the operable unit will be documented in the final closure plan/CMS report.

Figure 5-1. 100 N Surface Survey Area.

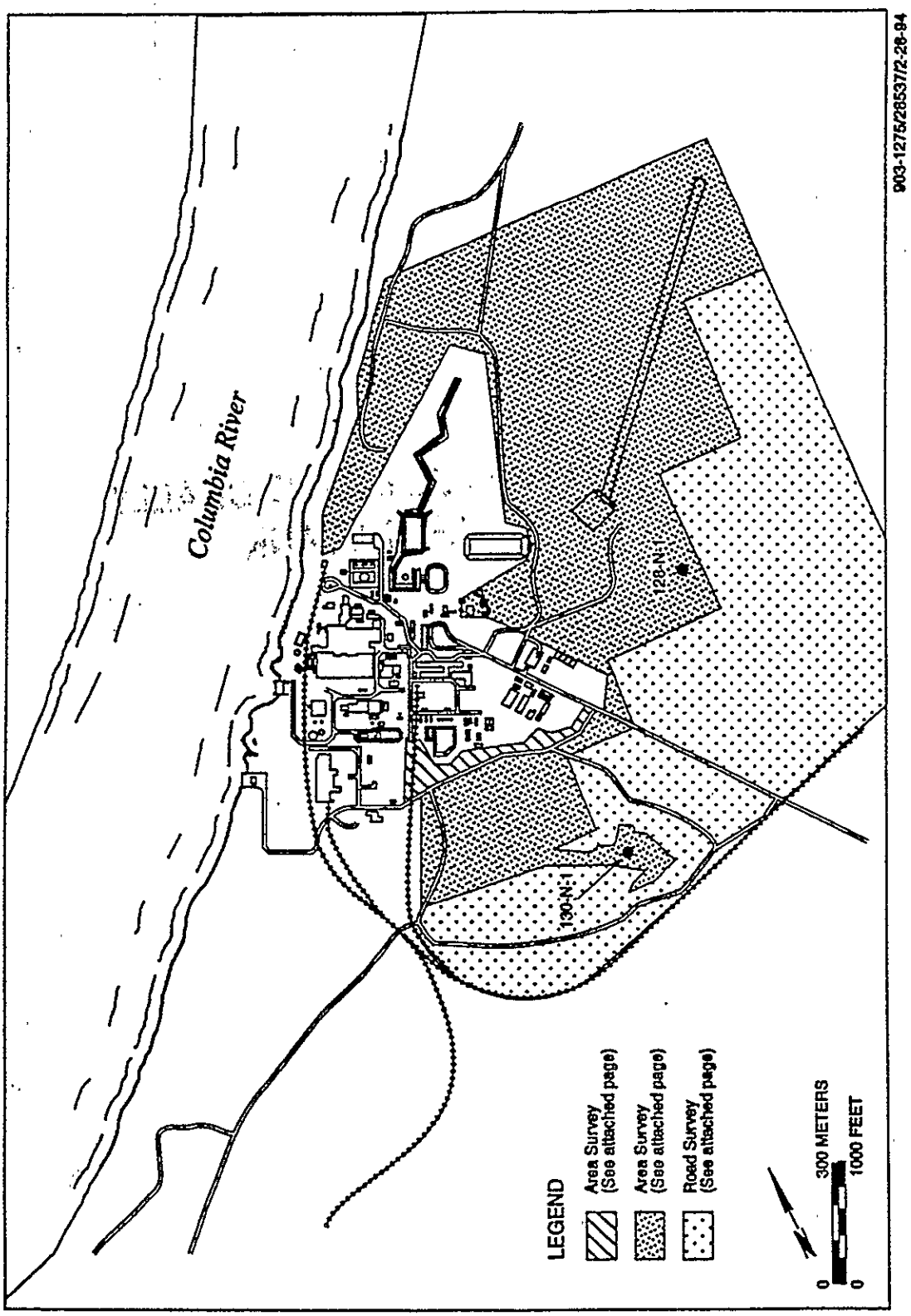

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Figure 5-2. Proposed Borehole Locations at High Priority Sites in the 100-NR-1 Operable Unit

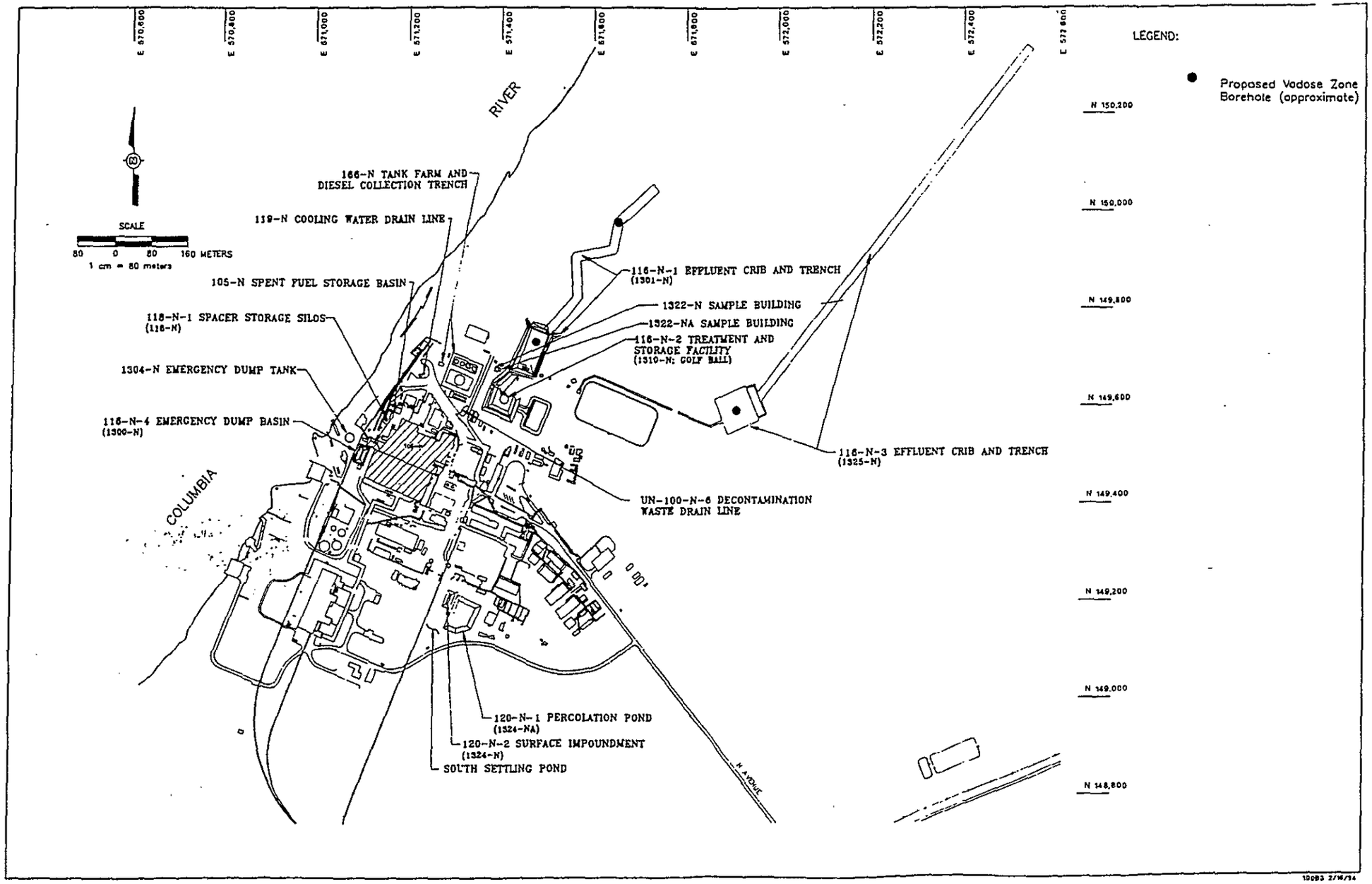

Table 5-1. 100-NR-1 Operable Unit Data Gaps.

SOURCE
Research available records for additional information and data concerning cleanup and remediation of unplanned releases. Rate of release of effluent to the cribs and trenches. Identify storage and use locations for pesticides, solvents, fuel oils, paints and process/maintenance chemicals. Identify wastes discharged to the Columbia River via the "260-cm outfall line" and through the "107-cm return line".
GEOLOGICAL
Data gaps are identified in the 100-NR-2 Groundwater Operable Unit Work Plan (DOE-RL 1994b).
SURFACE WATER AND SEDIMENTS
Data gaps are identified in Appendix D-1 of the 100-NR-2 Groundwater Operable Unit Work Plan (DOE-RL 1994b).
VADOSE ZONE
Nature and extent of contamination from effluent discharged to the 116-N-1 and 116-N-3 liquid waste disposal facilities. Volumes and analytical results from routine sampling of effluent generated by the 163-N demineralization plant and discharged to 100-N area surface impoundments. Locations of radioactive waste, diesel oil and chemical transfer lines.
GROUNDWATER
Data gaps are identified in the 100-NR-2 Groundwater Operable Unit Work Plan (DOE-1994b).
AIR
No data gaps have been identified.
ECOLOGICAL
Data gaps are identified in Appendix D-2 of the 100-NR-2 Groundwater Operable Unit Work Plan (DOE-RL 1994b).

Table 5-2. 100-NR-1 Operable Unit Source Sampling Investigation.

Location[a]	Numbers of Samples[b]	Types of Analysis		
		TAL	TCL	RAD
1322-N/1322-NA	3	X	X	X
116-N-2	1	X	X	X

[a]Specific site at each location may be specified in the DOW.
[b]Number of samples will be detailed in the DOW.

Table 5-3. 100-NR-1 Operable Unit Vadose Zone Investigation.

Location (number of borings)	Number of Samples[a]	Types of Analysis		
		TAL	TCL	RAD
120-N-2 (1)	8	X	X	X
120-N-1 (and south settling pond) (2)	16	X	X	X
1322-N/1322-NA (one boring north of 1322-N) (1)	8	X	X	X
116-N-1 (one boring in both crib and trench)	26	X		X
116-N-2 (one within the combined area of UN-100-25 and 100-UN-5) (1)	8	X	X	X
116-N-3 (one boring in crib)	13	X		X
UN-100-N-17 (1)	8	X	X	X
119-N cooling water drain line (1)	8	X	X	X

[a]The number of samples is estimated by collecting a sample every 5 ft assuming a depth of 40 ft except for 116-N-1 and 116-N-3. The total number of samples at 116-N-1 and 116-N-3 is estimated by collecting continuous samples in the first 12 ft, followed by two samples at 5 ft intervals, then five samples at 10 ft intervals, assuming a total depth of 65 to 75 ft. The total number of samples will be influenced by total depth of the borehole, results of field screening and lithology of the soils.

Table 5-4. Comparison of Content Requirements for Closure Plans, Corrective Measures Studies, and Feasibility Studies. (page 1 of 2)

Washington Administrative Code (WAC) Closure Plan Requirements	Corrective Measures Study (CMS) Requirements	Feasibility Study Requirements
WAC 610 (2) & (3)	Resource Conservation Recovery Act (RCRA) Draft Subpart S §264.524 and §264.525	National Contingency Plan 40 CFR 300 Remedial Investigation/ Feasibility Study (RI/FS) Guidance
Report		
Written closure plan and, if necessary, a contingent closure plan. [WAC 610(3)(a)]	Summarize results of investigation Detailed description of remedies assessed How proposed remedy meets criteria	Background Remedial Action Objectives - Include PRGs, ARARs General Response Actions Identification of Screening Technologies Development of Alternatives Detailed Analysis of Alternatives (9 Criteria) Comparative Analysis
Identify steps necessary to perform partial and/or final closure of the facility at any point during its active life. [WAC 610(3)(a)]		
Describe how each dangerous waste management unit at the facility will be closed in accordance with 610(2). [WAC 610(3)(ii)]		
Describe how final closure of the facility will be conducted in accordance with 610(2). [WAC 610(3)(a)(iii)]		
Identify the maximum extent of the operation which will be closed during the active life of the facility. [WAC 610(3)(a)(ii)]		
Estimate the maximum inventory of dangerous wastes ever on-site over the active life of the facility. [WAC 610(3)(a)(iii)]		
Describe in detail the methods to be used during partial and final closures. Including, methods for removing, transporting, treating storing, or disposing of all dangerous wastes, and identify the type of the off-site dangerous waste management units to be used, if applicable. [WAC 610(3)(a)(iv)]		
Describe in detail the steps needed to remove or decontaminate all dangerous waste residues and contaminated containment system components, equipment, structures, and soils during partial and final closure. Include procedures for cleaning equipment and removing contaminated soils, methods for sampling and testing surrounding soils, and criteria for determining the extent of decontamination required to satisfy 610(2). [WAC 610(3)(a)(v)]		
Describe in detail other activities necessary during the closure period to ensure that all partial closures and final closure satisfy the closure performance standards. Includes groundwater monitoring, leachate collection, and run-on and run-off control. [WAC 610(3)(a)(vi)]		
Include a schedule for closure of each dangerous waste management unit and for final closure of the facility. [WAC 610(3)(a)(vii)]		

Table 5-4. Comparison of Content Requirements for Closure Plans, Corrective Measures Studies, and Feasibility Studies. (page 2 of 2)

Selection Criteria		
Minimize need for further maintenance Protect human health and environment Return land to appearance and use of the surrounding land areas. Clean up standards (MTCA level B or A if appropriate) Natural Resource Damage Assessment	Standards ♦ be protective of human health and environment ♦ attain media cleanup ♦ control the source Long-term reliability & effectiveness Reduce toxicity, mobility or volume Short-term effectiveness Implementability Cost Natural Resource Damage Assessment	40 CFR 300.430(e)(9) Overall Protection of Human Health and Environment Compliance with ARARs Long-term effectiveness & permanence Reduce toxicity, mobility or volume through treatment Short-term effectiveness Implementability Cost State acceptance Community acceptance Natural Resource Damage Assessment
Range of Alternatives		
No Range of Alternatives Required	No Range of Alternatives Required	40 CFR 300.430(e)(3) No action Treatment alternative Little or no treatment (engineering controls) Groundwater units - must evaluate alternatives with different restoration periods
ARARs - Applicable or relevant and appropriate requirements MTCA - Model Toxics Control Act PRGs - Preliminary remediation goals WAC - Washington Administrative Code		

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6.0 SCHEDULE

This chapter presents (Section 6.1) the operable unit schedule which will be used as the baseline to measure progress in implementing this work plan. A 100 Area Pilot Project Program Management Plan will be prepared which details integration of 100 N Area activities. This chapter provides limited discussion of these activities as they may affect the work plan activities. It discusses integration with the N Reactor Shutdown Program in Section 6.2. The relationship to RCRA TSD facilities is discussed in Section 6.3. Integration with Decontamination and Decommissioning is discussed in Section 6.4.

The 100-NR-1 RFI/CMS schedule is based upon the current N Reactor Deactivation Program Plan (WHC 1993a) schedule. The DOE will identify the program interfaces and schedules of the N Reactor Deactivation Program and decommissioning and decontamination (D&D) Program and build a 100-NR-1 schedule for the proposed plan to coincide with them.

6.1 100-NR-1 OPERABLE UNIT WORK PLAN SCHEDULE

An operable unit schedule, which supports the Tri-Party Agreement Action Plan work schedule, has been prepared that details the work described in Chapter 5 of this work plan. This schedule (Figure 6-1) is the baseline that will be used to measure progress in implementing this work plan. The limited field investigation described in Section 5.1 was initiated for this operable unit, prior to public review of the work plan, with the understanding that additional investigations may be required as a result of public review comments. Should such additional investigations be required, the operable unit schedule and associated milestones will be adjusted accordingly. Non-intrusive investigations (Task 2) were initiated in July of 1992 with the conduct of a surface radiation survey. Intrusive investigations (Task 5) were initiated in November of 1992 with the start of vadose borehole drilling and were completed in April of 1993 with source sampling (Task 2).

During Tri-Party Agreement Change negotiations, completed in early 1994, it was agreed that the 116-N-1 and 116-N-3 sites (1301-N and 1325-N facilities) would be addressed in the work plan as "high-priority" sites on the IRM pathway (Ecology et al. 1994c). Other "high priority" sites would be rescheduled to occur subsequent to completion of these and other Pilot Project activities. A prioritized listing of these high-priority sites including their estimated time durations is shown in Table 6-1.

6.2 INTEGRATION WITH N REACTOR SHUTDOWN PROGRAM

The N Reactor Shutdown Program is designed to place N Reactor and supporting facilities in a radiologically and environmentally safe condition such that they can be transferred to the Decommissioning and RCRA Closure Program in FY 1999 for ultimate decommissioning. Transition activities primarily involve shutdown and isolation of operational systems and buildings, radiological/hazardous waste clean-up, and environmental stabilization of the facilities.

A schedule (Figure 6-2) was developed by the N Reactor deactivation program (WHC 1993a), assuming the availability of resources and funding. Because of the duration of this schedule through FY 1999, some 100-NR-1 remedial actions are impacted and can not be addressed immediately. Table 6-2 was developed to show the various items that are considered to interfere with remediation of specific 100-NR-1 Operable Unit past practice sites. Interference was categorized into two general types; that resulting directly from the presence of essential underground utilities, and that resulting from some other reason.

The process used to determine whether N Reactor shutdown activities interfered with past practice remedial activities consisted of three parts. The first part involved identifying those utilities (underground electrical, drain, water and fire lines) that are required by N Reactor shutdown activities. These essential utilities were identified and color coded on composite drawings of the underground lines. Secondly, the past practice sites were plotted on the index drawing. The third and final part consisted of checking the appropriate composite drawing to see if there were any identified utilities contained in or immediately adjacent to the past-practice site.

An example of an "other" type of interference is shown as "RR TRACKS". Radioactive solid waste is moved off-site using rail lines and specially shielded railroad cars. These rail lines (or RR Tracks) were therefore considered to be essential and a point of interference with the remediation of certain past practice sites.

If essential underground utilities were contained in or immediately adjacent to the particular past practice site, or there was an impact from some other origin, then there was considered to be interference and the impacted utility or cause was identified on Table 6-2. If there were no essential underground utilities in the past practice site area and there was no other reasons inhibiting remediation of that site, then there was considered to be no interference.

6.3 INTEGRATION WITH RESOURCE CONSERVATION ACT CLOSURES

There are four RCRA facilities at 100 N:

- 1301-N LWDF (116-N-1) (mixed waste)
- 1325-N LWDF (116-N-3) (mixed waste)
- 1324-N surface impoundment (120-N-1) (hazardous waste);
- 1324-NA percolation pond (120-N-2) (hazardous waste).

Draft closure plans submitted to Ecology in 1987 were scheduled to be resubmitted in 1994 under Tri-Party Agreement Milestones M-20-31 and M-20-35. The revision and submittal of these closure plans has been canceled by Change Number M-15-94-04 to the Tri-Party Agreement dated January 25, 1994 (Ecology et al. 1994c). Closure plans for the RCRA TSD facilities will be incorporated in the closure plan/CMS documents as required by Tri-Party Agreement Milestones M-15-01K and M-15-01J specified in Change Number M-15-94-04 (Ecology et al. 1994c). The following volumes will constitute the closure plan/CMS for the 100 N Area and meet requirements under Change Number M-15-94-04:

- *Closure Plan/CMS for the 100 N Area,* Executive Summary

- *Closure Plan/CMS for the 100 N Area*, Volume 1, "1301/1325-N Liquid Waste Disposal Facilities Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01J)

- *Closure Plan/CMS for the 100 N Area,* Volume 2, "100-NR-1 Interim Action Closure Plan/Corrective Measures Study, High-Priority Sites" (Tri-Party Agreement Milestone M-15-01K)

- *Closure Plan/CMS for the 100 N Area,* Volume 3, "1324-N/NA Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01K)

- *Closure Plan/CMS for the 100 N Area,* Volume 4, "100-NR-2 Groundwater Interim Action Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01K)

- *Closure Plan/CMS for the 100 N Area*, Volume 5, "100-NR-1, 100-NR-2 Final Closure Plan/Corrective Measures Study" (Tri-Party Agreement Milestone M-15-01K).

6.4 INTEGRATION WITH DECONTAMINATION AND DECOMMISSIONING

The scope of work for D&D is not fully defined at this time but is assumed to be the isolation of any remaining radioactive or hazardous waste to minimize environmental impact, especially potential health and safety impacts, on the public. The actual plans will depend upon future engineering studies and the NEPA process, which will evaluate options and will be followed by a ROD. In accordance with Change Number M-15-94-04 and resulting Tri-Party Agreement Milestones M-15-01A through M-15-01E, D&D activities will be integrated with the ongoing RFI/CMS and CERCLA activities in the 100 N Area under the N Area pilot project (Ecology et al. 1994c).

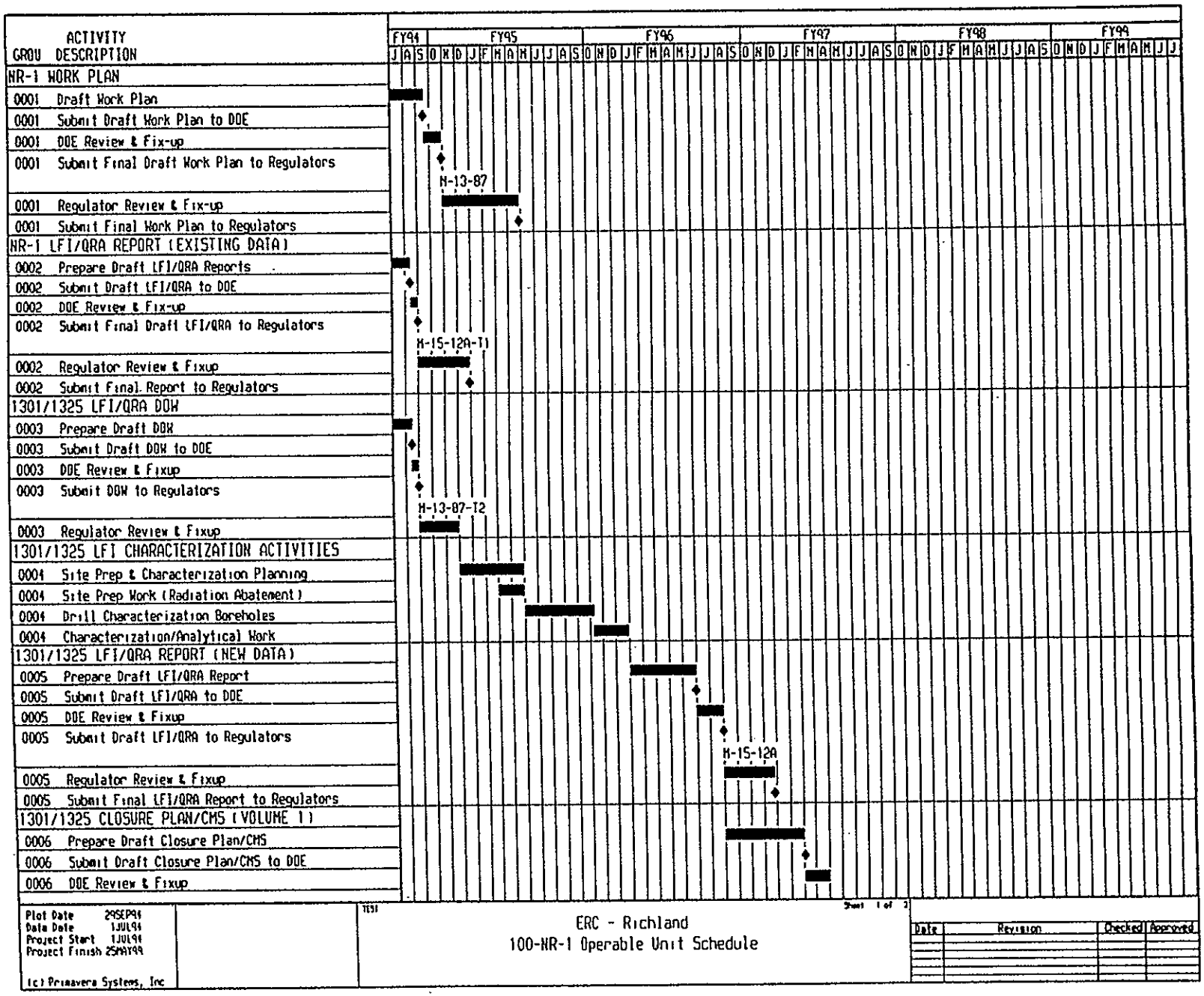

Figure 6-1. Operable Unit Schedule. (page 1 of 3)

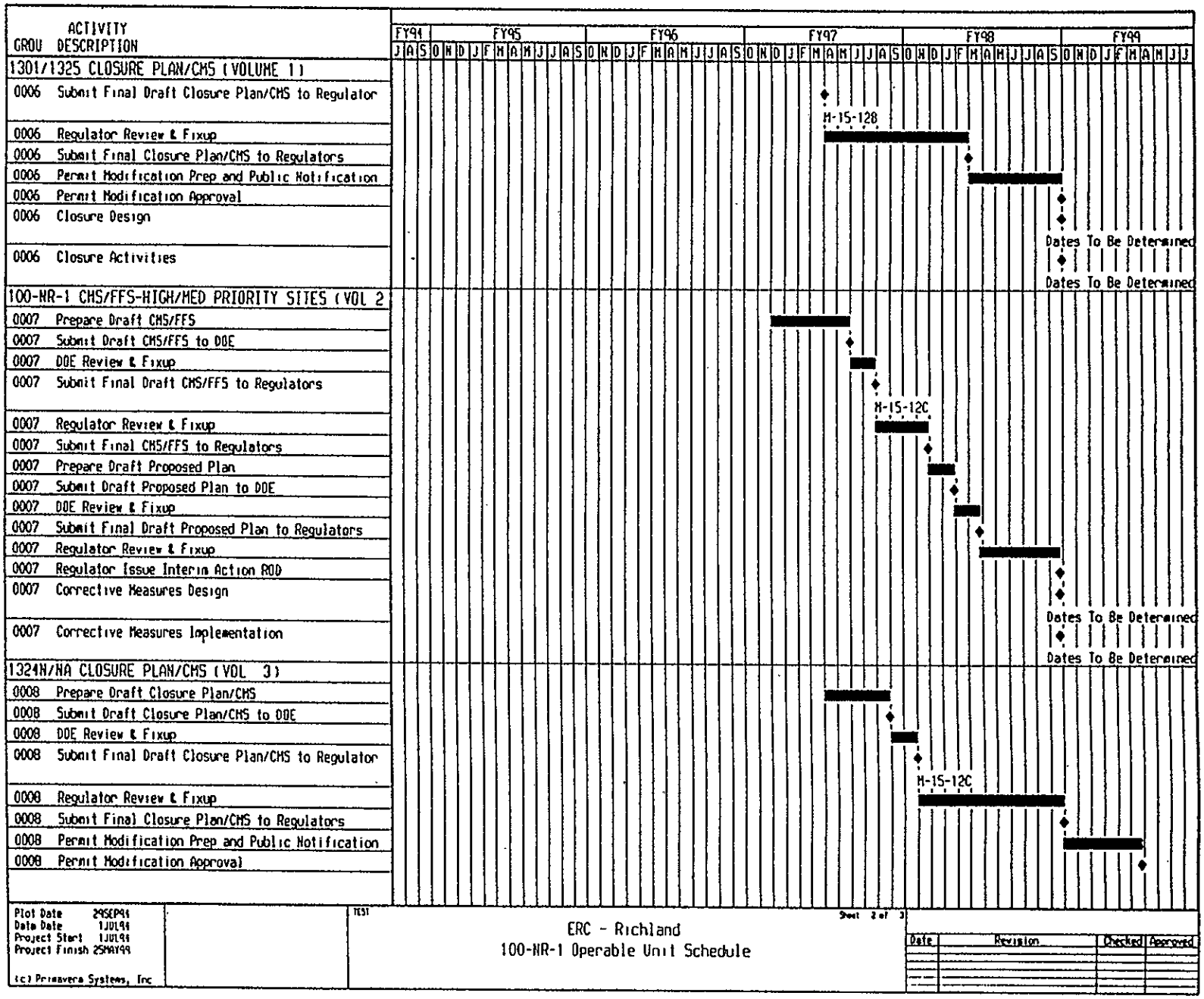

Figure 6-1. Operable Unit Schedule. (page 2 of 3)

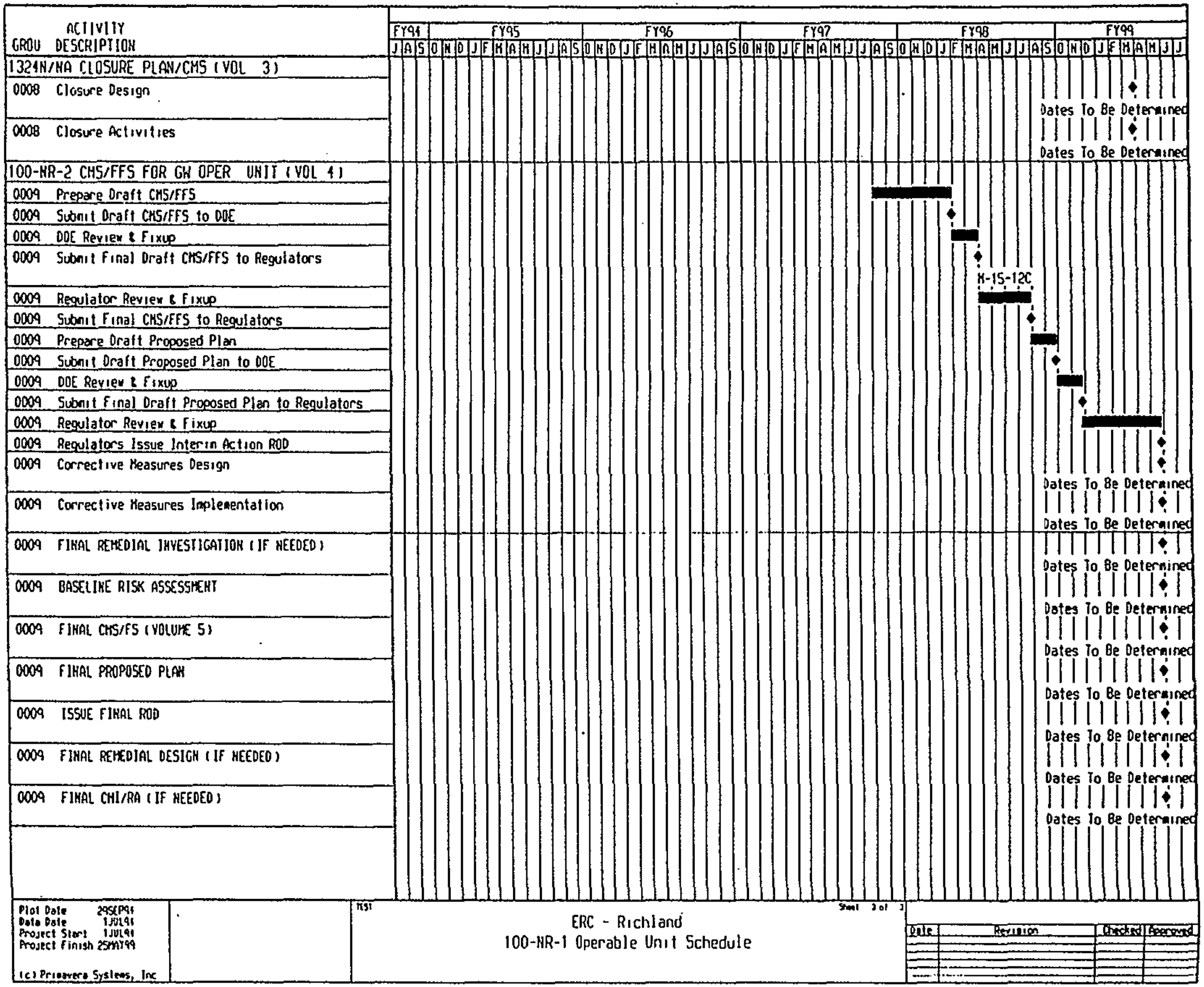

Figure 6-1. Operable Unit Schedule. (page 3 of 3)

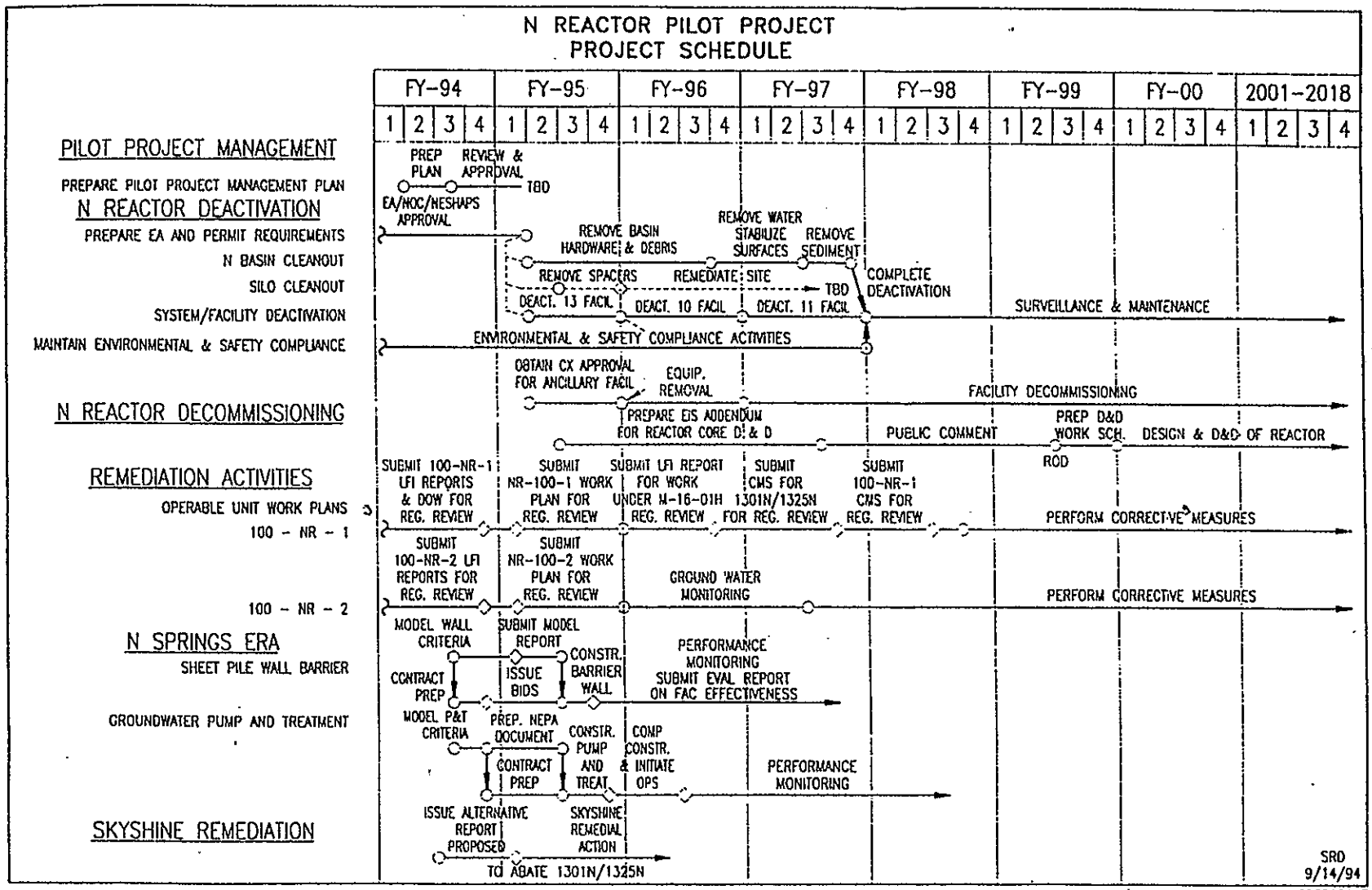

Figure 6-2. N Reactor Shutdown Program Schedule.

Table 6-1. Preliminary Prioritization and Estimated Remediation Durations for High Priority Waste Sites.

Official Name	Common Name	Prioritization Group	Remediation Duration (Months)
116-N-1	1301-N	A	9
116-N-2	Golf Ball	C	1
116-N-3	1325-N	A	8
116-N-4	Emergency Dump Basin	B	2
118-N-1	Spacer Storage Silos	B	1
120-N-1	Percolation Pond	D	4
120-N-2	Surface Impoundment	D	2
UN-100-N-17	166-N Tank Farm	C	1
UN-100-N-29	1304 Emergency Dump Tank	B	1
UN-100-N-4 UN-100-N-8	1322-N and 1322-NA	C	2
UN-100-N-6	Decontamination Waste Drain Line	B	1
UN-100-N-9	119-N	C	1

Notes:

1. The following Prioritization groups have been used:
   - A - Waste sites within this group have been selected by Ecology, EPA and DOE to be remediated first.
   - B - Waste sites within this group have been selected by Ecology, EPA, and DOE to be remediated second.
   - C - Waste sites within this group have been selected by Ecology, EPA, and DOE to be remediated third.
   - D - A remediation priority for waste sites within this group is yet to be determined.

   Final prioritization of remediation will be addressed as part of the IROD. It is expected that these groupings may change as specific plans are developed and operational requirements are addressed.

2. Durations are from the Hanford ER Program December 1993 Baseline estimates and are not based upon site surveys or engineering planning. The durations reflect an estimate of field time to remediate and do not include time for planning, procurement, procedure development, pre-remedial activities such as utility rerouting and site preparation, and operational considerations related to worker health and safety due to expected radiation levels.

Table 6-2. Waste Site Remediation Action Interference. (page 1 of 5)

Site (Alias)	Waste Site Description	No Interference	Waste Site Remedial Action Interference					
			Active Systems Supporting N Reactor Shutdown					
			Fire System Lines	Radioactive Effluent Drains	Regular Water Drains	Air System	Electrical or Utility Lines	Other
RCRA TSD Facilities								
116-N-1 (1301-N)	Effluent Crib	X						
116-N-3 (1325-N)	Effluent Crib	X						
120-N-2 (1324-N)	Percolation Pond	X						
120-N-1 (1324-NA)	Surface Impoundment	X						
120-N-1	South Settling Pond	X						
High Priority Sites								
118-N-1	Spacer Storage Silos		X	X	X		X	RR Tracks (Spacers not yet Removed)
1304-N	Emergency Dump Tank				X			RR Tracks
116-N-4 (1300-N)	Emergency Dump Basin		X	X	X			RR Tracks

Table 6-2. Waste Site Remediation Action Interference. (page 2 of 5)

Site (Alias)	Waste Site Description	No Interference	Waste Site Remedial Action Interference					
			Active Systems Supporting N Reactor Shutdown					
			Fire System Lines	Radioactive Effluent Drains	Regular Water Drains	Air System	Electrical or Utility Lines	Other
High Priority Sites (Cont)								
105-N Basin	Spent Fuel Storage Basin		X	X	X	X	X	N Reactor Shutdown Prerequisite
UN-100-N-6	Decontamination Waste Drain Line			X		X	X	
Other High Priority Sites								
1322-N/NA	Sample Buildings			X	X		X	
116-N-2 (1310-N)	Temporary Storage Facility		X	X	X	X	X	
166-N	UN-100-N-17			X				
119-N	Cooling Water Drain Line			X				
Low Priority Sites								
Spring 1983 UPR	NaOH Spill			X		X	X	
108-N (1106-N)	Chemical Unloading Facility	X						
120-N-7	French Drain Unloading Station	X						

Table 6-2. Waste Site Remediation Action Interference. (page 3 of 5)

Site (Alias)	Waste Site Description	No Interference	Waste Site Remedial Action Interference					
			Active Systems Supporting N Reactor Shutdown					
			Fire System Lines	Radioactive Effluent Drains	Regular Water Drains	Air System	Electrical or Utility Lines	Other
Low Priority Sites (Cont)								
120-N-6	H_2SO_4 Tank Fench Drains	X						
120-N-5	H^+/OH^- Transfer French Drain and Neutralization Unit	X						
120-N-3	Neutralization Pit and French Drain	X						
120-N-8	H_2SO_4 Day Tank Vent French Drain	X						
Regeneration-Waste Transport System	H^+/OH^- Regeneration Waste from 163-N	X						
166-N	Fuel Oil Unloading Station		X	X			X	RR Tracks (Possible)
Drum Storage Area	Reported Drum Storage Area		X				X	
181-N	Waste Oil Tank	X						

Table 6-2. Waste Site Remediation Action Interference. (page 4 of 5)

Site (Alias)	Waste Site Description	No Interference	Waste Site Remedial Action Interference					
			Active Systems Supporting N Reactor Shutdown					
			Fire System Lines	Radioactive Effluent Drains	Regular Water Drains	Air System	Electrical or Utility Lines	Other
Low Priority Sites								
184-N	Fuel Oil Day Tanks	X						
166-N TO 184-N	Fuel Oil Pumping		X	X	X		X	Reactor Ingress/ Egress Interference
Septic Tanks and Sanitary Waste Disposal Facilities								
124-N-4	Septic Tank and Drain Field	X						
124-N-3	107-N Cesspool							Active
124-N-1	Sewer System							Active
124-N-5	Septic Tank	X						
124-N-6	Septic Tank	X						
124-N-7	Septic Tank	X						
124-N-8	Septic Tank							Active
124-N-9	Septic Tank							Active
124-N-10	Sewer System							Active (216 Permit app.)

Table 6-2. Waste Site Remediation Action Interference. (page 5 of 5)

Site (Alias)	Waste Site Description	No Interference	Waste Site Remedial Action Interference					
			Active Systems Supporting N Reactor Shutdown					
			Fire System Lines	Radioactive Effluent Drains	Regular Water Drains	Air System	Electrical or Utility Lines	Other
Septic Tanks and Sanitary Waste Disposal Facilities (Cont)								
124-N-2	Septic Tank							Active
Other Low Priority Sites								
1314	Liquid Waste Loadout Facility			X			X	
128-N-1	Trash Burn Pit / Fuel Oil Starter	X						
1143-N	Paint Shop							Active
120-N-4	Storage Area	X						
N-17	Paint Shop							Active
HGP Burn Pit	Trash Burn Pit	X						
Construction Debris Dump	Dump	X						

HGP = Hanford Generating Plant
RCRA = Resource Conservation and Recovery Act
RR = Railroad tracks
TSD = Treatment Storage and/or Disposal
UPR = Unplanned release

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7.0 PROJECT MANAGEMENT

This chapter defines the administrative and institutional tasks necessary to support the RFI/CMS for the 100-NR-1 Operable Unit at the Hanford Site. Also, this chapter defines the responsibilities of the various participants, the organizational structure, and the project tracking and reporting procedures. This chapter is in accordance with the provisions of the Tri-Party Agreement Action Plan dated August 1990. Any revisions to the Tri-Party Agreement Action Plan that would result in changes to the project management requirements would supersede the provisions of this chapter.

7.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

7.1.1 Interface of Regulatory Authorities and the U.S. Department of Energy

The 100-NR-1 Operable Unit consists of inactive waste management units to be remediated under RCRA. Ecology has been designated as the lead regulatory agency, as defined in the Tri-Party Agreement. Accordingly, Ecology is responsible for overseeing remedial action activity at this unit and ensuring that the applicable authorities of both EPA and Ecology are applied. The specific responsibilities of EPA, Ecology, and the DOE are detailed in the Tri-Party Agreement Action Plan.

7.1.2 Project Organization and Responsibilities

The project organization for implementing remedial activities at the 100-NR-1 Operable Unit is shown in Figure 7-1. The following sections describe the responsibilities of the individuals shown in Figure 7-1.

7.1.2.1 Project Managers. The EPA, the DOE, and Ecology have each designated one individual as project manager for remedial activities at the Hanford Site. These project managers will serve as the primary point of contact for all activities to be carried out under the Tri-Party Agreement Action Plan. The responsibilities of the project managers are given in Section 4.1 of the Action Plan.

7.1.2.2 Unit Managers. As shown in Figure 7-1, EPA, DOE, and Ecology will each designate an individual as a unit manager for the 100-NR-1 Operable Unit.

The unit manager from Ecology will serve as the lead unit manager. The Ecology unit manager will be responsible for regulatory oversight of all RFI/CMS activities required for the 100-NR-1 Operable Unit.

The unit manager from EPA will be responsible for making decisions related to issues for which the supporting regulatory agency maintains authority. All such decisions will be made in consideration of recommendations made by the Ecology unit manager.

The unit manager from DOE will be responsible for maintaining and controlling the schedule and budget and keeping the EPA and Ecology unit managers informed as to the status of the RFI/CMS activities at the 100-NR-1 Operable Unit, particularly the status of agreements and commitments.

7.1.2.3 Quality Assurance Officer. The quality assurance officer is responsible for monitoring overall environmental restoration program activities through the establishment of Hanford Site quality assurance auditing program controls that may be appropriately applied to RFI/CMS activities. The quality assurance officer is specifically vested with the organizational independence and authority to identify conditions adverse to quality, and to systematically seek effective corrective action.

7.1.2.4 Quality Coordinator. The quality coordinator is responsible for coordinating and monitoring performance of the QAPjP requirements by means of internal surveillance techniques and by auditing, as directed by the quality assurance officer. The quality coordinator retains the necessary organizational independence and authority to identify conditions adverse to quality, and to inform the technical lead of needed corrective action.

7.1.2.5 Health and Safety Officer (Environmental Division/Environmental Field Services) The health and safety officer is responsible for monitoring all potential health and safety hazards, including those associated with radioactive, volatile, and/or toxic compounds during sample handling and sampling decontamination activities. The health and safety officer has the responsibility and authority to halt field activities resulting from unacceptable health and safety hazards.

7.1.2.6 Technical Lead. The technical lead will be a designated person within the Bechtel Hanford Incorporated. The responsibilities of the technical lead will be to plan, authorize, and control work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound.

7.1.2.7 RCRA Facility Investigation/Corrective Measures Study Coordinators. The RFI and CMS coordinators will be responsible for coordinating all activities related to the RFI and CMS, respectively, including data collection, analysis, and reporting. The RFI and CMS coordinators will be responsible for keeping the technical lead informed as to the RFI and CMS work status and any problems that may arise.

7.1.2.8 RCRA Facility Investigation/Corrective Measures Study Contractor. Figure 7-1 shows the organizational relationship of an offsite RFI/CMS contractor. Assuming a contractor is used to perform the RFI/CMS for the 100-NR-1 Operable Unit, the contractor would assume responsibilities of the RFI and CMS coordinators, as described above. In this instance, the contractor will be directly responsible for planning data collection activities and for analyzing and reporting the results of the data-gathering in the RFI and CMS reports. The BHI coordinator would retain the responsibility for securing and managing the field sampling efforts of the Hanford Site technical resource teams, described below. Figure 7-2 shows a sample organizational structure for an RFI/CMS contractor team.

7.1.2.9 Hanford Site Technical Resources. The various technical resources available on the Hanford Site for performing the RFI field studies are shown in Figures 7-3 through 7-6. Internal and external work orders and subcontractor task orders will be written by the BHI technical lead to use these technical resources, which are under the control of the technical lead. Statements of work will be provided to the technical teams and will include a discussion of authority and responsibility, a schedule with clearly defined milestones, and a task description including specific requirements. Each technical team will keep the RFI coordinator informed of the RFI work status performed by that group as well as any problems that may arise.

7.2 DOCUMENTATION AND RECORDS

All RFI/CMS plans and reports will be categorized as either primary or secondary documents as described by Section 9.1 of the Tri-Party Agreement Action Plan. The process for document review and comment will be as described in Section 9.2 of the Action Plan. Revisions, should they become necessary after finalization of any document, will be in accordance with Section 9.3 of the Tri-Party Agreement Action Plan. Changes in the work schedule, as well as minor field changes, can be made without having to process a formal revision. The process for making these changes will be as stated in Section 12.0 of the Tri-Party Agreement Action Plan. Administrative records, which must be maintained to support the Hanford Site RCRA activities, will be in accordance with Section 9.4 of the Tri-Party Agreement Action Plan.

7.3 FINANCIAL AND PROJECT TRACKING REQUIREMENTS

7.3.1 Management Control

Bechtel Hanford Incorporated will have the overall responsibility for planning and controlling the RFI/CMS activities, and providing effective technical, cost, and schedule baseline management. If a RFI/CMS contractor is used, the contractor will assume the direct day-to-day responsibilities for these management functions. The management control system used for this project must meet the requirements of DOE Order 4700.1, *Project Management System* (DOE 1987b), and DOE Order 2250.1C, *Cost and Schedule Systems Criteria* (DOE 1988b). The Bechtel Hanford Incorporated Management Control System (MCS) meets these requirements. The primary goals of the Bechtel Hanford Incorporated MCS are to provide methods for planning, authorizing, and controlling work so that it can be completed on schedule and within budget, and to ensure that all planning and work performance activities are technically sound and in conformance with management and quality requirements.

The RFI/CMS schedule for the 100-NR-1 Operable Unit and major milestones are described in Chapter 6.0. The schedule will be the primary vehicle for the unit managers and technical lead to track the progress of the RFI/CMS for the 100-NR-1 Operable Unit. The RFI/CMS schedule must be consistent with the work schedule contained in the Tri-Party Agreement Action Plan.

The RFI/CMS schedule in the work plan will be updated at least annually, to expand the new current fiscal year and the follow-on year. In addition, any approved schedule changes (see Section 12.0 of the Tri-Party Agreement Action Plan for the formal change control system) would be incorporated at this time, if not previously incorporated. This update will be performed in the fourth quarter of the previous fiscal year (e.g., July to September) for the upcoming current fiscal year. The work schedule can be revised at any time during the year if the need arises, but the changes would be restricted to major changes that would not be suitable for the change control process.

7.3.2 Meetings and Progress Reports

Both project and unit managers must meet periodically to discuss progress, review plans, and address any issues that have arisen. The project managers' meeting will take place at least quarterly, and is discussed in Section 8.1 of the Tri-Party Agreement Action Plan.

Unit managers shall meet monthly to discuss progress, address issues, and review near-term plans pertaining to their respective operable units and/or treatment, storage, and disposal groups/units. The meetings shall be technical in nature, with emphasis on technical issues and work progress. The assigned DOE unit manager for the 100-NR-1 Operable Unit will be responsible for preparing revisions to the RFI/CMS schedule prior to the meeting. The schedule shall address all ongoing activities associated with the operable unit, including actions on specific source units (e.g., sampling). This schedule will be provided to all parties and reviewed at the meeting. Any agreements and commitments (within the unit manager's level of authority) resulting from the meeting will be prepared and signed by all parties as soon as possible after the meeting. Meeting minutes will be issued by the DOE unit manager and will summarize the discussion at the meeting, with information copies given to the project managers. The minutes will be issued within five working days following the meeting. The minutes will include, at a minimum, the following information:

- status of previous agreements and commitments
- any new agreements and commitments
- schedules (with current status noted)

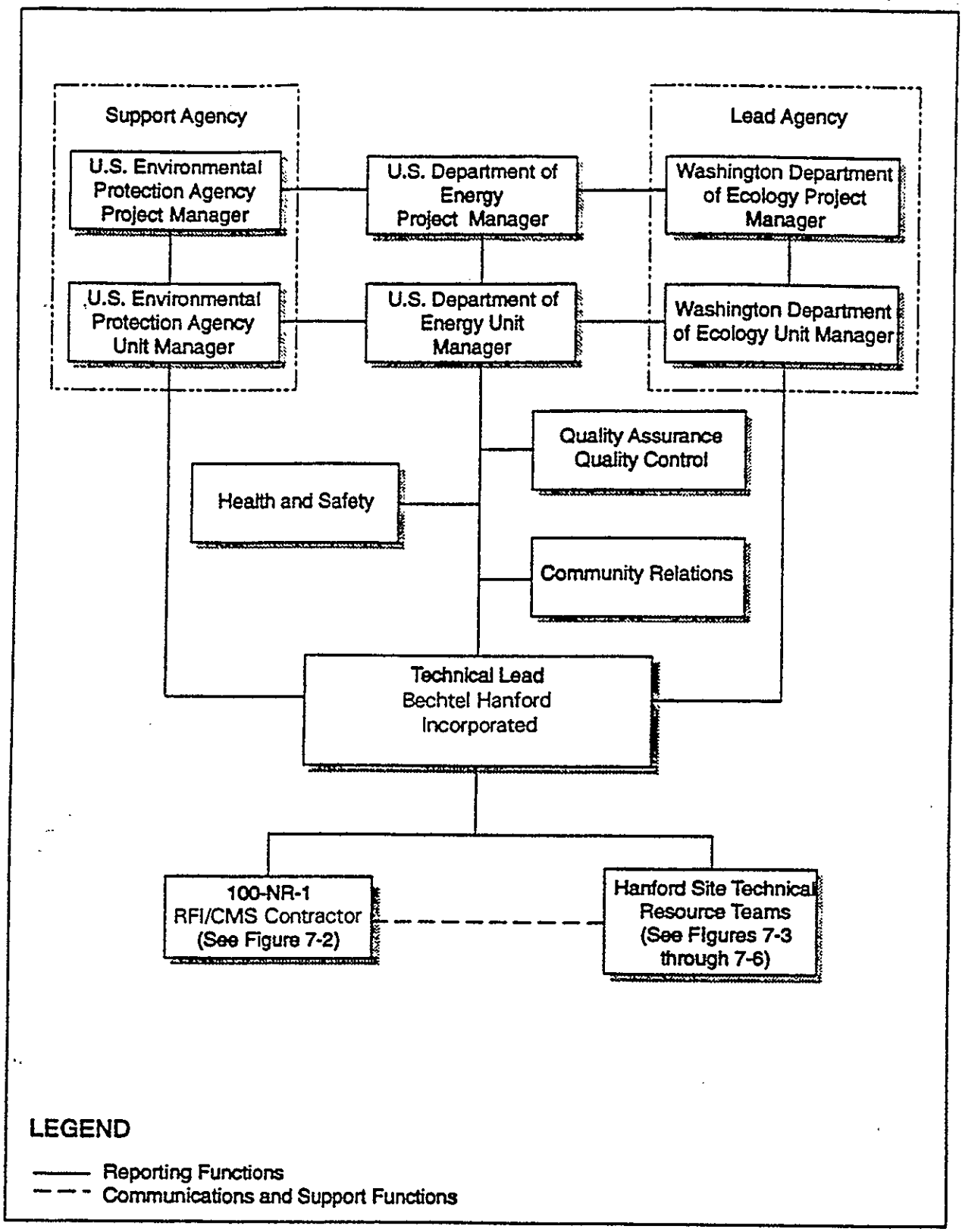
- any approved changes signed off at the meeting in accordance with Section 12.1 of the Tri-Party Agreement Action Plan.

Project coordinators for each operable unit also will meet on a monthly basis to share information and to discuss progress and problems.

The DOE shall issue a quarterly progress report for the Hanford Site within 45 days following the end of each quarter. Quarters end on March 31, June 30, September 30, and December 31. The quarterly progress reports will be placed in the public information repositories as discussed in Section 10.2 of the Tri-Party Agreement Action Plan. The report shall include the following:

- highlights of significant progress and problems
- technical progress with supporting information, as appropriate
- problem areas with recommended solutions. This will include any anticipated delays in meeting schedules, the reason(s) for the potential delay, and actions to prevent or minimize the delay
- significant activities planned for the next quarter
- work schedules (with current status noted).

Figure 7-1. Project Organization for the 100-NR-1 Operable Unit RFI/CMS Project.



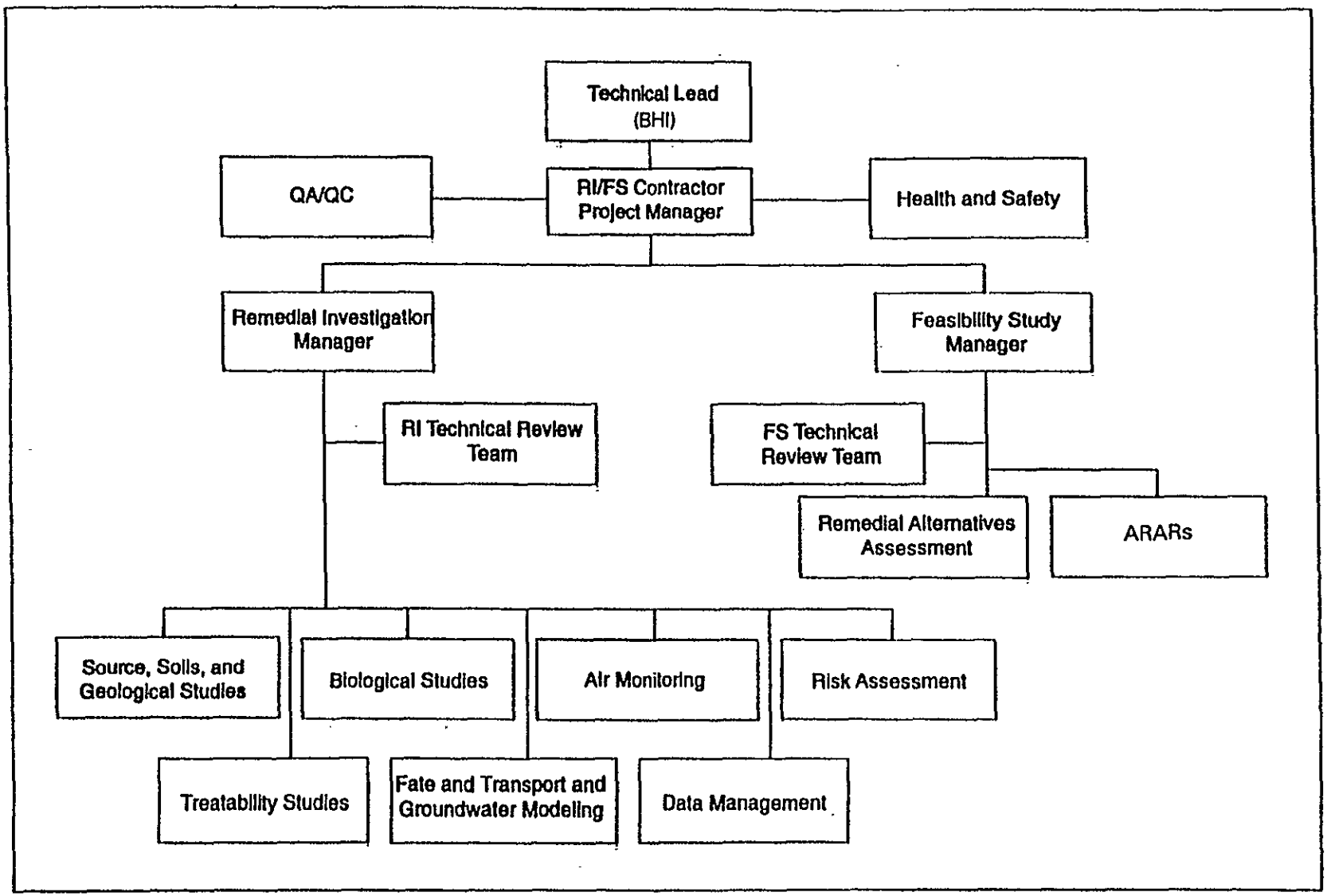


Figure 7-2. Example Project Organization for the 100-NR-1 Operable Unit RFI/CMS Contractor Team.

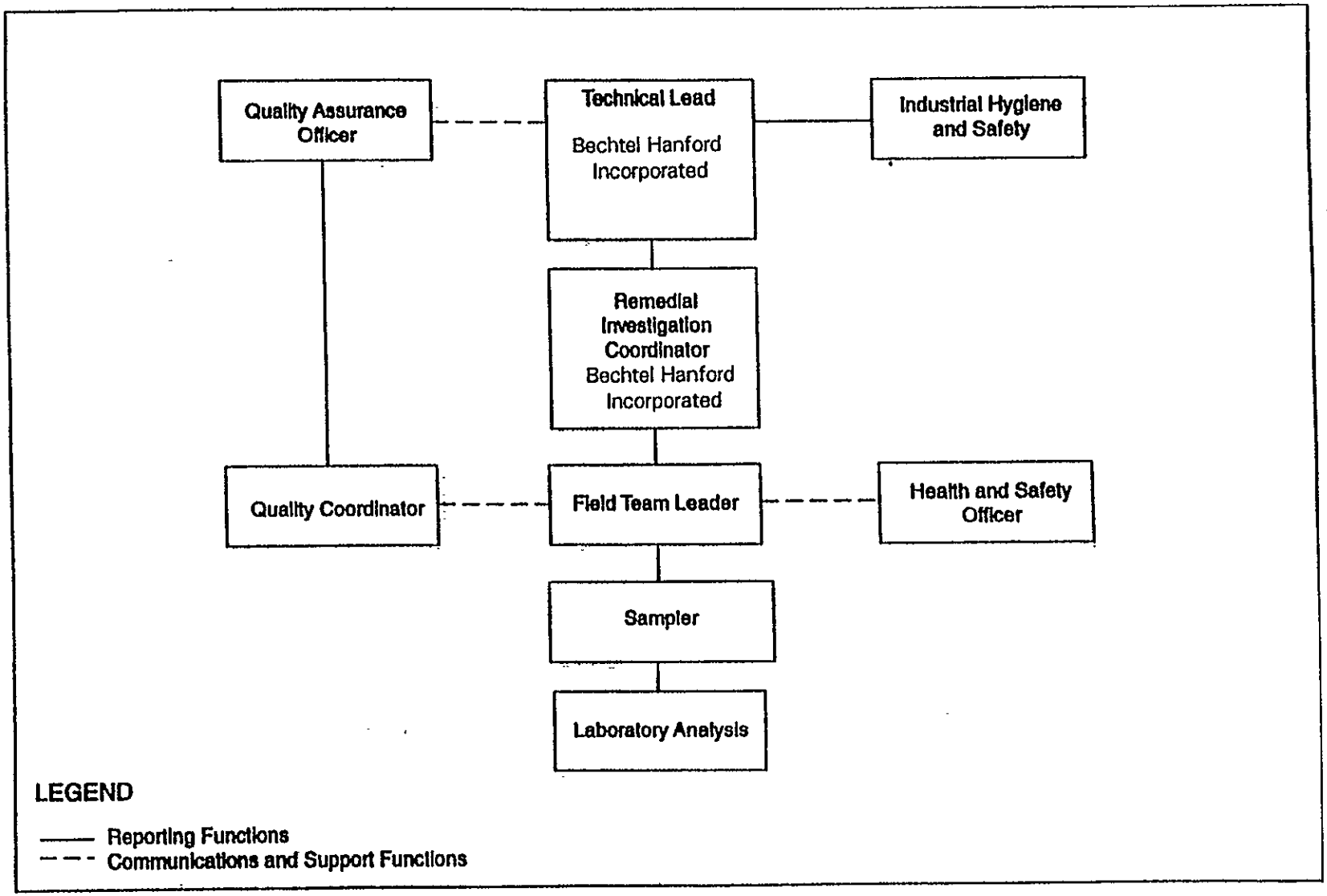


Figure 7-3. The Hanford Site Soil Sampling Team.

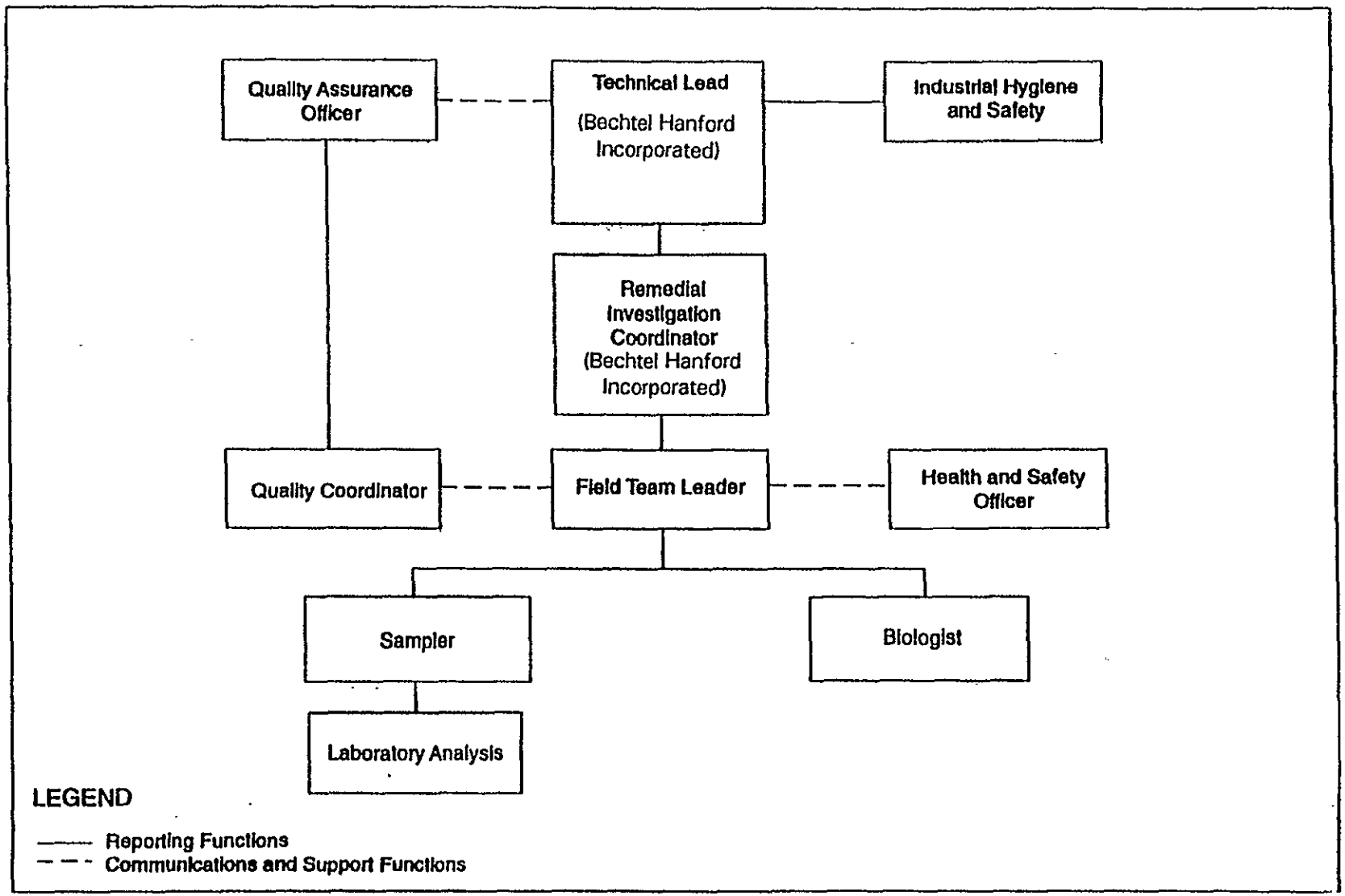


Figure 7-4. The Hanford Site Biological Sampling Team.

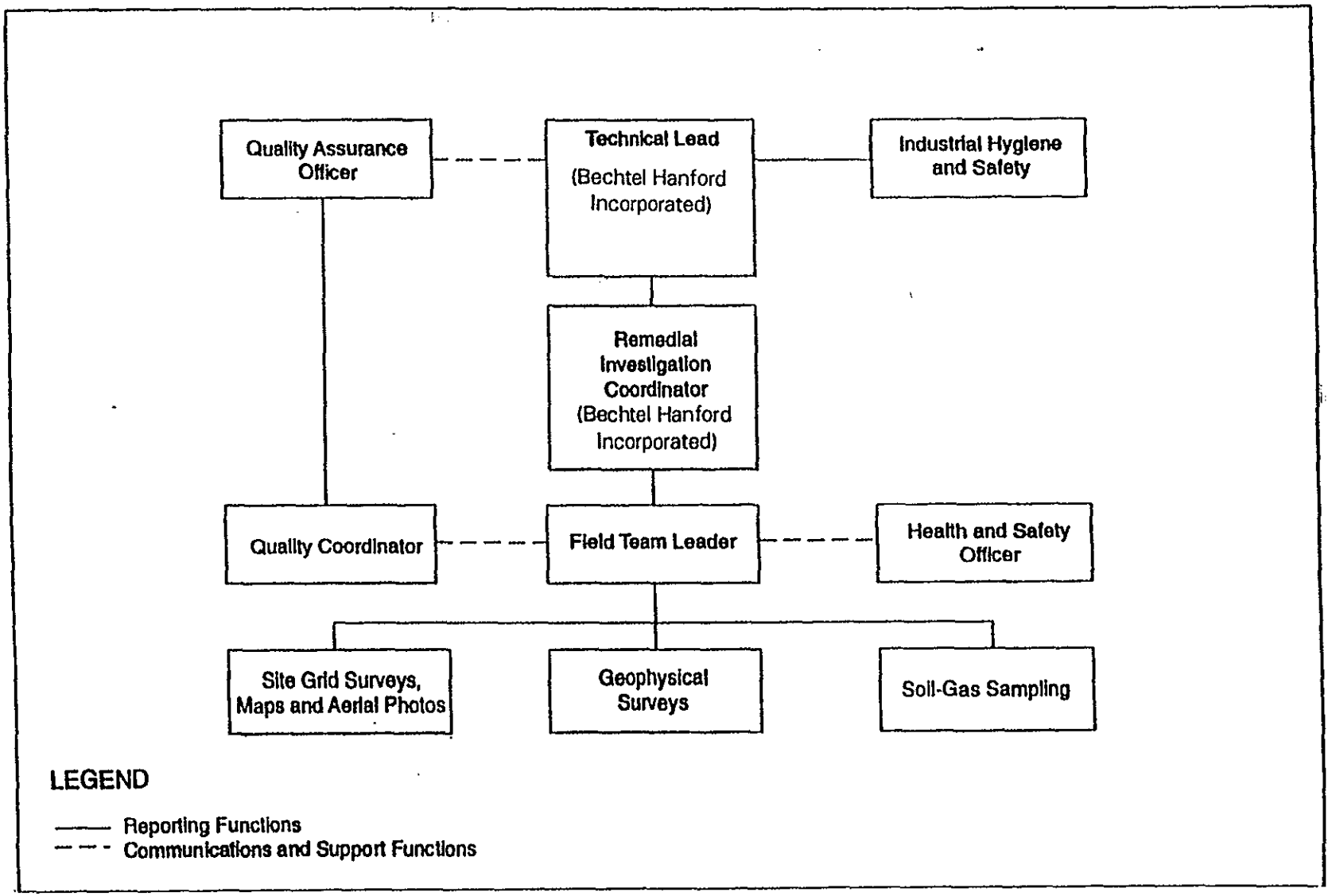


Figure 7-5. The Hanford Site Physical and Geophysical Survey Team.

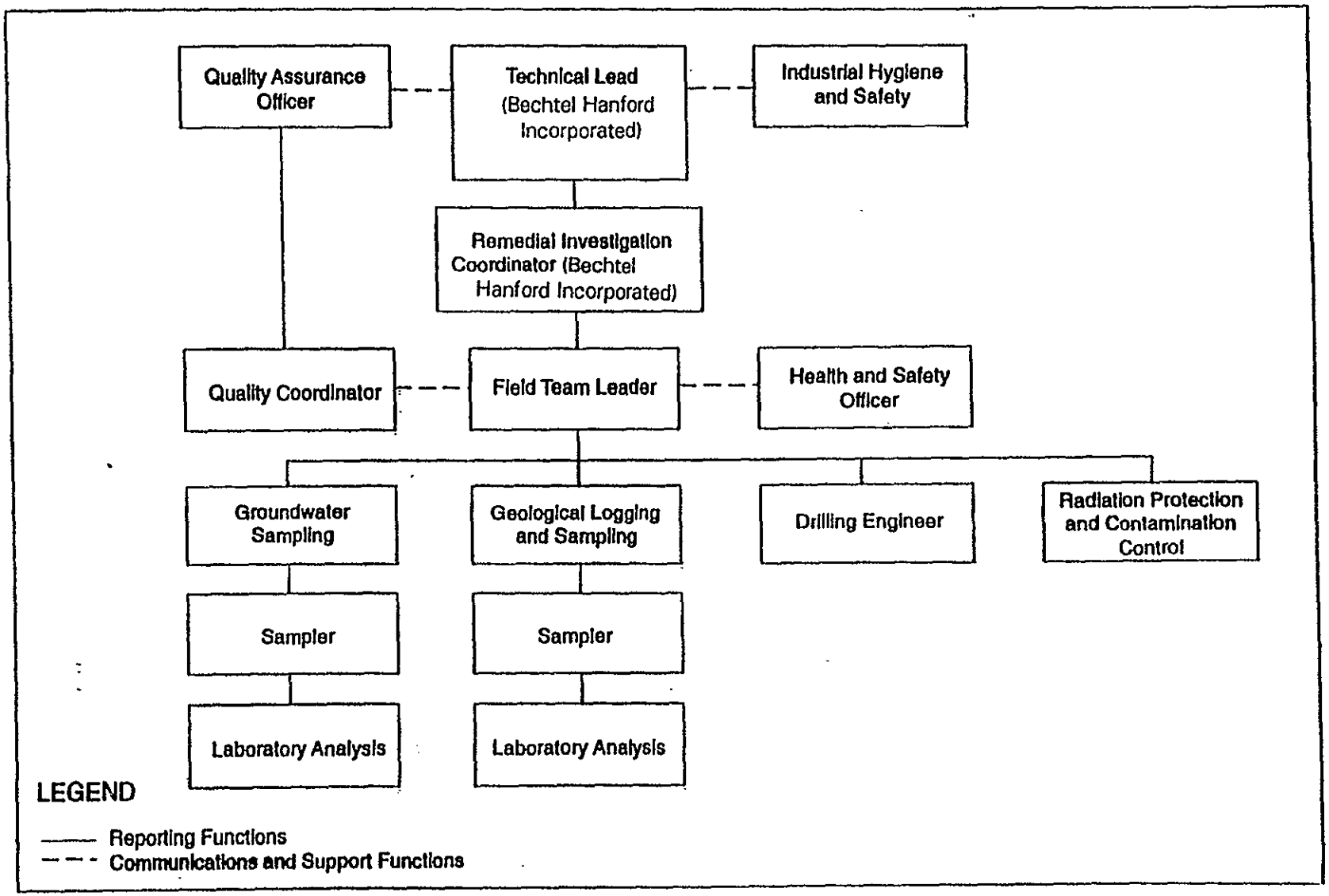


Figure 7-6. Drilling, Sampling and Well-Development Team.

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APPENDIX A

QUALITY ASSURANCE PROJECT PLAN (QAPjP)

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GLOSSARY

Accuracy: For the purposes of environmental investigations, accuracy may be interpreted as the measure of the bias in a system. Sampling accuracy is normally assessed through the evaluation of matrix-spiked samples, reference samples, and split samples.

Audit: For the purposes of environmental investigations, audits are considered to be systematic checks to verify the quality of operation of one or more elements of the total measurement system. In this sense, audits may be of two types: (1) performance audits, in which quantitative data are independently obtained for comparison with data routinely obtained in a measurement system, or (2) system audits, involving a qualitative onsite evaluation of laboratories or other organizational elements of the measurement system for compliance with established quality assurance program and procedure requirements. For environmental investigations at the Hanford Site, performance audit requirements are fulfilled by periodic submittal of blind samples to the primary laboratory, or the analysis of split samples by an independent laboratory. System audit requirements are implemented through the use of standard surveillance procedures.

Bias: Bias represents a systematic error that contributes to the difference between a population mean of a set of measurements and an accepted reference or true value.

Blind Sample: A blind sample refers to any type of sample routed to the primary laboratory for performance audit purposes, relative to a particular sample matrix and analytical method. Blind samples are not specifically identified as such to the laboratory. They may be made from traceable standards, or may consist of sample material spiked with a known concentration of a known compound. See the glossary entry for Audit.

Comparability: For the purposes of environmental investigations, comparability is an expression of the relative confidence with which one data set may be compared with another.

Completeness: For the purposes of environmental investigations, completeness may be interpreted as a measure of the amount of valid data obtained compared to the total data expected under correct normal conditions.

Deviation: For the purposes of environmental investigations, deviation refers to an approved departure from established criteria that may be required as a result of unforeseen field situations or that may be required to correct ambiguities in procedures that may arise in practical applications.

Equipment Blanks: Equipment blanks consist of pure deionized, distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. They are used to verify the adequacy of sampling equipment decontamination procedures, and are normally collected at the same frequency as field duplicate samples.

Field Blanks: Field blanks for water analyses consist of pure deionized, distilled water, transferred to a sample container at the site and preserved with the reagent specified for the analytes of interest. They are used to check for possible contamination originating with the reagent or the sampling environment, and are normally collected at the same frequency as field duplicate samples.

Field Duplicate Sample: Field duplicate samples are samples retrieved from the same sampling location using the same equipment and sampling technique, placed in separate, identically prepared and preserved containers, and analyzed independently. Field duplicate samples are generally used to verify the repeatability or reproducibility of analytical data, and are normally analyzed with each analytical batch or every 20 samples, whichever is greater.

Matrix-Spiked Samples: Matrix-spiked samples are a type of laboratory quality control sample. They are prepared by splitting a sample received from the field into two homogenous aliquots (i.e., replicate samples) and adding a known quantity of a representative analyte of interest to one aliquot in order to calculate the percentage of recovery of that analyte.

Nonconformance: A nonconformance is a deficiency in the characteristic, documentation, or procedure that renders the quality of material, equipment, services, or activities unacceptable or indeterminate. When the deficiency is of a minor nature, does not effect a permanent or significant change in quality if it is not corrected and can be brought into conformance with immediate corrective action, it shall not be categorized as a nonconformance. If the nature of the condition is such that it cannot be immediately and satisfactorily corrected, however, it shall be documented in compliance with approved procedures and brought to the attention of management for disposition and appropriate corrective action.

Precision: Precision is a measure of the repeatability or reproducibility of specific measurements under a given set of conditions. The Relative Percent Difference (RPD) is used to assess the precision of the sampling and analytical method. RPD is a quantitative measure of the variability. Specifically, precision is a quantitative measure of the variability of a group of measurements compared to their average value. Precision is normally expressed in terms of standard deviation, but may also be expressed as the coefficient of variation (i.e., relative standard deviation) and range (i.e., maximum value minus minimum value). Precision is assessed by means of duplicate/replicate sample analysis.

Quality Assurance: For the purposes of environmental investigations, QA refers to the total integrated quality planning, quality control, quality assessment and corrective action activities that collectively ensure that the data from monitoring and analysis meets all end user requirements and/or the intended end use of the data.

Quality Assurance Project Plan: The QAPjP is an orderly assembly of management policies, project objectives, methods and procedures that defines how data of known quality will be produced for a particular project or investigation.

Quality Control: For the purposes of environmental investigations, QC refers to the routine application of procedures and defined methods to the performance of sampling, measurement and analytical processes.

Range: Range refers to the difference between the largest and smallest reported values in a sample, and is a statistic for describing the spread in a set of data.

Reference Samples: Reference samples are a type of laboratory quality control sample prepared from an independent, traceable standard at a concentration other than that used for analytical equipment calibration, but within the calibration range. Such reference samples are required for every analytical batch or every 20 samples, whichever is greater.

Replicate Sample: Replicate samples are two aliquots removed from the same sample container in the laboratory and analyzed independently.

Representativeness: For the purposes of environmental investigations, representativeness may be interpreted as the degree to which data accurately and precisely represent a characteristic of a population parameter, variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that is most concerned with the proper design of a sampling program.

Split Sample: A split sample is produced through homogenizing a field sample and separating the sample material into two equal aliquots. Field split samples are usually routed to separate laboratories for independent analysis, generally for purposes of auditing the performance of the primary laboratory relative to a particular sample matrix and analytical method. See the glossary entry for Audit. In the laboratory, samples are generally split to create matrix-spiked samples (see the glossary entry).

VOA Trip Blanks: Volatile Organics Analysis (VOA) trip blanks are a type of field quality control sample, consisting of pure deionized distilled water in a clean, sealed sample container, accompanying each batch of containers shipped to the sampling site and returned unopened to the laboratory. Trip blanks are used to identify any possible contamination originating from container preparation methods, shipment, handling, storage or site conditions.

Validation: For the purposes of environmental investigations, validation refers to a systematic process of reviewing data against a set of criteria to provide assurance that the data are acceptable for their intended use. Validation methods may include review of verification activities, editing, screening, cross-checking or technical review.

Verification: For the purposes of environmental investigations, verification refers to the process of determining whether procedures, processes, data or documentation conform to specified requirements. Verification activities may include inspections, audits, surveillance or technical review.

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1.0 PROJECT DESCRIPTION

1.1 PROJECT OBJECTIVE

The objectives of the environmental investigations in the 100-NR-1 operable unit are defined in Section 1.2 of the work plan. Analytical data resulting from the sampling portion of the investigation will be validated and evaluated to determine the most feasible options for additional investigation, remediation, or closure.

1.2 BACKGROUND INFORMATION

The 100-NR-1 operable unit is located within the 100 Area of the Hanford Site, shown in Figure 1-1 of the work plan. Detailed background information regarding the history and present use of the unit is provided in Chapter 2.0 of the work plan.

1.3 QUALITY ASSURANCE PROJECT PLAN SCOPE AND RELATIONSHIP TO BECHTEL HANFORD INC. QUALITY MANAGEMENT PLAN (BHI QMP)

This quality assurance project plan (QAPjP) applies specifically to the field activities and laboratory analyses performed as part of the Limited Field Investigation (LFI) for the 100-NR-1 operable unit. It is prepared specifically for this phase of investigation, and is prepared in compliance with the requirements of the Bechtel Hanford Inc. (BHI) *Quality Management Plan* (QMP, BHI 1994a). This QAPjP utilizes procedural resources compiled from the BHI QMP (BHI 1994a), the BHI *Quality Assurance Department Procedure Manual* (QADP, BHI 1994b), the BHI *Environmental Investigations Procedures* (BHI-EE-01, BHI 1994c), and other resources that also support the 100-NR-1 Operable Unit work plan. Final sampling locations, required sampling intervals, sample quantities, sampling frequency, and schedules for all technical activities addressed in this investigation shall be defined by investigation-specific Descriptions of Work (DOW) prepared in compliance with Environmental Investigation Instruction (EII) 1.14 "Preparation of Descriptions of Work" (BHI 1994c). All EIIs in BHI-EE-01 (BHI 1994c) and this QAPjP are subject to mandatory review and approval by the Environmental Protection Agency (EPA) and the Washington State Department of Ecology (Ecology) before use. Distribution and revision control of the work plan and the QAPjP will be performed in compliance with BHI QMP, Part 1, Section A.5 "Documents" (BHI 1994a).

Interim changes to this QAPjP or the work plan shall be documented, reviewed, and approved as required by EII 1.9, "Primary and Secondary Document Review and Control" (BHI 1994c) and shall be documented in Project Managers' meeting minutes. QAPjP distribution shall routinely include all review/approval personnel indicated on the title page of the document and all other individuals designated by the BHI technical lead. All plans and procedures referenced in the QAPjP are available for regulatory review on request at the direction of the technical lead.

1.4 PROJECT ACTIVITIES

Investigations to be conducted in the 100-NR-1 operable unit, include source geological, and vadose zone investigations, as well as an investigation made up of other miscellaneous tasks. More detailed discussions of individual tasks are contained in Chapter 5.0 of the work plan. Procedures directly applicable to the tasks described here are discussed in Chapter 4.0 of the QAPjP.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 QUALITY ASSURANCE OFFICER RESPONSIBILITIES

The Quality Assurance Officer is responsible for coordination and/or oversight of performance to the QAPjP requirements by means of internal auditing and surveillance techniques. The Quality Assurance Officer has the necessary organizational independence and authority to identify conditions adverse to quality and to inform the technical lead of needed corrective action.

2.2 TECHNICAL LEAD RESPONSIBILITIES

The Environmental Engineering function of BHI has primary responsibilities for conducting this investigation. Organizational charts, responsibility descriptions, and individual BHI field team descriptions are addressed in Chapter 7.0 of the work plan and in the governing project procedures identified in Section 4 of this QAPjP.

External participant contractors or subcontractors shall be evaluated and selected for certain portions of task activities at the direction of the technical lead in compliance with BHI QMP, Part 1, Section 4.0,"Procurement" (BHI 1994a). Major participant contractor and subcontractor resources are discussed in Chapter 7.0 of the work plan. All contractor or subcontractor plans and procedures shall be approved before their use, and shall be available for regulatory review after BHI approval.

2.3 ANALYTICAL LABORATORIES

The BHI field sampling team will be responsible for screening all samples for radioactivity in compliance with EII 1.15 "Preparation of SOW/LOI" (BHI 1994c) and the *WHC Radiological Control Manual*, WHC-CM-1-6 (WHC 1993a).

If the total activity of the sample is equal to or greater than 200 picocuries/gram (pCi/g), or if the alpha activity of the sample is equal to or greater than 60 pCi/g, samples shall be packaged and shipped in compliance with EII 5.11, "Sample Packaging and Shipping" (BHI 1994c) routed to a contractor or subcontractor laboratory equipped and qualified to handle the analysis of radioactive samples. Samples that do not exceed either of the above criteria may be routed to any approved participant contractor or subcontractor analytical laboratory. All analyses shall be coordinated through Analytical Services and shall be performed in compliance with BHI-approved laboratory Quality Assurance (QA) plans and analytical procedures; all analytical laboratories shall be subject to the surveillance controls described by BHI QADP 1.8 "QA Independent Assessment" (BHI 1994b). For subcontractors or participant contractors, applicable quality requirements shall be invoked as part of the approved procurement documentation or work order; see Section 3.0 and 4.1.2 of this QAPjP. Services of alternate qualified laboratories shall be procured for radioactive sample analysis if onsite laboratory capacity is not available, and/or for the performance of split sample analysis at the technical lead's discretion. If such an option is selected, the laboratory shall provide objective evidence of appropriate Nuclear Regulatory Commission (NRC) or state radioactive materials handling licenses. The laboratory shall submit its QA plan and applicable analytical procedures for BHI approval prior to their use, as noted in Section 4.1.2.

2.4 OTHER SUPPORT CONTRACTORS

Procurement of all other field services and supporting items, materials, or equipment shall comply with standard BHI procurement procedures as discussed in Sections 2.1 and 4.1 of this QAPjP. All work shall comply with BHI-approved QA plans and/or procedures, and is subject to the controls of BHI QMP, Part 1, Section B, "Assessments" (BHI 1994a). Applicable quality requirements shall be invoked as part of the approved procurement documentation or work order as noted in Section 4.1.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENTS

The rationale for establishing data quality objectives (DQOs) and data needs for this investigation is presented in Sections 4.1.1 and 4.1.2 of the work plan.

All analytical parameters that have been selected for this investigation are listed in Table QAPjP-1, cross-referenced to analytical method requirements and maximum detection or quantitation limit values and maximum acceptable ranges for precision and accuracy, in both soil and water matrices. Where EPA Contract Laboratory Program (CLP) methods are specified, the Contract Required Detection Limits (CRDLs) for inorganic parameters, Contract Required Quantitation Limits (CRQLs) for organic parameters, and the maximum precision and accuracy ranges specified for each parameter by the appropriate CLP Statements of Work (SOWs) apply without modification; see U.S. EPA *Contract Laboratory Program Statement of Work for Inorganics Analysis* (EPA 1991a) and U.S. EPA *Contract Laboratory Program Statement of Work for Organics Analysis* (EPA 1991b). For non-CLP parameters, CRQLs and precision and accuracy ranges are provided that shall be considered maximum values that can be reliably achieved by analytical laboratories under routine conditions. The requirements of Table QAPjP-1 shall be considered a minimum performance standard, and shall be incorporated into the agreements for services established with individual Westinghouse Hanford, participant contractor, or subcontractor analytical laboratories. Any modification of Table QAPjP-1 requirements shall be justified by the requestor, and shall be considered a formal modification of this QAPjP, and is subject to regulatory review and approval.

Goals for data representativeness will be addressed qualitatively by the specification of sampling depths and intervals in the DOWs prepared for this investigation, as previously described in Section 1.3 of this QAPjP. Sampling locations will be specified in the DOW or work orders issued to the subcontractors or participating contractors responsible for conducting sampling activities. Objectives for the completeness of this investigation shall require that contractually or procedurally established requirements for precision and accuracy be met for at least 90 percent of the total number of requested determinations. Failure to meet this criterion shall be documented and evaluated in the validation process described in Section 8.0 of this QAPjP; corrective action shall be taken as warranted, as described in Section 13.0. Approved analytical procedures shall require the use of the reporting techniques and units specified in the EPA reference methods specified in Table QAPjP-1 in order to facilitate the comparability of data sets in terms of precision and accuracy.

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 1 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL volatile organics	Chloromethane	i	10	i	i	10	i	i
	Bromomethane	i	10	i	i	10	i	i
	Vinyl chloride	i	10	i	i	10	i	i
	Chloroethane	i	10	i	i	10	i	i
	Methylene chloride	i	10	i	i	10	i	i
	Acetone	i	10	i	i	10	i	i
	Carbon disulfide	i	10	i	i	10	i	i
	1,1-Dichloroethene	i	10	i	i	10	i	i
	1,1-Dichloroethane	i	10	i	i	10	i	i
	1,2-Dichloroethene (total)	i	10	i	i	10	i	i
	Chloroform	i	10	i	i	10	i	i
	1,2-Dichloroethane	i	10	i	i	10	i	i
	2-Butanone	i	10	i	i	10	i	i
	1,1,1-Trichloroethane	i	10	i	i	10	i	i
	Carbon tetrachloride	i	10	i	i	10	i	i
	Bromodichloromethane	i	10	i	i	10	i	i
	1,2-Dichloropropene	i	10	i	i	10	i	i
	Trichloroethene	i	10	i	i	10	i	i
	Dibromochloromethane	i	10	i	i	10	i	i
	1,1,2-Trichloroethane	i	10	i	i	10	i	i
	Benzene	i	10	i	i	10	i	i
	trans-1,3-Dichloropropene	i	10	i	i	10	i	i
	cis-1,3-Dichloropropene	i	10	i	i	10	i	i
	Bromoform	i	10	i	i	10	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit.
(sheet 2 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL volatile organics (Cont.)	Tetrachloroethene	i	10	i	i	10	i	i
	Toluene	i	10	i	i	10	i	i
	1,1,2,2-Tetrachloroethane	i	10	i	i	10	i	i
	Chlorobenzene	i	10	i	i	10	i	i
	Ethyl benzene	i	10	i	i	10	i	i
	Styrene	i	10	i	i	10	i	i
	Xylenes (total)	i	10	i	i	10	i	i
CLP TCL semi-volatile organics	Phenol	i	330	i	i	10	i	i
	bis(2-Chloroethyl) ether	i	330	i	i	10	i	i
	2-Chlorophenol	i	330	i	i	10	i	i
	1,3-Dichlorobenzene	i	330	i	i	10	i	i
	1,4-Dichlorobenzene	i	330	i	i	10	i	i
	1,2-Dichlorobenzene	i	330	i	i	10	i	i
	2-Methylphenol	i	330	i	i	10	i	i
	2,2'-oxybis (1-Chloropropane)	i	330	i	i	10	i	i
	4-Methylphenol	i	330	i	i	10	i	i
	N-Nitroso-di-n-dipropylamine	i	330	i	i	10	i	i
	Hexachloroethane	i	330	i	i	10	i	i
	Nitrobenzene	i	330	i	i	10	i	i
	Isophorone	i	330	i	i	10	i	i
	2-Nitrophenol	i	330	i	i	10	i	i
	2,4-Dimethylphenol	i	330	i	i	10	i	i
	bis(2-Chloroethoxy) methane	i	330	i	i	10	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 3 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL semi-volatile organics (Cont.)	2,4-Dichlorophenol	i	330	i	i	10	i	i
	1,2,4-Trichlorobenzene	i	330	i	i	10	i	i
	Naphthalene	i	330	i	i	10	i	i
	4-Chloroaniline	i	330	i	i	10	i	i
	Hexachlorobutadiene	i	330	i	i	10	i	i
	4-Chloro-3-methylphenol	i	330	i	i	10	i	i
	2-Methylnaphthalene	i	330	i	i	10	i	i
	Hexachlorocyclopentadiene	i	330	i	i	10	i	i
	2,4,6-Trichlorophenol	i	330	i	i	10	i	i
	2,4,5-Trichlorophenol	i	800	i	i	25	i	i
	2-Chloronapthalene	i	330	i	i	10	i	i
	2-Nitroaniline	i	800	i	i	25	i	i
	Dimethylphthalate	i	330	i	i	10	i	i
	Acenaphthylene	i	330	i	i	10	i	i
	2,6-Dinitrotoluene	i	330	i	i	10	i	i
	3-Nitroaniline	i	800	i	i	25	i	i
	Acenaphthene	i	330	i	i	10	i	i
	2,4-Dinitrophenol	i	800	i	i	25	i	i
	4-Nitrophenol	i	800	i	i	25	i	i
	Dibenzofuran	i	330	i	i	10	i	i
	2,4-Dinitrotoluene	i	330	i	i	10	i	i
	Diethylphthalate	i	330	i	i	10	i	i
	4-Chlorophenyl-phenylether	i	330	i	i	10	i	i
	Fluorene	i	330	i	i	10	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit.
(sheet 4 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL semi-volatiles (Cont.)	4-Nitroaniline	i	800	i	i	25	i	i
	4,6-Dinitro-2-methylphenol	i	800	i	i	25	i	i
	N-nitrosodiphenylamine	i	330	i	i	10	i	i
	4-Bromophenyl-phenylether	i	300	i	i	10	i	i
	Hexachlorobenzene	i	300	i	i	10	i	i
	Pentachlorophenol	i	800	i	i	25	i	i
	Phenanthrene	i	330	i	i	10	i	i
	Anthracene	i	330	i	i	10	i	i
	Carbazole	i	330	i	i	10	i	i
	Di-n-butylphthalate	i	330	i	i	10	i	i
	Fluoranthene	i	330	i	i	10	i	i
	Pyrene	i	330	i	i	10	i	i
	Butylbenzylphthalate	i	330	i	i	10	i	i
	3-3'-Dichlorobenzidine	i	330	i	i	10	i	i
	Benzo(a)anthracene	i	330	i	i	10	i	i
	Chrysene	i	330	i	i	10	i	i
	bis(2-Ethylhexyl)phthalate	i	330	i	i	10	i	i
	Di-n-octylphthalate	i	330	i	i	10	i	i
	Benzo(b)fluoranthene	i	330	i	i	10	i	i
	Benzo(k)fluoranthene	i	330	i	i	10	i	i
	Benzo(a)pyrene	i	330	i	i	10	i	i
	Ideno(1,2,3-cd)pyrene	i	330	i	i	10	i	i
	Didenz(a,h)anthracene	i	330	i	i	10	i	i
	Benzo(g,h,i)perylene	i	330	i	i	10	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 5 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL Pesticides/ Aroclors	alpha-BHC	i	1.7	i	i	0.05	i	i
	beta-BHC	i	1.7	i	i	0.05	i	i
	delta-BHC	i	1.7	i	i	0.05	i	i
	gamma-BHC (Lindane)	i	1.7	i	i	0.05	i	i
	Heptachlor	i	1.7	i	i	0.05	i	i
	Aldrin	i	1.7	i	i	0.05	i	i
	Heptachlor epoxide	i	1.7	i	i	0.05	i	i
	Endosulfan I	i	1.7	i	i	0.05	i	i
	Dieldrin	i	3.3	i	i	0.10	i	i
	4,4'-DDE	i	3.3	i	i	0.10	i	i
	Endrin	i	3.3	i	i	0.10	i	i
	Endosulfan II	i	3.3	i	i	0.10	i	i
	4,4'-DDD	i	3.3	i	i	0.10	i	i
	Endosufan sulfate	i	3.3	i	i	0.10	i	i
	4,4'-DDT	i	3.3	i	i	0.10	i	i
	Methoxychlor	i	17.0	i	i	0.50	i	i
	Endrin ketone	i	3.3	i	i	0.10	i	i
	Endrin aldehyde	i	3.3	i	i	0.10	i	i
	alpha-Chlordane	i	1.7	i	i	0.05	i	i
	gamma-Chlordane	i	1.7	i	i	0.05	i	i
	Toxaphene	i	170.0	i	i	5.0	i	i
	Aroclor-1016	i	33.0	i	i	1.0	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 6 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TCL Pesticides/ Aroclors (Cont.)	Aroclor-1221	i	33.0	i	i	1.0	i	i
	Aroclor-1232	i	67.0	i	i	2.0	i	i
	Aroclor-1242	i	33.0	i	i	1.0	i	i
	Aroclor-1248	i	33.0	i	i	1.0	i	i
	Aroclor-1254	i	33.0	i	i	1.0	i	i
	Aroclor-1260	i	33.0	i	i	1.0	i	i
CLP TAL Inorganics	Aluminum	i	20	i	i	200	i	i
	Antimony	i	6	i	i	60	i	i
	Arsenic	i	1	i	i	10	i	i
	Barium	i	20	i	i	200	i	i
	Beryllium	i	.5	i	i	5	i	i
	Cadmium	i	.5	i	i	5	i	i
	Calcium	i	500	i	i	5000	i	i
	Chromium	i	1	i	i	10	i	i
	Cobalt	i	5	i	i	50	i	i
	Copper	i	2.5	i	i	25	i	i
	Iron	i	10	i	i	100	i	i
	Lead	i	.3	i	i	3	i	i
	Magnesium	i	500	i	i	5000	i	i
	Manganese	i	1.5	i	i	15	i	i
	Mercury	i	.02	i	i	0.2	i	i
	Nickel	i	4	i	i	40	i	i
	Potassium	i	500	i	i	5000	i	i
	Selenium	i	.5	i	i	5	i	i

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 7 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
CLP TAL Inorganics (Cont.)	Silver	i	1	i	i	10	i	i
	Sodium	i	500	i	i	5000	i	i
	Thallium	i	1	i	i	10	i	i
	Vanadium	i	5	i	i	50	i	i
	Zinc	i	2	i	i	20	i	i
	Cyanide	i	10	i	i	10	i	i
Anions	Ammonia as Nitrogen	350.3[c]	N/A	N/A	N/A	30	±20	75-125
	Chloride	EPA 300/modified[d], 325.3[c], or 325.2[c]	N/A	N/A	N/A	10,000	±20	75-125
	Fluoride	EPA 300/modified[d] or 340.2	0.5	±35	75-125	100	±20	75-125
	Nitrate	EPA 300/modified[d], 352.1[c], 353.3[c], 353.2[c], or 354.1[c]	1.0	±35	75-125	100	±20	75-125
	Phosphate	EPA 300/modified[d], 365.1[c], 365.2[c], 365.3[c]	N/A	N/A	N/A	500	±20	75-125
	Sulfate	EPA 300/modified[d], 375.2[c], 375.3[c], 375.4[c]	20.0	±35	75-125	2,000	±20	75-125

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 8 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water
Radionuclides	Hydrogen-3	Water 906.0[f]	N/A	N/A	N/A	400 pCi/L	±20	75-125
	Carbon-14	ii	ii	ii	ii	ii	ii	ii
	Strontium-90	Sr-01[h]	1 pCi/g	±35	75-125	10 pCi/L	±20	75-125
	Technetium-99	Tc-01[h]	N/A	N/A	N/A	10 pCi/L	±20	75-125
	Alpha spectrometry (uranium-235, uranium-238, plutonium-239, plutonium-240, and americium-241)	ASTM D 3084[i]	1 pCi/g	±35	75-125	3 pCi/L	±20	75-125
	Gross alpha	Water 900[f] Soil[g]	1pCi/g	±35	75-125	3pCi/L	±20	75-125
	Gross beta	Water 900[f] Soil[g]	4 pCi/g	±35	75-125	4 pCi/L	±20	75-125
	Gamma spectrometry (report all identifiable and quantifiable isotopes)	Water 901.1[f] Soil[g]	0.5 pCi/g	±35	75-125	5 pCi/L	±20	75-125

Table QAPjP-1. Analytical Methods, Analytical Parameters, Detection Limits, and Precision and Accuracy Requirements for the 100-NR-1 Source Operable Unit. (sheet 9 of 9)

Analytical Category	Analytical Parameters	Analytical Method	CRDL or CRQL, soil[a]	Precision[b], Soil	Accuracy[b], Soil	CRDL or CRQL, Water[a]	Precision[b], Water	Accuracy[b], Water

[a] - For all CLP analytical categories, CRDL refers to the Contract Required Detection Limit specified on the *US EPA Contract Laboratory Program Statement of Work for Inorganics Analysis* (EPA 1991a); CRQL refers to the Contract Required Quantitation Limit specified in the *US EPA Contract Laboratory Program Statement of Work for Organics Analysis* (EPA 1991b). CRQLs are provided for all other (non-CLP) categories, and represent maximum values that can be reliably achieved by analytical laboratories under routine normal conditions. Unless otherwise specified, all inorganic soil values are expressed in mg/kg, and all organic soil values are expressed as µg/kg; CLP Target Compound List (TCL) values for inorganic soil CRDLs are the lower of the values specified in the CLP SOW (EPA 1991a). All CRDL/CRQL values for water are expressed in µg/L. Laboratory agreements for services shall require updating as necessary to accommodate periodic updates of the CLP SOWs (EPA 1991a and 1991b).

[b] - Acceptable ranges for precision and accuracy for EPA Contract Laboratory Program (CLP) TCL organics and TAL inorganic parameters shall be as specified for each analyte by the applicable CLP Statements of Work (SOWs; see EPA 1990a and 1990b). For all other parameters, the ranges provided shall be considered maximum values that can be reliably achieved by the laboratories under routine normal conditions. Precision is expressed as Relative Percent Difference (RPD); accuracy is expressed as percent recovery (%R). In all cases, these limits apply to sample results greater than five times the CRDL or CRQL, and shall be considered requirements in the absence of known or suspected interferences which may hinder achieving the limit by the analytical laboratory.

[c] - Methods specified are from *Methods for Chemical Analysis of Water and Wastes* (Kopp and McKee 1983).

[d] - Method specified is from *Determination of Inorganic Anions in Aqueous and Solid Samples by Ion Chromatography* (Lindahl 1984), and is a modification of EPA method 300.0.

[e] - Methods specified are from *Test Methods for Evaluating Solid Waste* (EPA 1986).

[f] - Method specified is from *Prescribed Procedures for Measurement of Radioactivity in Drinking Water* (Krieger and Whittaker 1980).

[g] - Method shall be based on the specified water method, modified to allow distillation of the parameter of interest in a soil sample and shall be submitted for Bechtel Hanford Inc. (BHI) review and approval prior to use.

[h] - Methods specified are from the *EML Procedures Manual* (Volchok and dePlanque 1982).

[i] - Method specified is from the *1994 Annual Book of ASTM Standards* (ASTM 1994).

i - As specified in the CLP SOWs for organic and inorganic analysis; all analytical methods, CRDLs, CRQLs, and precision and accuracy requirements shall be as specified therein without modification.

ii - Methods, CRQLs, and maximum ranges for precision and accuracy shall be developed and approved in compliance with BHI or BHI-approved participant contractor or subcontractor procedures.

4.0 SAMPLING PROCEDURES

4.1 PROCEDURE APPROVALS AND CONTROL

4.1.1 Bechtel Hanford Inc. Procedures

The BHI procedures cited in this QAPjP include EIIs from the BHI QMP (BHI 1994a), BHI QADPs (BHI 1994b), the *Environmental Investigations Procedures* (BHI 1994c), and BHI functional manuals as required. Procedure approval, revision, and distribution control requirements applicable to EIIs are addressed in EII 1.2, "Preparation and Revision of Environmental Investigations Instructions" (BHI 1994c); requirements applicable to approval, revision, and distribution of functional procedures are addressed in the BHI QMP, Part 1, Section A.5, "Documents" (BHI 1994a). The various procedures and manuals identified in the QAPjP are available for regulatory review on request, at the direction of the BHI technical lead.

4.1.2 Participant Contractor/Subcontractor Procedures

As previously noted in Section 2.1, participant contractor and/or subcontractor services shall be procured under the applicable requirements of the BHI QMP, Part 1, Section A.4 "Procurement" (BHI 1994c). Requirements for submittal of procedures for BHI review and approval before use shall be included in the procurement document or work order, as applicable, when such services require procedural controls. Analytical laboratories shall be required to submit the current version of their internal QA program plans, in addition to analytical procedures. All analytical laboratory plans and procedures shall be reviewed and approved before use by qualified personnel from the BHI organization, or other qualified personnel, as directed by the technical lead. All reviewers shall be qualified under the requirements of EII 1.7, "Indoctrination, Training, and Qualification" (BHI 1994c). All participant contractor or subcontractor procedures, plans, and/or manuals shall be retained as project records in compliance with the BHI QMP Part 1, Section A.6 (BHI 1994a). All such documents are available for regulatory review on request, at the direction of the BHI technical lead.

4.2 SAMPLING PROCEDURES

4.2.1 Sample Acquisition

All soil and sludge sampling shall be performed in accordance with EII 5.2, "Soil and Sediment Sampling" (BHI 1994c). All drilling activities shall be in compliance with EII 6.7, "Documentation of Well Drilling and Completion Operations" (BHI 1994c). All boreholes shall be logged in compliance with EII 9.1, "Geologic Logging" (BHI 1994c). Sampling procedure applicability to individual project tasks is shown in Table QAPjP-2. Sampling depths and intervals will be identified in the DOW prepared for this investigation as noted in Section 1.3 of this QAPjP. Sample locations will be detailed in the DOWs or work orders issued to the responsible subcontractors or participating contractors. Documentation requirements are defined within individual EIIs.

Table QAPjP-2. Sampling and Investigative Procedures for the Limited Field Investigations in the 100-NR-1 Source Operable Unit. (sheet 1 of 2)

EII	Procedure Title or Subject[a,b]	Task 2 Source Investigation	Task 3 Geological Investigation[c]	Task 5 Vadose Zone Investigation	Task 7 Air Investigation
1.1	Hazardous Waste Site Entry Requirements	X		X	X
1.2	Preparation and Revision of Environmental Investigations Instructions	X		X	X
1.4	Instruction Change Authorizations	X		X	X
1.5	Field Logbooks	X		X	
1.6	Records Management	X		X	X
1.7	Indoctrination, Training and Qualification	X		X	X
1.9	Primary and Secondary Document Review and Control	X		X	X
1.10	Identifying, Evaluating, and Documenting Suspect Waste Sites	X			
1.12	Performance Audits	X		X	X
1.13	Environmental Readiness Review	X		X	X
1.14	Preparation of Descriptions of Work	X		X	X
2.1	Preparation of Site- Specific Health and Safety Plans	X		X	X
2.2	Occupational Health Monitoring	X		X	X
3.2	Health and Safety Monitoring Instruments	X		X	X
4.2	Interim Control of Unknown, Suspected Hazardous and Mixed Waste, and Radioactive Waste	X		X	
5.1	Chain of Custody/Sample Analysis Request	X		X	X
5.2	Soil and Sediment Sampling	X		X	
5.4	Field Cleaning and/or Decontamination of Equipment			X	
5.5	Laboratory Cleaning of RCRA/CERCLA Sampling Equipment	X		X	

Table QAPjP-2. Sampling and Investigative Procedures for the Limited Field Investigations in the 100-NR-1 Source Operable Unit. (sheet 2 of 2)

EII	Procedure Title or Subject[a,b]	Task 2 Source Investigation	Task 3 Geological Investigation[c]	Task 5 Vadose Zone Investigation	Task 7 Air Investigation
5.7A	Hanford Geotechnical Sample Library Control	X		X	
5.9	Soil-Gas Sampling	X		X	
5.10	Obtaining Sample Identification Numbers and Accessing HEIS Data	X		X	
5.11	Sample Packaging and Shipping	X		X	
5.12	Air Quality Sampling of Ambient and Downwind Air at Waste Sites			X	X
6.7	Documentation of Well Drilling and Completion Operations			X	
6.9	Groundwater Well and Borehole Identification and Tracking			X	
9.1	Geologic Logging			X	
11.1	Geophysical Logging			X	
14.1	Analytical Laboratory Data Management	X		X	X
[d]	Data Validation	X		X	

[a] = Procedures are latest versions of Bechtel Hanford Inc. Environmental Investigations Instructions (EII) selected from BHI-EE-01, *Environmental Investigations Procedures* (BHI 1994c) unless otherwise indicated.
[b] = Companion document is *WHC Radiological Control Manual*, WHC-CM-1-6 (WHC 1993a).
[c] = Geologic activities will be conducted under the Task 3 Vadose Zone Investigation and related groundwater operable unit investigations.
[d] = WHC-SD-EN-SPP-001 Rev. 1, *Data Validation Process for Radiological and Chemical Analysis* (WHC 1993b) WHC-SD-EN-SPP-002, Rev. 1, *Data Validation Process for Chemical Analysis* (WHC 1993c)

EII = Environmental Investigation Instructions (BHI 1994c)
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act of 1980
HEIS = Hanford Environmental Information System
RCRA = Resource Conservation and Recovery Act of 1976

4.2.2 Sample Container Selection

Sample container types, preservation requirements, preparation requirements, and special handling requirements are defined in EII 5.2, "Soil and Sediment Sampling" and EII 5.11, "Sample Packaging and Shipping" (BHI 1994c).

4.3 OTHER INVESTIGATIVE AND SUPPORTING PROCEDURES

Other procedures that will be required in this phase of the investigation are identified in Table QAPjP-2 referenced to individual tasks as applicable. Documentation requirements shall be addressed within individual procedures. Analytical procedures required for Phase I of this investigation are listed in Table QAPjP-1. All computer software models developed for this investigation shall be documented and verified in compliance with the BHI QMP, Part 1, Section A.7 (BHI 1994a).

4.4 PROCEDURE CHANGES

Should deviations from established EIIs be required to accommodate unforeseen field situations, they may be authorized by the field team leader in accordance with the requirements specified in EII 1.4, "Instructions Change Authorizations" (BHI 1994c). Documentation, review and disposition of instruction change authorization forms shall be defined by EII 1.4. Other types of procedure change requests shall be documented as required by BHI QMP Part 1, Section A.5 "Documents" (BHI 1994a).

5.0 SAMPLE CUSTODY

All samples obtained during the course of this investigation shall be controlled as required by EII 5.1, "Chain of Custody/Sample Analysis Request" (BHI 1994c), from the point of origin to the analytical laboratory. Laboratory chain-of-custody procedures shall be reviewed and approved in compliance with the requirements of Section 4.1 of this QAPjP, and shall ensure the maintenance of sample integrity and identification throughout the analytical process. At the direction of the technical lead, requirements for the return of residual sample materials after completion of analysis shall be defined in accordance with procedures described in the procurement documentation to subcontractor or participant contractor laboratories. Chain-of-custody forms shall be initiated for returned residual samples as required by the approved procedures applicable within the laboratory. All analytical results shall be controlled as permanent project quality records as required by Part 1, Section A.6 of the BHI QMP (BHI 1994a).

6.0 CALIBRATION PROCEDURES

Calibration of all BHI measuring and test equipment, whether in existing inventory or purchased for this investigation, shall be controlled as required by the BHI QMP, Section 3, Part C.13, "Control of Measuring and Test Equipment" (BHI 1994a). Other specific requirements shall be incorporated in the text of investigation-specific DOWs prepared in compliance with EII 1.14 (BHI 1994c). Routine operational checks for BHI field equipment shall be as defined within applicable EIIs or procedures; similar information shall be provided in BHI-approved participant

contractor or subcontractor procedures or included in the text of applicable DOWs as indicated above. All calibration requirements applicable to analytical laboratory equipment shall be as defined by laboratory QA plans and/or applicable standard analytical methods, subject to BHI review and approval.

7.0 ANALYTICAL PROCEDURES

All analytical methods that have been selected for this investigation are listed in Table QAPjP-1, cross-referenced to the parameters of interest and the maximum detection or quantitation limit values and maximum acceptable ranges for precision and accuracy for both soil and water matrices. Where EPA CLP methods are specified, the CRDLs for inorganic parameters, the CRQLs for organic parameters, and the maximum precision and accuracy ranges specified for each parameter by the appropriate CLP Statements of Work (SOWs) apply without modification (see EPA 1991a and 1991b). For non-CLP parameters, CRQLs and precision and accuracy ranges are provided that shall be considered maximum values which can be reliably achieved by analytical laboratories. Applicable physical testing parameters for soils acquired in this investigation are defined in Table QAPjP-3. In order to facilitate the comparability of data sets in terms of precision and accuracy, all analytical data shall be reported in the standard units specified in the applicable reference method. The reporting requirements so defined and the applicable requirements of Tables QAPjP-1 and QAPjP-3 shall be considered minimum performance standards that shall be incorporated into the agreements for services established with individual BHI participant contractor, or subcontractor analytical laboratories. As previously noted in Section 3, any modification of Table QAPjP-1 requirements shall be justified by the requestor, and shall be considered a formal modification of this QAPjP, and is subject to regulatory review and approval.

All analytical procedures approved for use in this investigation shall require the use of the standard units specified by the analytical methods referenced in Table QAPjP-1, in order to facilitate the comparability of data sets in terms of precision and accuracy. All approved procedures shall be retained in the project quality records and shall be available for review on request.

8.0 DATA REDUCTION, VALIDATION, AND REPORTING

8.1 DATA REDUCTION AND DATA PACKAGE PREPARATION

All analytical laboratories shall be responsible for preparing a report summarizing the results of analysis and for preparing a detailed data package that includes identifying samples, sampling and analysis dates, raw analytical data, reduced data, data outliers, reduction formulas, recovery percentages, quality control check data, equipment calibration data, supporting chromatogram or spectrograms, and documentation of any nonconformances affecting the measurement system in use during the analysis of the particular group of samples. Data reduction schemes shall be contained within individual laboratory analytical methods and/or QA manuals, submitted for BHI review and approval as discussed in Section 4.1. The completed data package shall be reviewed and approved by the analytical laboratory's QA manager (or field team leader for field screening type analysis) before its submittal to the BHI technical lead. Completed data packages shall be submitted to the Analytical Services for tracking and data validation functions. The requirements of this section

shall be included in procurement documentation or work orders, as appropriate, to comply with the standard BHI procurement control procedures noted in Section 4.1.

8.2 VALIDATION

Validation of the completed data package will be performed by qualified BHI-approved subcontractors. Subcontracted validation responsibilities shall be defined in procurement documentation or work orders as appropriate. All validation shall be performed in compliance with WHC-SD-EN-SPP-001, Rev. 1, "Data Validation Process for Radiological and Chemical Analysis (WHC 1993b) and WHC-SD-EN-SPP-002, Rev. 2, "Data Validation Process for Chemical Analysis" (WHC 1993c).

Table QAPjP-3. Soil Physical Parameters for the 100-NR-1 Source Operable Unit.

Parameter	ASTM or Other Standard Method
Bulk density	[a]
Particle size distribution	D-422[b]
Permeability	D-2434[b]
Moisture content	D-2216[b]

[a]Method shall be developed by the laboratory contractor and submitted for BHI review and approval before use.
[b]Method is from the *1994 Annual Book of ASTM Standards* (ASTM 1994).

8.3 FINAL REVIEW AND RECORDS MANAGEMENT CONSIDERATIONS

All verification and validation reports and supporting analytical data packages shall be subject to a final technical review by a qualified reviewer at the direction of the BHI technical lead, before their submittal to regulatory agencies; prior to entry into the Hanford Environmental Information System (HEIS) in compliance with EII 14.1, "Analytical Laboratory Data Management," (BHI 1994c); or before inclusion in reports or technical memoranda. All verification and validation reports, data packages, and review comments shall be retained as permanent project quality records in compliance with Part 1, Section A.6 of the BHI QMP (BHI 1994a).

8.4 REQUIREMENTS FOR HANDLING UNACCEPTABLE OR SUSPECT DATA

The analytical data flow and data management process is described in detail in EII 14.1, "Analytical Laboratory Data Management" (BHI 1994c). Data errors or procedural discrepancies related to laboratory analytical processes shall prompt data requalification by the validator, requests for reanalysis, or other appropriate corrective action by the responsible laboratory as required by approved subcontractor data validation procedures. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be formally documented as a nonconformance in compliance with Part 1, Section A.3 of the BHI QMP (BHI 1994a). If problems are observed with validated data, either as part of the data assessment process described in Section 12 of this QAPjP or if separately observed by any of the operable unit managers, the data shall be documented as a nonconformance; if the data have been

entered in the HEIS, the HEIS Data Custodian shall be immediately notified in order that the data may be flagged [in compliance with EII 14.1 (BHI 1994c) and WHC-EP-0372, the *HEIS User's Manual* (WHC 1992)] as suspect, pending resolution of the nonconformance and completion of all required corrective actions.

9.0 INTERNAL QUALITY CONTROL

All analytical samples shall be subject to in-process QC measures in both the field and laboratory. Unless otherwise specified in the approved statements of work or work orders for sampling activities, or in applicable EIIs, the following minimum field quality control requirements shall apply. These requirements are adapted from *Test Methods for Evaluating Solid Waste* (EPA 1986), as modified by the proposed rule changes included in the *Federal Register*, 1989, Volume 54, No. 13, pp 3212-3228, and 1990, Volume 55, No. 27, pp 4440-4445.

- Field duplicate samples. For each shift of sampling activity under an individual sampling subtask, a minimum of five percent of the total collected samples shall be duplicated, or one duplicate shall be collected for every 20 samples, whichever is greater. Duplicate samples shall be retrieved from the same sampling location using the same equipment and sampling technique, and shall be placed into two identically prepared and preserved containers. All field duplicates shall be analyzed independently to provide an indication of gross errors in sampling techniques.

- Split samples. Upon specific BHI or regulator request, and at the technical lead's direction, field or field duplicate samples may be split in the field and sent to an alternative laboratory as a performance audit of the primary laboratory. Frequency shall meet the minimum schedule requirements of Chapter 10.0 below or the specific needs of the requesting organization.

- Blind samples. At the technical lead's discretion, blind reference samples may be introduced into any sampling round as a quality control check of the primary laboratory. Blind sample type shall be as directed by the technical lead; frequency shall meet the minimum schedule requirements in Chapter 10.0.

- Field blanks. Field blanks shall consist of pure deionized distilled water, transferred into a sample container at the site and preserved with the reagent specified for the analytes of interest. Field blanks are used as a check on reagent and environmental contamination, and shall be collected at the same frequency as field duplicate samples.

- Equipment rinseate blanks. Equipment blanks shall consist of pure deionized distilled water washed through decontaminated sampling equipment and placed in containers identical to those used for actual field samples. Equipment blanks are used to verify the adequacy of sampling equipment decontamination procedures, and shall be collected at the same frequency as field duplicate samples where applicable.

- Volatile organic analysis (VOA) trip blanks. VOA trip blanks consist of pure deionized distilled water added to one clean sample container, accompanying each batch (cooler) of containers shipped to the sampling facility. Trip blanks shall be returned unopened to the laboratory, and are prepared as a check on possible

contamination originating from container preparation methods, shipment, handling, storage or site conditions. The trip blank shall be analyzed for volatile organic compounds only, as shown on EPA's target compound list (TCL; see EPA 1991b). In compliance with standard BHI procurement procedures, requirements for trip blank preparation shall be included in procurement documents of work orders to the sample container supplier and/or preparer.

Unless otherwise specified in BHI-approved analytical methods, internal quality control checks performed by analytical laboratories shall meet the following minimum requirements.

- Matrix-spike/matrix-spike duplicate samples. Matrix-spiked samples require the addition of a known quantity of a representative analyte of interest to the sample as a measure of recovery percentage and as a test of analytical precision. The spike shall be made in a replicate of a field duplicate sample. Replicate samples are separate aliquots removed from the same sample container in the laboratory. Spike compound selection, quantities, and concentrations shall be described in the analytical procedures submitted for BHI review and approval. One sample shall be spiked per analytical batch, or once every 20 samples, whichever is more frequent.

- Quality control reference samples. A quality control reference sample shall be prepared from an independent standard at a concentration other than that used for calibration, but within the calibration range. Reference samples are required as an independent check on analytical technique and methodology, and shall be run with every analytical batch, or every 20 samples, whichever is more frequent.

Other requirements specific to laboratory analytical equipment calibration are included in Section 6.0 of this QAPjP. For field screening gas chromatography (GC) analysis, at least one duplicate sample per shift shall be routed to a qualified laboratory as an overcheck on the proper use and functioning of field GC procedures and equipment. Duplicates shall be selected, whenever possible, from samples in which significant readings have been observed during field analysis. The minimum requirements of this section shall be invoked in procurement documents or work orders in compliance with standard BHI procedures as noted in Section 4.1 of this QAPjP.

10.0 PERFORMANCE AND SYSTEM ASSESSMENTS

Assessments and surveillances scheduled to begin early in the execution of this work plan and continue through work plan completion. Collectively the assessments address quality affecting activities that include, but are not limited to, measurement system accuracy, intramural and extramural analytical laboratory services, field activities, and data collection, processing, validation and management.

Assessments to ensure of the accuracy of laboratory analysis are implemented in accordance with QADP 1.6 "Independent Assessments" (BHI 1994b) and EII 1.12 "Performance Audit" (BHI 1994c). Surveillances will be performed regularly throughout the course of the work plan activities in accordance with QADP 1.7 A "Surveillances" (BHI 1994b). Additional performance and system surveillances may be scheduled as a consequence of corrective action requirements, or may be performed upon request. All quality affecting activities are subject to surveillance.

All aspects of inter-operable unit activities will also be evaluated as part of routine environmental restoration program-wide QA assessments in compliance with BHI QMP, Part 1, Section B.8 "Assessments" (BHI 1994a). Program assessments shall be conducted by assessors qualified in accordance with QADP 1.11, "Qualification of Lead Auditors and Auditors" (BHI 1994b).

11.0 PREVENTIVE MAINTENANCE

All measurement and testing equipment used in the field and laboratories that directly affect the quality of the field and analytical data shall be subject to preventive maintenance measures that ensure minimization of measurement system downtime and corresponding schedule delays. Laboratories shall be responsible for performing or managing the maintenance of their analytical equipment. Maintenance requirements, spare parts lists and instructions shall be included in individual laboratory QA plans, subject to BHI review and approval as noted in Sections 2.1, 2.2, and 4.1.2 of this QAPjP. When samples are analyzed using EPA reference methods, the preventative maintenance requirements for laboratory analytical equipment are as defined in the procured laboratory's QA plan(s). Bechtel Hanford Inc. field equipment shall be drawn from inventories subject to standard preventive maintenance and calibration procedures. Any field procedures submitted for BHI approval by participant contractors or subcontractors shall contain, as appropriate, provisions for preventive maintenance schedules and spare parts lists in order to ensure minimization of equipment downtime.

12.0 DATA ASSESSMENT PROCEDURES

All analytical data shall be compiled, reduced, and reviewed by the laboratory prior to presentation to subcontractor personnel for validation as described in Section 8 of this QAPjP. Assessment of the validated data will follow the general guidelines established in Section 5.1.1.10 of the work plan; depending on the distribution and statistical characteristics of the validated data and other unit- or area-specific considerations, various statistical and/or probabilistic techniques may be selected for use in the process of data comparison or analysis. The selection of any such methodology shall be subject to the approval and authorization of the BHI technical lead. Methods shall be documented, signed, dated, retained as project records in compliance with BHI QMP, Part 1, Section A.6. (BHI 1994a), and, as appropriate, considered in the risk assessment and field report preparation tasks described in Sections 5.1.1.11 and 5.1.1.13 of the work plan.

13.0 CORRECTIVE ACTION

13.1 GENERAL REQUIREMENTS FOR CORRECTIVE ACTION

Corrective action requests required as a result of surveillance reports, nonconformance reports, assessment activities, or as a result of the specific request of the operable unit manager, shall be documented and dispositioned by the BHI technical lead and QA Coordinator. Corrective action reports prepared under BHI QMP, Part 1, Section A.3 (BHI 1994a) requirements shall

identify the affected requirement, the probable cause of the deviation, any data which may have been affected by the deviation, and the corrective action required both to resolve the immediate situation and to reduce or preclude its recurrence. Corrections of plans or procedures related to the overall measurement system that do not constitute nonconformances, but may be required as a result of data validation, data assessment, or routine review processes, shall be resolved as required by their governing procedures or shall be referred to the BHI technical lead for resolution and appropriate management action. All documentation related to surveillances, audits, and corrective action shall be maintained in compliance with EII 1.6, "Record Processing" (BHI 1994c) and routed to the project quality records upon completion or closure for retention in compliance with Part 1, Section A.3 of the BHI QMP (BHI 1994a), and shall be made available for operable unit manager review upon request through the BHI technical lead.

13.2 CORRECTIVE ACTION REQUIREMENTS RELATED TO CALIBRATION ERRORS

Field measuring and test equipment found to be out of calibration shall be documented as a nonconformance in compliance with BHI QMP, Part 2, Section C.13 (BHI 1994a). Nonconforming items shall be tagged, removed from service, and segregated pending resolution of the nonconformance and initiation of appropriate corrective action. Calibration errors related to laboratory analytical processes that may be observed in the data validation activities described in Section 8 shall prompt requests for reanalysis or other appropriate corrective action by the responsible laboratory as required by the approved subcontractor data validation procedures. If sample holding time requirements are compromised, insufficient sample material is available for reanalysis, or any other condition prevents compliance with governing analytical methods and data validation protocols, the situation shall be initiated in compliance with the requirements of QADP 1.8 "Corrective Action" (BHI 1994b) and brought to the attention of the BHI technical lead and QA Coordinator for their appropriate action.

13.3 CORRECTIVE ACTION RELATED TO PROCEDURAL DEVIATIONS

Planned deviations from EII requirements shall be processed in compliance with EII 1.4, "Instruction Change Authorizations" (BHI 1994c). Unplanned procedural deviations observed during system surveillance, or program assessment activities shall be documented as nonconformances, findings, or observations in compliance with the procedures described in Section 10. Corrective action shall be initiated in compliance with QADP 1.8, "Corrective Action" (BHI 1994b) previously noted in Section 13.1.

13.4 CORRECTIVE ACTION REQUIREMENTS RELATED TO PURCHASED MATERIALS, ITEMS, OR EQUIPMENT

Purchased materials, items, and equipment found to be out of compliance with their governing procurement specifications shall be documented as a nonconformance in compliance with BHI QMP Part 1 Section A.3 (BHI 1994a). Nonconforming items shall be tagged and segregated pending resolution of the nonconformance and initiation of appropriate corrective action in compliance with QADP 1.8, "Corrective Action" (BHI 1994b).

14.0 QUALITY ASSURANCE REPORTS

As previously stated in Chapters 10.0 and 13.0, project activities shall be regularly assessed by surveillances and program assessments. Surveillance, nonconformance, assessment and corrective action documentation shall be routed to the project quality records on completion or closure of the activity. A report summarizing corrective action and instruction change authorization activity (see Sections 4.4 and 13.2), as well as any associated corrective actions, shall be prepared for the technical lead by QA at the completion of the field and laboratory investigations. Such information will become an integral part of the remedial investigation report prepared under Task 13 (see Section 5.1.1.13 of the work plan). The final report shall include an assessment of the overall adequacy of the total measurement system with regard to the data quality objectives of the investigation.

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APPENDIX B

HEALTH AND SAFETY PLAN

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1.0 GENERAL CONSIDERATIONS AND REQUIREMENTS

1.1 INTRODUCTION

The purpose of this Health and Safety Plan (HSP) is to establish standard health and safety procedures for Bechtel Hanford Inc. (BHI) employees and contractors engaged in remedial investigation activities in the 100-NR-1 Operable Unit. These activities will include surface investigation, drilling and sampling boreholes, and environmental sampling in areas of known chemical and radiological contamination. Appropriate site-specific safety documents [e.g., Hazardous Waste Operations Permit (HWOP) or Job Safety Analysis (JSA)] will be written for each task or group of tasks.

All employees of BHI or any other contractors who are participating in onsite activities in the 100-NR-1 Operable Unit shall read the site-specific safety document and attend a pre-job safety or tailgate meeting to review and discuss the task.

1.2 DESIGNATED SAFETY PERSONNEL

The field team leader and site safety officer are responsible for site safety and health. Specific individuals will be assigned on a task-by-task basis by project management, and their names will be properly recorded before the task is initiated.

All activities onsite must be cleared through the field team leader. The field team leader has responsibility for the following:

- Allocating and administering resources to successfully comply with all technical and health and safety requirements
- Verifying that all permits, supporting documentation, and clearances are in place [e.g., electrical outage requests, welding permits, excavation permits, HWOP or JSA, sampling plan, radiation work permits (RWP), and onsite/offsite radiation shipping records]
- Providing technical advice during routine operations and emergencies
- Informing the appropriate site management and safety personnel of the activities to be performed each day
- Coordinating resolution of any conflicts that may arise between RWPs and the implementation of the HWOP or JSA with health physics
- Handling emergency response situations as may be required
- Conducting pre-job and daily tailgate safety meetings
- Interacting with adjacent building occupants and/or inquisitive public.

The site safety officer is responsible for implementing the HWOP at the site. The site safety officer shall do the following.

- Monitor chemical, physical, and (in conjunction with the health physics technician) radiation hazards to assess the degree of hazard present; monitoring shall specifically include organic vapor detection, radiation screening, and confined space evaluation where appropriate.
- Determine protection levels, clothing, and equipment needed to ensure the safety of personnel in conjunction with the health physics department.
- Monitor the performance of all personnel to ensure that the required safety procedures are followed.
- Halt operations immediately, if necessary, because of safety or health concerns.
- Conduct safety briefings as necessary.
- Assist the field team leader in conducting safety briefings as necessary.

The health physics technician is responsible for ensuring that all radiological monitoring and protection procedures are being followed as specified in the Radiation Protection Manual and in the appropriate RWP. Bechtel Hanford Inc. safety and fire protection personnel will provide safety overview during drilling operations consistent with BHI policy and, as requested, will provide technical advice. Also, downwind sampling for hazardous materials and radiological contaminants and other analyses may be requested from appropriate contractor personnel as required.

The ultimate responsibility and authority for employee's health and safety lies with the employee and the employee's colleagues. Each employee is responsible for exercising the utmost care and good judgment in protecting his or her personal health and safety and that of fellow employees. Should any employee observe a potentially unsafe condition or situation, it is the responsibility of that employee to immediately bring the observed condition to the attention of the appropriate health and safety personnel, as designated previously. In the event of an immediately dangerous or life-threatening situation, the employee automatically has temporary "stop work" authority and the responsibility to immediately notify the field team leader or site safety officer. When work is temporarily halted because of a safety or health concern, personnel will exit the exclusion zone and meet at a predetermined place in the support zone. The field team leader, site safety officer, and health physics technician will determine the next course of action.

1.3 MEDICAL SURVEILLANCE

All field team members engaged in operable unit activities at sites governed by an HWOP must have baseline physical examinations and be participants in BHI (or an equivalent) hazardous waste worker medical surveillance program.

Medical examinations will be designed to identify any pre-existing conditions that may place an employee at high risk, and will verify that each worker is physically able to perform the work required by this work plan without undue risk to personal health. The physician shall determine the

existence of conditions that may reduce the effectiveness or prevent the employee's use of respiratory protection. The physician shall also determine the presence of conditions that may pose undue risk to the employee while performing the physical tasks of this work plan using level B personal protection equipment. This would include any condition that increases the employee's susceptibility to heat stress.

The examining physician's report will not include any nonoccupational diagnoses unless directly applicable to the employee's fitness for the work required.

1.4 TRAINING

Before engaging in any onsite remedial investigation activities, each team member is required to have received 40 hours of health and safety training related to hazardous waste site operations and at least 8 hours of refresher training each year thereafter as specified in 29 Code of Federal Regulations (CFR) 1910.120. In addition, each inexperienced employee (never having performed site characterization) will be directly supervised by a trained/experienced person for a minimum of 24 hours of field experience.

The field team leader and the site safety officer shall receive an additional 8 hours of training (in addition to the refresher training previously discussed).

1.5 TRAINING FOR VISITORS

For the purposes of this plan, a visitor is defined as any person visiting the Hanford Site, who is not a BHI employee or a BHI-contractor directly involved in the Resource Conservation and Recovery Act (RCRA)/Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) facility investigation activities, including but not limited to those engaged in surveillance, inspection, or observation activities.

Visitors who must, for whatever reason, enter a controlled (either contamination reduction or exclusion) zone, shall be subject to all of the applicable training, respirator fit testing, and medical surveillance requirements discussed in BHI Environmental Investigation Instruction (EII) 1.1 and Appendix B to EII 1.1 (BHI 1994).

All visitors shall be informed of potential hazards and emergency procedures by their escorts and shall conform to EII 1.1 (BHI 1994).

1.6 RADIATION DOSIMETRY

All personnel engaged in onsite activities shall be assigned dosimeters according to the requirements of the RWP applicable to that activity. All visitors shall be assigned basic dosimeters, as a minimum, that will be exchanged annually.

1.7 REQUIREMENTS FOR THE USE OF RESPIRATORY PROTECTION

All employees of BHI and subcontractors who may be required to use air-purifying or air-supplied respirators must be included in the medical surveillance program and be approved for the use of respiratory protection by the Hanford Environmental Health Foundation (HEHF) or other licensed physician. Each team member must be trained in the selection, limitations, and proper use and maintenance of respiratory protection (existing respiratory protection training may be applicable towards the 40-hour training requirement).

Before using a negative pressure respirator, each employee must have been fit-tested (within the previous year) for the specific make, model, and size according to BHI fit-testing procedures. Beards (including a few days' growth), large sideburns, or moustaches that may interfere with a proper respirator seal are not permitted.

Subcontractors must provide evidence to BHI that personnel are participants in a medical surveillance and respiratory protection program that complies with 29 CFR 1910.120 and 29 CFR 1910.134, respectively.

2.0 GENERAL PROCEDURES

The following personal hygiene and work practice guidelines are intended to prevent injuries and adverse health effects. A hazardous waste site poses a multitude of health and safety concerns because of the variety and number of hazardous substances present. These guidelines represent the minimum standard procedures for reducing potential risks associated with this project and are to be followed by all job-site employees at all times.

2.1 GENERAL WORK SAFETY PRACTICES

2.1.1 Work Practices

The following work practices must be observed.

- Eating, drinking, smoking, taking certain medications, chewing gum, and similar actions are prohibited within the exclusion zone. All sanitation facilities shall be located outside the exclusion zone; decontamination is required before using such facilities.

- Personnel shall avoid direct contact with contaminated materials unless necessary for sample collecting or required observation. Remote handling of such things as casings and auger flights will be practiced whenever practical.

- While operating in the controlled zone, personnel shall use the "buddy system" where appropriate, or be in visual contact with someone outside of the controlled zone.

- The buddy system will be used where appropriate for manual lifting.

- Requirements of BHI radiation protection and RWP manuals shall be followed for all work involving radioactive materials or conducted within a radiologically controlled area.

- Onsite work operations shall only be carried out during daylight hours, unless the entire control zone is adequately illuminated with artificial lighting. A new tour (shift) will operate the drilling rig after completion of each shift.

- Do not handle soil, waste samples, or any other potentially contaminated items unless wearing the protective gloves specified in the HWOP or JSA.

- Whenever possible, stand upwind of excavations, boreholes, well casings, drilling spoils, and the like, as indicated by an onsite windsock.

- Stand clear of trenches during excavation. Always approach an excavation from upwind.

- Be alert to potentially changing exposure conditions as evidenced by such indications as perceptible odors, unusual appearance of excavated soils, or oily sheen on water.

- Do not enter any test pit or trench deeper than 1 m (4 ft) unless in accordance with procedures specified in the HWOP.

- Do not <u>under any circumstances</u> enter or ride in or on any backhoe bucket, materials hoist, or any other similar device not specifically designed for carrying passengers.

- All drilling team members must make a conscientious effort to remain aware of their own and others' positions in regards to rotating equipment, cat heads, or u-joints. Drilling operations members must be extremely careful when assembling, lifting, and carrying flights or pipe to avoid pinch-point injuries and collisions.

- Tools and equipment will be kept off the ground whenever possible to avoid tripping hazards and the spread of contamination.

- Personnel not involved in operation of the drill rig or monitoring activities shall remain a safe distance from the rig as indicated by the field team leader.

- Follow all provisions of each site-specific hazardous work permit as addressed in the HWOP, including cutting and welding, confined space entry, and excavation.

- Catalytic converters on the underside of vehicles are sufficiently hot to ignite dry prairie grass. Team members should not drive over dry grass that is higher than the ground clearance of the vehicle and should be aware of the potential fire hazard posed by catalytic converters at all times. Never allow a running or hot vehicle to sit in a stationary location over dry grass or other combustible materials.

- Follow all provisions of each site-specific RWP.

- Team members will attempt to minimize truck tire disturbance of all stabilized sites.

2.1.2 Personal Protective Equipment

- Personal protective equipment will be selected specifically for the hazards identified in the HWOP. The site safety officer in conjunction with BHI Health Physics and Industrial Hygiene and Safety is responsible for choosing the appropriate type and level of protection required for different activities at the job site.

- Levels of protection shall be appropriate to the hazard to avoid either excessive exposure or additional hazards imposed by excessive levels of protection. The HWOP will contain provisions for adjusting the level of protection as necessary. These personal protective equipment specifications must be followed at all times, as directed by the field team leader, health physics technician, and site safety officer.

- Each employee must have a hard hat, safety glasses, and substantial protective footwear available to wear as specified in the HWOP or JSA.

- The exclusion zone around drilling or other noisy operations will be posted "Hearing Protection Required" and team members will have noise control training

- Personnel should maintain a high level of awareness of the limitations in mobility, dexterity, and visual impairment inherent in the use of level B and level C personal protective equipment.

- Personnel should be alert to the symptoms of fatigue, heat stress, and cold stress and their effects on the normal caution and judgment of personnel.

- Life jackets must be worn and employees shall use the buddy system for any activities over water (e.g., water column sampling of the Columbia River). Additional rescue equipment as required by the Occupational Safety and Health Administration (OSHA), Washington Industrial Safety and Health Act (WISHA), or standards for working over water will be available and used.

2.1.3 Personal Decontamination

- The HWOP will describe in detail methods of personnel decontamination, including the use of contamination control corridors and step-off pads when appropriate.

- Thoroughly wash hands and face before eating or putting anything in the mouth to avoid hand-to-mouth contamination.

- At the end of each work day or each job, disposable clothing shall be removed and placed in (chemical contamination) drums, plastic-lined boxes or other containers as appropriate. Clothing that can be cleaned may be sent to the Hanford Site laundry.

- Individuals are expected to thoroughly shower before leaving the work site or Hanford Site if directed to do so by the health physics technician, site safety officer, or field team leader.

2.1.4 Emergency Preparation

- A multipurpose dry chemical fire extinguisher, a fire shovel, a complete field first-aid kit, and a portable pressurized spray wash unit shall be available at every site where there is potential for personnel contamination.

- Prearranged hand signals or other means of emergency communication will be established when respiratory protection equipment is to be worn, because this equipment seriously impairs speech.

- The Hanford Fire Department shall be initially notified before the start of the site investigation project. This notification shall include the location and nature of the various types of field work activities as described in the work plan. A site location map shall be included in this notification.

2.2 CONFINED SPACE/TEST PIT ENTRY PROCEDURES

The following procedures apply to the entry of any confined space, which for the purpose of this document shall be defined as any space having limited egress (access to an exit) and the potential for the presence or accumulation of a toxic or explosive atmosphere. This includes manholes, certain trenches (particularly those through waste disposal areas), and all test pits greater than 1 m (4 ft) deep. If confined spaces are to be entered as part of the work operations, a hazardous work permit (filled out for confined space entry) must be obtained from Industrial Safety and Fire Protection.

The identified remedial investigation activities on the 100-NR-1 Operable Unit should not require confined space entry. Nevertheless, the hazards associated with confined spaces are of such severity that all employees should be familiar with the safe work discussed in the following paragraphs.

No employee shall enter any test pit or trench deeper than 1 m (4 ft) unless the sides are shored or laid back to a stable slope as specified in OSHA 29 CFR 1926.652 or equivalent state occupational health and safety regulations.

When an employee is required to enter a pit or trench 1 m (4 ft) deep or more, an adequate means of access and egress, such as a slope of at least 2:1 to the bottom of the pit or a secure ladder or steps shall be provided.

Before entering any confined space, including any test pit, the atmosphere will be tested for flammable gases, oxygen deficiency, and organic vapors. If other specific contamination, such as radioactive materials or other gases and vapors may be present, additional testing for those substances shall be conducted. Depending on the situation, the space may require ventilation and retesting before entry.

An employee entering a confined or partially confined space must be equipped with an appropriate level of respiratory protection in keeping with the monitoring procedures discussed previously and the action levels for airborne contaminants (see "Warnings and Action Levels" in HWOP).

No employee shall enter any test pit requiring the use of level B protection, unless a backup person also equipped with a pressure-demand self-contained breathing apparatus (SCBA) is present. No backup person shall attempt any emergency rescue unless a second backup person equipped with an SCBA is present, or the appropriate emergency response authorities have been notified and additional help is on the way.

3.0 SITE BACKGROUND

Specific details on the 100-NR-1 Operable Unit background, including known and suspected contamination are described in Chapters 2.0 and 3.0 of the work plan. The 100-NR-1 Operable Unit is one of two operable units located within the 100 N Area of the U.S. Department of Energy Hanford Site, in the south central portion of the state of Washington. The 100 N Area is located in Benton County along the south bank of the Columbia River in the north-central part of the Hanford

Site, in the area generally referred to as the 100 Area. The 100 N Area is approximately 43 km (27 mi) north-north-west of the city of Richland, Washington and covers about 2.6 km^2 (640 acre).

The N Reactor was the last major production reactor constructed by the U.S. Government to produce plutonium for nuclear weapons. The N reactor differs from previous reactors constructed at the Hanford Site in that steam produced by the reactor was used to generate electricity. The reactor started operation in 1963, and except for periodic maintenance shutdowns, operated until 1987, when it was shutdown for extensive maintenance and safety overhaul. In 1988, the reactor was placed in cold standby and permanent shutdown of the reactor was announced in October 1991.

Operation of the reactor has resulted in the release of chemical and radioactive contaminants into the soil, air, and water of the area. For clean-up purposes, the 100-NR-1 Source Operable Unit consists of all surface structures, and the 100-NR-2 Groundwater Operable Unit addresses all groundwater contamination.

Table 2-1 of the work plan lists facilities and waste disposal sites located within the 100-NR-1 Source Operable Unit. Section 3.1 of the work plan summarizes known and suspected contamination at the operable unit. Figures 3-1 and 3-2 show the general site layout and identifies waste disposal facilities, and unplanned release sites.

4.0 SCOPE OF WORK AND POTENTIAL HAZARDS

While the information presented in Section 3.1 of the work plan is believed to be representative of the constituents and quantities of wastes at the time of discharge, the present chemical nature, location, extent, and ultimate fate of these wastes in and around the liquid disposal facilities are largely unknown. The emphasis of the RCRA facility investigation in the 100-NR-1 Operable Unit will be to characterize the nature of contamination in the vadose (unsaturated subsurface soil) zone.

4.1 WORK TASKS

- Work tasks are described in Chapter 5.0 of the work plan.

4.2 POTENTIAL HAZARDS

Onsite tasks will involve noninstrusive surface sampling procedures and intrusive soil sampling either directly in or immediately adjacent to areas known or suspected to contain potentially hazardous chemical substances, toxic metals, and radioactive materials.

Surface radiological contamination and fugitive dust will be the potential hazards of primary concern during nonintrusive mapping and sampling activities.

Existing data indicate that hazardous substances may be encountered during intrusive sampling; these include radionuclides, heavy metals, and corrosives. In addition, volatile organics may also be associated with certain facilities such as the solvent storage buildings or underground storage tanks.

Potential hazards include the following:

- External radiation (gamma and to a lesser extract, beta) from radioactive materials in the soil
- Internal radiation resulting from radionuclides present in contaminated soil entering the body by ingestion or through open cuts and scratches
- Internal radiation resulting from inhalation of particulate (dust) contaminated with radioactive materials
- Inhalation of toxic vapors or gases such as volatile organics or ammonia
- Inhalation or ingestion of particulate (dust) contaminated with inorganic or organic chemicals, and toxic metals
- Dermal exposure to soil or groundwater contaminated with radionuclides
- Dermal exposure to soil or groundwater contaminated with inorganic or organic chemicals, and toxic metals
- Physical hazards such as noise, heat stress, and cold stress
- Slips, trips, falls, bumps, cuts, pinch points, falling objects, other overhead hazards, crushing injuries, and other hazards typical of a construction-related job site
- Unknown or unexpected underground utilities
- Biological hazards; snakes, spiders, etc.

4.3 ASSESSMENT AND MITIGATION OF POTENTIAL HAZARDS

The likelihood of significant exposure (100 mR/h or greater) to external radiation is remote and can be readily monitored and controlled by limiting exposure time, increasing distance, and employing shielding as required.

Internal radiation by inhalation or inadvertent ingestion of contaminated dust is a realistic concern and must be continuously evaluated by the health physics technician. Appropriate respiratory protection, protective clothing, and decontamination procedures will be implemented as necessary to reduce potential inhalation, ingestion, and dermal exposure to acceptable levels.

Dermal exposure to toxic chemical substances is not expected to pose a significant problem for the identified tasks given the use of the designated protective clothing. The appropriate level of personal protective clothing and respiratory protection will vary from work site to work site.

5.0 ENVIRONMENTAL AND PERSONAL MONITORING

The site safety officer or authorized delegate shall be present at all times during work activities which require an HWOP, and shall be in charge of all environmental/personal monitoring equipment. Industrial Hygiene and Safety shall review all activities involving or potentially involving radiological exposure or contamination control and shall prescribe the appropriate level of technical support and/or monitoring requirements. Other equipment deemed necessary by the site safety officer or Industrial Hygiene and Safety shall be obtained at their direction; work will be initiated or continued until such equipment is in place. These instruments are to be used only by persons who are trained in their usage and who understand their limitations. No work shall be done unless instrumentation is available and in proper working order.

Air sampling may be required downwind of the referenced waste sites to monitor particulates and vapors before job startup. Siting of such sampling devices will be determined by Health Physics, the site safety officer, and HEHF, if appropriate. Any time personnel exposure monitoring, other than radiological, is required to determine exposure levels, it must be done by HEHF. Discrete sampling of ambient air within the work zone and breathing zones will be conducted using a direct-reading instrument, as specified in the site-specific safety document, and other methods as deemed appropriate (e.g., pumps with tubes, O_2 meters). The following standards will be used in determining critical levels:

- "Radionuclide Concentrations in Air," in Chapter XI, DOE Order 5480.1B (DOE 1986)
- "Air Contaminants - Permissible Exposure Limits," in 29 CFR 1910.1000
- *Threshold Limit Values and Biological Exposure Indices for 1990-1991* (ACGIH 1991)
- *Occupational Safety and Health Standards*, 29 CFR 1910.1000
- *Pocket Guide to Chemical Hazards* (NIOSH 1991), which provides National Institute of Occupational Safety and Health (NIOSH)-recommended exposure limits for substances that do not have either a threshold limit value or a permissible exposure limit.

5.1 AIRBORNE RADIOACTIVE AND RADIATION MONITORING

An onsite health physics technician will monitor airborne radioactive contamination levels and external radiation levels. Action levels will be consistent with derived air concentrations and applicable guidelines as specified in the radiation protection manual WHC-CM-4-10 (WHC 1988).

Appropriate respiratory protection shall be required when conditions are such that the airborne contamination levels may exceed an eight-hour derived air concentration (e.g., the presence of high levels of uncontained, loose contamination on exposed surfaces or operations that may raise excessive levels of dust contaminated with airborne radioactive materials, such as excavation or drilling under extremely dry conditions).

Specific conditions requiring the use of respiratory protection because of radioactive materials in air will be incorporated into the RWP. If, in the judgement of the health physics technician, any of these conditions arise, work shall cease until appropriate respiratory protection is provided.

6.0 PERSONAL PROTECTIVE EQUIPMENT

The level of personal protective equipment required initially at a site will be specified in the site-specific safety document for each task or group of tasks. Personal protective clothing and respiratory protection shall be selected to limit exposure to anticipated chemical and radiological hazards. Work practices and engineering controls may be used to control exposure.

7.0 SITE CONTROL

The field team leader, site safety officer, and health physics technician are designated to coordinate access control and security on the site. Special site control measures will be necessary to restrict public access. The zones will be clearly marked with rope and/or appropriate signs. The size and shape of the control zone will be dictated by the types of hazards expected, the climatic conditions, and specific operations required.

Control zone boundaries may be increased or decreased based on results of field monitoring, environmental changes, or work technique changes. The site RWP and the contractor's standard operating procedures for radiation protection may also dictate the boundary size and shape. All team members must be surveyed for radioactive contamination when leaving the controlled zone if in a radiation zone.

The onsite command post and staging area will be established near the upwind side of the control zone as determined by an onsite windsock. Exact location for the command post is to be determined just before start of work. Vehicle access, availability of utilities (power and telephone), wind direction, and proximity to sample locations should be considered in establishing a command post location.

8.0 DECONTAMINATION PROCEDURES

Remedial investigation activities will require entry into areas of known chemical and radiological contamination. Consequently, it is possible that personnel and equipment could be contaminated with hazardous chemical and radiological substances.

During site activities, potential sources of contamination may include airborne vapors, gases, dust, mists, and aerosols; splashes and spills; walking through contaminated areas; and handling contaminated equipment. Personnel who enter the exclusion zone will be required to go through the appropriate decontamination procedures on leaving the zone. Decontamination procedures shall be consistent with EII 5.4, "Field Decontamination of Drilling, Well Development, and Sampling Equipment," and EII 5.5, "Decontamination of Equipment for RCRA/CERCLA Sampling" (WHC 1991), or other approved decontamination procedures.

9.0 CONTINGENCY AND EMERGENCY RESPONSE PLANS

As a general rule, in the event of an unanticipated, potentially hazardous situation indicated by instrument readings, visible contamination, unusual or excessive odors, or other indications, team members shall temporarily cease operations and move upwind to a predesignated safe area as specified in the site-specific safety documentation.

10.0 REFERENCES

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